



# Kathir College of Engineering

[An Autonomous Institution | Approved by AICTE | Affiliated to Anna University | Accredited by NAAC with 'A+' Grade]

Wisdom Tree, Avinashi Road, Neelambur, Coimbatore 641062

## REGULATION 2024

## DEPARTMENT OF COMPUTER AND COMMUNICATION ENGINEERING

**DEPARTMENT OF COMPUTER AND COMMUNICATION ENGINEERING****Vision**

To equip students to contribute in the fields of Computing and Communication Engineering by addressing real-world emergent needs through the convergence of cutting-edge technologies, innovation, collaboration, and societal needs.

**Mission**

- To provide a robust educational foundation in Computer Science and Communication Engineering principles with hands-on experience, keeping pace with scientific advancements.
- To drive technological progress, educate future leaders, engage with industry and community, promote sustainable practices, and address global challenges.
- To acquire knowledge, endorse diversity and inclusion within the field for ethical practices with keen edge to leadership.

**PROGRAM EDUCATIONAL OBJECTIVES (PEOs)**

|             | <b>Graduates</b>                                                                                                                                                                                                 |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>PEO1</b> | Will contribute to technological innovation and effectively solve engineering problems by leveraging their analytical skills, creativity, and comprehensive understanding of Computer and Communication systems. |
| <b>PEO2</b> | Will conduct cutting edge research, commit to lifelong learning to stay current with emerging technologies and methodologies and develop solutions on problems of social relevance.                              |
| <b>PEO3</b> | Will demonstrate a commitment to professional ethics, social responsibility, and sustainability in their engineering practices.                                                                                  |

**KNOWLEDGE AND ATTITUDE PROFILE (WK)**

| <b>WK</b> | <b>Knowledge and Attitude Profile</b>                                                                                                                                                                                                                                                            |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| WK1       | A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.                                                                                                                                                         |
| WK2       | Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.                                                                                    |
| WK3       | A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.                                                                                                                                                                                       |
| WK4       | Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.                                                                                         |
| WK5       | Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.                                                                             |
| WK6       | Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.                                                                                                                                                                                              |
| WK7       | Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.                                                                            |
| WK8       | Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.                                                                                                        |
| WK9       | Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes. |

**PROGRAM OUTCOMES (POs)**

| <b>PO</b> | <b>Program Outcome</b>                                                                                                                                                                                                                                                                                                 |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1         | <b>Engineering knowledge:</b> Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.                                                               |
| 2         | <b>Problem analysis:</b> Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)                                                                                                      |
| 3         | <b>Design/development of solutions:</b> Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5) |
| 4         | <b>Conduct investigations of complex problems:</b> Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).                                                            |
| 5         | <b>Engineering tool usage:</b> Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)                                                                     |
| 6         | <b>The Engineer and The World:</b> Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).                                       |
| 7         | <b>Ethics:</b> Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)                                                                                                                                                       |
| 8         | <b>Individual and Collaborative Team work:</b> Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.                                                                                                                                                                   |
| 9         | <b>Communication:</b> Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences                      |
| 10        | <b>Project management and finance:</b> Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.                                          |
| 11        | <b>Life-long learning:</b> Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)                                                  |

**PROGRAM SPECIFIC OUTCOMES (PSOs)**

|             | <b>The Students will be able</b>                                                                                                                                                                                                   |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>PSO1</b> | To lead through strong theoretical foundation to excellence and excitement towards research, to provide innovative solutions to complex problems.                                                                                  |
| <b>PSO2</b> | To integrate knowledge from Computer Engineering and Communication technologies, to address complex problems in diverse specialized fields.                                                                                        |
| <b>PSO3</b> | To design, implement, and integrate computer systems and communication networks to solve real-world problems by exhibiting design and programming skills to build and automate business solutions using cutting edge technologies. |

**CURRICULUM (APPLICABLE FOR STUDENTS ADMITTED FROM 2024-2025)**

| <b>SEMESTER I</b>           |                    |                                      |                 |                         |                |                |                 |
|-----------------------------|--------------------|--------------------------------------|-----------------|-------------------------|----------------|----------------|-----------------|
| <b>S No.</b>                | <b>Course Code</b> | <b>Course</b>                        | <b>L/T/P</b>    | <b>Contact hrs/week</b> | <b>Credits</b> | <b>Ext/Int</b> | <b>Category</b> |
| <b>THEORY</b>               |                    |                                      |                 |                         |                |                |                 |
| 1                           | 24MA211            | Matrices and Calculus                | 3/1/0           | 4                       | 4              | 60/40          | BS              |
| 2                           | 24CS312            | Programming in C                     | 3/0/0           | 3                       | 3              | 60/40          | PC              |
| <b>THEORY CUM PRACTICAL</b> |                    |                                      |                 |                         |                |                |                 |
| 3                           | 24HS114            | Technical English                    | 2/0/2           | 4                       | 3              | 40/60          | HS              |
| 4                           | 24AC213            | Chemistry for Computing Sciences     | 3/0/2           | 5                       | 4              | 40/60          | BS              |
| 5                           | 24EG315            | Engineering Graphics                 | 1/0/4           | 5                       | 3              | 40/60          | ES              |
| <b>PRACTICAL</b>            |                    |                                      |                 |                         |                |                |                 |
| 6                           | 24CS316            | Programming in C laboratory          | 0/0/4           | 4                       | 2              | 40/60          | PC              |
| 7                           | 24EP315            | Engineering Practices Laboratory     | 0/0/4           | 4                       | 2              | 40/60          | ES              |
| <b>MANDATORY</b>            |                    |                                      |                 |                         |                |                |                 |
| 8                           | 24MC901            | Mandatory Course I Induction Program | 3 Weeks Program |                         | 0              | 0              | MC              |
| <b>Total</b>                |                    |                                      | <b>12/1/16</b>  | <b>29</b>               | <b>21</b>      | <b>700</b>     |                 |

| <b>SEMESTER II</b>          |                    |                                                 |               |                         |                |                |                 |
|-----------------------------|--------------------|-------------------------------------------------|---------------|-------------------------|----------------|----------------|-----------------|
| <b>S No.</b>                | <b>Course Code</b> | <b>Course</b>                                   | <b>L/T/P</b>  | <b>Contact hrs/week</b> | <b>Credits</b> | <b>Ext/Int</b> | <b>Category</b> |
| <b>THEORY</b>               |                    |                                                 |               |                         |                |                |                 |
| 1                           | 24MA221            | Differential Equations and Complex Functions    | 3/1/0         | 4                       | 4              | 60/40          | BS              |
| 2                           | 24CS423            | Object Oriented Programming and Java            | 3/0/0         | 3                       | 3              | 60/40          | PC              |
| 3                           | 24EE312            | Basic Electrical and Electronics Engineering    | 3/0/0         | 3                       | 3              | 60/40          | ES              |
| <b>THEORY CUM PRACTICAL</b> |                    |                                                 |               |                         |                |                |                 |
| 4                           | 24HS124            | Professional English                            | 2/0/2         | 4                       | 3              | 40/60          | HS              |
| 5                           | 24AP225            | Physics for Computing Sciences                  | 3/0/2         | 5                       | 4              | 40/60          | BS              |
| <b>PRACTICAL</b>            |                    |                                                 |               |                         |                |                |                 |
| 6                           | 24CS427            | Object Oriented Programming and Java Laboratory | 0/0/4         | 4                       | 2              | 40/60          | PC              |
| <b>MANDATORY</b>            |                    |                                                 |               |                         |                |                |                 |
| 7                           | 24MC902            | Mandatory Course II Heritage of Tamils          | 2/0/0         | 2                       | 0              | -              | MC              |
| <b>Total</b>                |                    |                                                 | <b>16/1/8</b> | <b>25</b>               | <b>19</b>      | <b>600</b>     |                 |

| <b>SEMESTER III</b>         |                    |                                                                  |                |                         |                |                |                 |
|-----------------------------|--------------------|------------------------------------------------------------------|----------------|-------------------------|----------------|----------------|-----------------|
| <b>S No.</b>                | <b>Course Code</b> | <b>Course</b>                                                    | <b>L/T/P</b>   | <b>Contact hrs/week</b> | <b>Credits</b> | <b>Ext/Int</b> | <b>Category</b> |
| <b>THEORY</b>               |                    |                                                                  |                |                         |                |                |                 |
| 1                           | 24MA232            | Transforms and Partial Differential Equations                    | 3/1/0          | 4                       | 4              | 60/40          | BS              |
| 2                           | 24EC335            | Fundamentals of Signals and Systems                              | 3/1/0          | 4                       | 4              | 60/40          | PC              |
| 3                           | 24CS433            | Python Programming                                               | 3/0/0          | 3                       | 3              | 60/40          | PC              |
| 4                           | 24CC336            | Data Structures and Algorithms                                   | 3/0/0          | 3                       | 3              | 60/40          | PC              |
| <b>THEORY CUM PRACTICAL</b> |                    |                                                                  |                |                         |                |                |                 |
| 5                           | 24AD332            | Foundations of Data Science                                      | 3/0/2          | 5                       | 4              | 40/60          | ES              |
| 6                           | 24EC336            | Digital Principles and Computer Organization                     | 3/0/2          | 5                       | 4              | 40/60          | ES              |
| <b>PRACTICAL</b>            |                    |                                                                  |                |                         |                |                |                 |
| 7                           | 24CS437            | Python Programming Laboratory                                    | 0/0/4          | 4                       | 2              | 40/60          | PC              |
| 8                           | 24CC339            | Data Structures and Algorithms Laboratory                        | 0/0/4          | 4                       | 2              | 40/60          | PC              |
| <b>MANDATORY</b>            |                    |                                                                  |                |                         |                |                |                 |
| 9                           | 24MC903            | Mandatory Course III<br>Environmental Science and Sustainability | 2/0/0          | 2                       | 0              | -              | MC              |
| <b>Total</b>                |                    |                                                                  | <b>20/2/12</b> | <b>34</b>               | <b>26</b>      | <b>800</b>     |                 |

| <b>SEMESTER IV</b>          |                    |                                                                 |               |                         |                |                |                 |
|-----------------------------|--------------------|-----------------------------------------------------------------|---------------|-------------------------|----------------|----------------|-----------------|
| <b>S No.</b>                | <b>Course Code</b> | <b>Course</b>                                                   | <b>L/T/P</b>  | <b>Contact hrs/week</b> | <b>Credits</b> | <b>Ext/Int</b> | <b>Category</b> |
| <b>THEORY</b>               |                    |                                                                 |               |                         |                |                |                 |
| 1                           | 24MA243            | Probability and Random Processes                                | 3/1/0         | 4                       | 4              | 60/40          | BS              |
| 2                           | 24CC432            | Database Management Systems                                     | 3/0/0         | 3                       | 3              | 60/40          | PC              |
| 3                           | 24CS442            | Operating Systems                                               | 3/0/0         | 3                       | 3              | 60/40          | PC              |
| <b>THEORY CUM PRACTICAL</b> |                    |                                                                 |               |                         |                |                |                 |
| 4                           | 24EC445            | Digital Signal Processing and Applications                      | 3/0/2         | 5                       | 4              | 40/60          | PC              |
| 5                           | 24CC445            | Communication Theory                                            | 3/0/2         | 5                       | 4              | 40/60          | PC              |
| <b>PRACTICAL</b>            |                    |                                                                 |               |                         |                |                |                 |
| 6                           | 24CC436            | Database Management Systems Laboratory                          | 0/0/4         | 4                       | 2              | 40/60          | PC              |
| <b>MANDATORY</b>            |                    |                                                                 |               |                         |                |                |                 |
| 7                           | 24MC904            | Mandatory Course IV<br>Introduction to Women and Gender Studies | 2/0/0         | 2                       | 0              | -              | MC              |
| <b>Total</b>                |                    |                                                                 | <b>17/1/8</b> | <b>26</b>               | <b>20</b>      | <b>600</b>     |                 |

| SEMESTER V                  |             |                                                         |                |                  |           |            |          |
|-----------------------------|-------------|---------------------------------------------------------|----------------|------------------|-----------|------------|----------|
| S No.                       | Course Code | Course                                                  | L/T/P          | Contact hrs/week | Credits   | Ext/Int    | Category |
| <b>THEORY</b>               |             |                                                         |                |                  |           |            |          |
| 1                           | 24AM351     | Artificial Intelligence and Machine Learning            | 3/0/0          | 3                | 3         | 60/40      | ES       |
| 2                           | 24XX5XX     | Professional Elective I                                 | 3/0/0          | 3                | 3         | 60/40      | PE       |
| 3                           | 24OE6XX     | Open Elective I                                         | 3/0/0          | 3                | 3         | 60/40      | OE       |
| <b>THEORY CUM PRACTICAL</b> |             |                                                         |                |                  |           |            |          |
| 4                           | 24CC444     | Digital Communication Techniques                        | 3/0/2          | 5                | 4         | 40/60      | PC       |
| 5                           | 24CS456     | Computer Networks                                       | 3/0/2          | 5                | 4         | 40/60      | PC       |
| 6                           | 24CC456     | Wireless Communication                                  | 3/0/2          | 5                | 4         | 40/60      | PC       |
| <b>PRACTICAL</b>            |             |                                                         |                |                  |           |            |          |
| 7                           | 24AM357     | Artificial Intelligence and Machine Learning Laboratory | 0/0/4          | 4                | 2         | 40/60      | ES       |
| <b>Total</b>                |             |                                                         | <b>18/0/10</b> | <b>28</b>        | <b>23</b> | <b>700</b> |          |

| SEMESTER VI                 |             |                                    |               |                  |           |            |          |
|-----------------------------|-------------|------------------------------------|---------------|------------------|-----------|------------|----------|
| S No.                       | Course Code | Course                             | L/T/P         | Contact hrs/week | Credits   | Ext/Int    | Category |
| <b>THEORY</b>               |             |                                    |               |                  |           |            |          |
| 1                           | 24MB151     | Principles of Management           | 3/0/0         | 3                | 3         | 60/40      | HS       |
| 2                           | 24CC462     | Mobile Communication               | 3/0/0         | 3                | 3         | 60/40      | PC       |
| 3                           | 24XX5XX     | Professional Elective II           | 3/0/0         | 3                | 3         | 60/40      | PE       |
| 4                           | 24OE6XX     | Open Elective II                   | 3/0/0         | 3                | 3         | 60/40      | OE       |
| 5                           | 24OE6XX     | Open Elective III                  | 3/0/0         | 3                | 3         | 60/40      | OE       |
| <b>THEORY CUM PRACTICAL</b> |             |                                    |               |                  |           |            |          |
| 6                           | 24CS466     | Software Engineering Methodologies | 3/0/2         | 5                | 4         | 40/60      | ES       |
| 7                           | 24AD467     | Big Data Analytics                 | 3/0/2         | 5                | 4         | 40/60      | ES       |
| <b>INTERNSHIP</b>           |             |                                    |               |                  |           |            |          |
| 8                           | 24CC861     | Internship                         | 0/0/0         | 0                | 2         | 0/100      | IP       |
| <b>Total</b>                |             |                                    | <b>21/0/4</b> | <b>25</b>        | <b>25</b> | <b>800</b> |          |

| SEMESTER VII                |             |                                         |               |                  |           |            |          |
|-----------------------------|-------------|-----------------------------------------|---------------|------------------|-----------|------------|----------|
| S No.                       | Course Code | Course                                  | L/T/P         | Contact hrs/week | Credits   | Ext/Int    | Category |
| <b>THEORY</b>               |             |                                         |               |                  |           |            |          |
| 1                           | 24HS171     | Human Values and Ethics                 | 2/0/0         | 2                | 2         | 60/40      | HS       |
| 2                           | 24CC472     | Cryptography and Cyber Security         | 3/0/0         | 3                | 3         | 60/40      | PC       |
| 3                           | 24CS373     | Distributed Computing                   | 3/0/0         | 3                | 3         | 60/40      | PC       |
| 4                           | 24XX5XX     | Professional Elective III               | 3/0/0         | 3                | 3         | 60/40      | PE       |
| 5                           | 24XX5XX     | Professional Elective IV                | 3/0/0         | 3                | 3         | 60/40      | PE       |
| 6                           | 24XX5XX     | Professional Elective V                 | 3/0/0         | 3                | 3         | 60/40      | PE       |
| 7                           | 24OE6XX     | Open Elective IV                        | 3/0/0         | 3                | 3         | 60/40      | OE       |
| <b>THEORY CUM PRACTICAL</b> |             |                                         |               |                  |           |            |          |
| 8                           | 24EC366     | Embedded Systems and Internet of Things | 3/0/2         | 5                | 4         | 40/60      | ES       |
| <b>Total</b>                |             |                                         | <b>23/0/2</b> | <b>25</b>        | <b>24</b> | <b>800</b> |          |

| SEMESTER VIII |             |              |               |                  |           |            |          |
|---------------|-------------|--------------|---------------|------------------|-----------|------------|----------|
| S No.         | Course Code | Course       | L/T/P         | Contact hrs/week | Credits   | Ext/Int    | Category |
| 1.            | 24CC781     | Project Work | 0/0/24        | 24               | 12        | 40/60      | PW       |
| <b>Total</b>  |             |              | <b>0/0/24</b> | <b>24</b>        | <b>12</b> | <b>100</b> |          |

**HUMANITIES SCIENCES (11 Credits)**

| S. No | Course Code | Course Title             | L/T/P | Contact Hrs/Wk | Credits |
|-------|-------------|--------------------------|-------|----------------|---------|
| 1.    | 24HS114     | Technical English        | 2/0/2 | 4              | 3       |
| 2.    | 24HS124     | Professional English     | 2/0/2 | 4              | 3       |
| 3.    | 24MB151     | Principles of Management | 3/0/0 | 3              | 3       |
| 4.    | 24HS171     | Human Values and Ethics  | 2/0/0 | 2              | 2       |

**BASIC SCIENCES (24 Credits)**

| S. No | Course Code | Course Title                                  | L/T/P | Contact Hrs/Wk | Credits |
|-------|-------------|-----------------------------------------------|-------|----------------|---------|
| 1.    | 24MA211     | Matrices and Calculus                         | 3/1/0 | 4              | 4       |
| 2.    | 24AP213     | Physics for Computing Sciences                | 3/0/2 | 5              | 4       |
| 3.    | 24MA221     | Differential Equations and Complex Functions  | 3/1/0 | 4              | 4       |
| 4.    | 24AC213     | Chemistry for Computing Sciences              | 3/0/2 | 5              | 4       |
| 5.    | 24MA232     | Transforms and Partial Differential Equations | 3/1/0 | 4              | 4       |
| 6.    | 24MA243     | Probability and Random Processes              | 3/1/0 | 4              | 4       |

**ENGINEERING SCIENCES (33 Credits)**

| S. No | Course Code | Course Title                                            | L/T/P | Contact Hrs/Wk | Credits |
|-------|-------------|---------------------------------------------------------|-------|----------------|---------|
| 1.    | 24EE312     | Basic Electrical and Electronics Engineering            | 3/0/0 | 3              | 3       |
| 2.    | 24EP315     | Engineering Practices Laboratory                        | 0/0/4 | 4              | 2       |
| 3.    | 24EG315     | Engineering Graphics                                    | 1/0/4 | 5              | 3       |
| 4.    | 24AD332     | Foundations of Data Science                             | 3/0/2 | 5              | 4       |
| 5.    | 24EC336     | Digital Principles and Computer Organization            | 3/0/2 | 5              | 4       |
| 6.    | 24AM451     | Artificial Intelligence and Machine Learning            | 3/0/0 | 3              | 3       |
| 7.    | 24AM357     | Artificial Intelligence and Machine Learning Laboratory | 0/0/4 | 4              | 2       |
| 8.    | 24CS466     | Software Engineering Methodologies                      | 3/0/2 | 5              | 4       |
| 9.    | 24EC366     | Embedded Systems and Internet of Things                 | 3/0/2 | 5              | 4       |
| 10.   | 24AD467     | Big Data Analytics                                      | 3/0/2 | 5              | 4       |

**PROGRAM CORE (61 Credits)**

| S. No | Course Code | Course Title                                    | L/T/P | Contact Hrs/Wk | Credits |
|-------|-------------|-------------------------------------------------|-------|----------------|---------|
| 1.    | 24CS312     | Programming in C                                | 3/0/0 | 3              | 3       |
| 2.    | 24CS316     | Programming in C Laboratory                     | 0/0/4 | 4              | 2       |
| 3.    | 24CS423     | Object Oriented Programming and Java            | 3/0/0 | 3              | 3       |
| 4.    | 24CS427     | Object Oriented Programming and Java Laboratory | 0/0/4 | 4              | 2       |
| 5.    | 24CS433     | Python Programming                              | 3/0/0 | 3              | 3       |
| 6.    | 24EC335     | Fundamentals of Signals and Systems             | 3/1/0 | 4              | 4       |
| 7.    | 24CS345     | Operating Systems                               | 3/0/0 | 3              | 3       |
| 8.    | 24CS437     | Python Programming Laboratory                   | 0/0/4 | 4              | 2       |
| 9.    | 24CC432     | Database management Systems                     | 3/0/0 | 3              | 3       |
| 10.   | 24CS336     | Data Structures and Algorithms                  | 3/0/2 | 5              | 4       |
| 11.   | 24CS339     | Data Structures and Algorithms Laboratory       | 0/0/4 | 4              | 2       |
| 12.   | 24EC445     | Digital Signal Processing and Applications      | 3/0/2 | 5              | 4       |
| 13.   | 24CC445     | Communication Theory                            | 3/0/2 | 5              | 4       |
| 14.   | 24CC436     | Database Management Systems Laboratory          | 0/0/4 | 4              | 2       |
| 15.   | 24CC444     | Digital Communication Techniques                | 3/0/2 | 5              | 4       |
| 16.   | 24CS456     | Computer Networks                               | 3/0/2 | 5              | 4       |
| 17.   | 24CC456     | Wireless Communication                          | 3/0/2 | 5              | 4       |
| 18.   | 24CC472     | Cryptography and Cyber Security                 | 3/0/0 | 3              | 3       |
| 19.   | 24CS373     | Distributed Computing                           | 3/0/0 | 3              | 3       |
| 20.   | 24CC462     | Mobile Communication                            | 3/0/0 | 3              | 3       |

**INDUSTRY PRACTICES (2 Credits)**

| S. No | Course Code | Course Title | L/T/P | Contact Hrs/Wk | Credits |
|-------|-------------|--------------|-------|----------------|---------|
| 1.    | 24CC861     | Internship   | 0/0/0 | 0              | 2       |

**PROJECT WORK (12 Credits)**

| S. No | Course Code | Course Title | L/T/P  | Contact Hrs/Wk | Credits |
|-------|-------------|--------------|--------|----------------|---------|
| 1.    | 24CC781     | Project Work | 0/0/24 | 24             | 12      |

**PROFESSIONAL ELECTIVE COURSES (15 Credits)**

| Vertical I                         | Vertical II                         | Vertical III                                        | Vertical IV                              | Vertical V                                 |
|------------------------------------|-------------------------------------|-----------------------------------------------------|------------------------------------------|--------------------------------------------|
| <b>ANALYTICS ENGINEERING</b>       | <b>FULL STACK DEVELOPMENT</b>       | <b>CLOUD COMPUTING AND DATA CENTER TECHNOLOGIES</b> | <b>EMERGING TECHNOLOGIES</b>             | <b>COMMUNICATIONS</b>                      |
| Exploratory Data Analysis          | Web Technology                      | Cloud Computing Essentials                          | Augmented Reality/Virtual Reality        | Optical Communication and Networks         |
| Image and Video Analytics          | App Development                     | Cloud Services Management                           | Robotic Process Automation               | Advanced Wireless Communication Techniques |
| Healthcare Analytics               | Software Testing and Automation     | Virtualization                                      | Neural Networks and Deep Learning        | Wireless Broad Band Networks               |
| Text and Speech Analysis           | Web Application Security            | Security and Privacy in Cloud                       | Cryptocurrency and Blockchain Technology | Telecommunication Switching and Networks   |
| Business Analytics                 | Principles of Programming Languages | Storage Technology                                  | Video Creation and Editing               | Vehicular Networks                         |
| Ethics and Artificial Intelligence | Advanced Databases                  | Stream Processing                                   | Digital Marketing                        | Software Defined Networks                  |

**PROFESSIONAL ELECTIVE COURSES (15 Credits)**

| S. No                                               | Course Code | Course Title                        | L/T/P | Contact Hrs/Wk | Credits |
|-----------------------------------------------------|-------------|-------------------------------------|-------|----------------|---------|
| <b>ANALYTICS ENGINEERING</b>                        |             |                                     |       |                |         |
| 1.                                                  | 24AD501     | Exploratory Data Analysis           | 3/0/0 | 3              | 3       |
| 2.                                                  | 24AD502     | Image and Video Analytics           | 3/0/0 | 3              | 3       |
| 3.                                                  | 24AD503     | Healthcare Analytics                | 3/0/0 | 3              | 3       |
| 4.                                                  | 24AD504     | Text and Speech Analysis            | 3/0/0 | 3              | 3       |
| 5.                                                  | 24AD505     | Business Analytics                  | 3/0/0 | 3              | 3       |
| 6.                                                  | 24AD506     | Ethics and Artificial Intelligence  | 3/0/0 | 3              | 3       |
| <b>FULL STACK DEVELOPMENT</b>                       |             |                                     |       |                |         |
| 7.                                                  | 24CC501     | Web Technology                      | 3/0/0 | 3              | 3       |
| 8.                                                  | 24CC502     | App Development                     | 3/0/0 | 3              | 3       |
| 9.                                                  | 24CC503     | Software Testing and Automation     | 3/0/0 | 3              | 3       |
| 10.                                                 | 24CC504     | Web Application Security            | 3/0/0 | 3              | 3       |
| 11.                                                 | 24CC505     | Principles of Programming Languages | 3/0/0 | 3              | 3       |
| 12.                                                 | 24CC506     | Advanced Databases                  | 3/0/0 | 3              | 3       |
| <b>CLOUD COMPUTING AND DATA CENTER TECHNOLOGIES</b> |             |                                     |       |                |         |
| 13.                                                 | 24CS501     | Cloud Computing Essentials          | 3/0/0 | 3              | 3       |
| 14.                                                 | 24CS502     | Cloud Services Management           | 3/0/0 | 3              | 3       |
| 15.                                                 | 24CS503     | Virtualization                      | 3/0/0 | 3              | 3       |
| 16.                                                 | 24CS504     | Security and Privacy in Cloud       | 3/0/0 | 3              | 3       |
| 17.                                                 | 24CS505     | Storage Technology                  | 3/0/0 | 3              | 3       |
| 18.                                                 | 24CS506     | Stream Processing                   | 3/0/0 | 3              | 3       |

| <b>EMERGING TECHNOLOGIES</b> |         |                                            |       |   |   |
|------------------------------|---------|--------------------------------------------|-------|---|---|
| 19.                          | 24AD508 | Augmented Reality/Virtual Reality          | 3/0/0 | 3 | 3 |
| 20.                          | 24AD509 | Robotic Process Automation                 | 3/0/0 | 3 | 3 |
| 21.                          | 24AM505 | Neural Networks and Deep Learning          | 3/0/0 | 3 | 3 |
| 22.                          | 24AM501 | Cryptocurrency and Blockchain Technology   | 3/0/0 | 3 | 3 |
| 23.                          | 24AM502 | Video Creation and Editing                 | 3/0/0 | 3 | 3 |
| 24.                          | 24AM503 | Digital Marketing                          | 3/0/0 | 3 | 3 |
| <b>COMMUNICATIONS</b>        |         |                                            |       |   |   |
| 25.                          | 24CC511 | Optical Communication and Networks         | 3/0/0 | 3 | 3 |
| 26.                          | 24CC512 | Advanced Wireless Communication Techniques | 3/0/0 | 3 | 3 |
| 27.                          | 24CC513 | Wireless Broad Band Networks               | 3/0/0 | 3 | 3 |
| 28.                          | 24CC514 | Telecommunication Switching and Networks   | 3/0/0 | 3 | 3 |
| 29.                          | 24CC515 | Vehicular Networks                         | 3/0/0 | 3 | 3 |
| 30.                          | 24EC521 | Software Defined Networks                  | 3/0/0 | 3 | 3 |

**OPEN ELECTIVE COURSES (12 Credits)**

| S. No | Course Code | Course Title                 | L/T/P | Contact Hrs/Wk | Credits |
|-------|-------------|------------------------------|-------|----------------|---------|
| 1.    | 24OE611     | Database Fundamentals        | 3/0/0 | 3              | 3       |
| 2.    | 24OE612     | Basics of Image Processing   | 3/0/0 | 3              | 3       |
| 3.    | 24OE613     | Vehicular Ad hoc Networks    | 3/0/0 | 3              | 3       |
| 4.    | 24OE614     | Web Technology Fundamentals  | 3/0/0 | 3              | 3       |
| 5.    | 24OE615     | App development Fundamentals | 3/0/0 | 3              | 3       |

**MANDATORY COURSES (Non-Credit)**

| S. No | Course Code | Course Title                             | Category |
|-------|-------------|------------------------------------------|----------|
| 1.    | 24MC901     | Induction Program                        | MC       |
| 2.    | 24MC902     | Heritage of Tamils                       | MC       |
| 3.    | 24MC903     | Environmental Science and Sustainability | MC       |
| 4.    | 24MC904     | Introduction to Women and Gender Studies | MC       |

**SCHEME OF CREDIT DISTRIBUTION – SUMMARY**

| Stream                      | Credits/Semester |           |           |           |           |           |           |           | KCE Credits | KCE%  | AICTE Credits (CSE 2022) | AICTE % (CSE 2022) |
|-----------------------------|------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-------------|-------|--------------------------|--------------------|
|                             | I                | II        | III       | IV        | V         | VI        | VII       | VIII      |             |       |                          |                    |
| Humanities (HS)             | 3                | 3         |           |           |           | 3         | 2         |           | 11          | 6.47  | 16                       | 9.82               |
| Basic Sciences(BS)          | 8                | 8         | 4         | 4         |           |           |           |           | 24          | 14.12 | 23                       | 14.11              |
| Engineering Sciences(ES)    | 5                | 3         | 8         |           | 5         | 8         | 4         |           | 33          | 19.41 | 29                       | 17.89              |
| Program Core(PC)            | 5                | 5         | 14        | 16        | 12        | 3         | 6         |           | 61          | 35.88 | 59                       | 36.20              |
| Professional Electives (PE) |                  |           |           |           | 3         | 3         | 9         |           | 15          | 8.82  | 12                       | 7.36               |
| Open Electives(OE)          |                  |           |           |           | 3         | 6         | 3         |           | 12          | 7.06  | 9                        | 5.52               |
| Project Work(PW)            |                  |           |           |           |           |           |           | 12        | 12          | 7.06  | 15                       | 9.2                |
| Industry Practices (IP)     |                  |           |           |           |           | 2         |           |           | 2           | 1.18  |                          |                    |
| Mandatory Course (MC)       | -                | -         | -         | -         | 0         | 0         | 0         | 0         | -           | 0.00  | -                        | -                  |
| <b>Total</b>                | <b>21</b>        | <b>19</b> | <b>26</b> | <b>20</b> | <b>23</b> | <b>25</b> | <b>24</b> | <b>12</b> | <b>170</b>  |       | 163                      |                    |

\* Minor variations are permitted by AICTE based on the need

**SCHEME OF COURSE DISTRIBUTION – SUMMARY**

| Stream                     | No. of Courses |          |          |          |          |          |          |          | Total No. of courses |
|----------------------------|----------------|----------|----------|----------|----------|----------|----------|----------|----------------------|
|                            | I              | II       | III      | IV       | V        | VI       | VII      | VIII     |                      |
| Humanities (HS)            | 1              | 1        |          |          |          | 1        | 1        |          | 4                    |
| Basic Sciences(BS)         | 2              | 2        | 1        | 1        |          |          |          |          | 6                    |
| Engineering Sciences(ES)   | 2              | 1        | 2        |          | 2        | 2        | 1        |          | 10                   |
| Program Core(PC)           | 2              | 2        | 5        | 5        | 3        | 1        | 2        |          | 20                   |
| Professional Electives(PE) |                |          |          |          | 1        | 1        | 3        |          | 5                    |
| Open Electives(OE)         |                |          |          |          | 1        | 2        | 1        |          | 4                    |
| Project Work(PW)           |                |          |          |          |          |          |          | 1        | 1                    |
| Mandatory Course (MC)      | 1              | 1        | 1        | 1        |          |          |          |          | 4                    |
| Industry Practices (IP)    |                |          |          |          |          | 1        |          |          | 1                    |
| <b>Total</b>               | <b>8</b>       | <b>7</b> | <b>9</b> | <b>7</b> | <b>7</b> | <b>8</b> | <b>8</b> | <b>1</b> | <b>55</b>            |

## SEMESTER V - VI

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Course Name                                                            | Category               | Hours/Week                |   |   | C    |   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|------------------------|---------------------------|---|---|------|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                        |                        | L                         | T | P |      |   |
| 24AM351                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Artificial Intelligence and Machine Learning                           | EC                     | 3                         | 0 | 0 | 3    |   |
| Regulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Nature of the Course                                                   | Semester               | Data Book/Codes/Standards |   |   |      |   |
| 2024                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Theory                                                                 | V                      | -                         |   |   |      |   |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                        | Co-requisite Course(s) |                           |   |   |      |   |
| Foundations of Data Science, Python Programming                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                        | -                      |                           |   |   |      |   |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                        |                        |                           |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | To Study Basics of AI, Intelligent Agents and Problem solving          |                        |                           |   |   |      |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Apply the techniques of Knowledge Representation and Reasoning         |                        |                           |   |   |      |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Apply the Machine Learning and supervised learning algorithms          |                        |                           |   |   |      |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Construct the ensemble algorithms and unsupervised learning algorithms |                        |                           |   |   |      |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Understand the basics of deep learning using neural networks           |                        |                           |   |   |      |   |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                        |                        |                           |   |   |      |   |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                        |                        |                           |   |   |      |   |
| CO351.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Understand Basics of AI, Intelligent Agents and Problem solving        |                        |                           |   |   | [U]  |   |
| CO351.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Apply Knowledge Representation and Reasoning                           |                        |                           |   |   | [AP] |   |
| CO351.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Apply the supervised learning models                                   |                        |                           |   |   | [AP] |   |
| CO351.4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Apply ensemble learning and unsupervised models                        |                        |                           |   |   | [AP] |   |
| CO351.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Apply neural network models and understand deep learning               |                        |                           |   |   | [AP] |   |
| Course Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                        |                        |                           |   |   |      |   |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | INTELLIGENT AGENTS AND PROBLEM SOLVING                                 |                        |                           |   |   | CO1  | 9 |
| <b>Introduction to Artificial Intelligence</b> - Definition and applications of AI,<br><b>Intelligent Agents</b> - Agents and environments, Rational agents, PEAS description, Types of agents - Simple reflex agents, Model-based agents, Goal-based agents, Utility-based agents, Learning agents<br><b>Problem Solving by Search:</b> Problem formulation, State-space representation, Uninformed search -Breadth First Search , Depth First Search, Uniform Cost Search , Informed search - Best First Search, A* Search, Heuristic functions |                                                                        |                        |                           |   |   |      |   |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | KNOWLEDGE REPRESENTATION AND REASONING                                 |                        |                           |   |   | CO2  | 9 |
| <b>Knowledge-Based Agents</b> -Knowledge representation, Knowledge base, Inference mechanism, Knowledge engineering process<br><b>Propositional Logic</b> -Syntax and semantics, Logical connectives, Entailment, Inference rules<br><b>First Order Logic</b> – Predicates, Quantifiers, Representation of facts and relations<br><b>Reasoning</b> -Forward chaining, Backward chaining, Resolution concept<br><b>Reasoning Under Uncertainty</b> Probability fundamentals, Bayes theorem, Naïve Bayes classifier (Introduction)                  |                                                                        |                        |                           |   |   |      |   |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | SUPERVISED LEARNING                                                    |                        |                           |   |   | CO3  | 9 |
| Introduction to Machine Learning, Types of Machine Learning ; CART Algorithm<br><b>Regression:</b> Regression and its types, Performance Evaluation Metrics for Regression (MAE, MSE, RMSE, R <sup>2</sup> ).<br><b>Classification:</b> Logistic Regression, Decision Trees, Support Vector Machines, Performance Evaluation Metrics for Classification (Confusion Matrix, Accuracy, Precision, Recall, F1-Score).                                                                                                                                |                                                                        |                        |                           |   |   |      |   |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING                          |                        |                           |   |   | CO4  | 9 |
| <b>Combining multiple learners:</b> Model combination schemes ; <b>Ensemble Learning</b> - bagging, boosting, stacking,<br><b>Unsupervised learning:</b> K-means Clustering, <b>Instance Based Learning:</b> KNN, Basics of Expectation maximization                                                                                                                                                                                                                                                                                              |                                                                        |                        |                           |   |   |      |   |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | NEURAL NETWORKS AND DEEP LEARNING                                      |                        |                           |   |   | CO5  | 9 |
| <b>Artificial Neural Networks:</b> Introduction, Activation Functions, Perceptron, Multilayer Perceptron,                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                        |                        |                           |   |   |      |   |

|                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Backpropagation, Hyperparameter tuning, Batch normalization, Regularization,<br><b>Deep Learning fundamentals:</b> Convolutional Neural Networks, Applications of Deep Learning. |                                                                                                                                                                                                                                                                                                             |
| <b>Total Hours</b>                                                                                                                                                               | <b>45</b>                                                                                                                                                                                                                                                                                                   |
| <b>Textbooks:</b>                                                                                                                                                                |                                                                                                                                                                                                                                                                                                             |
| 1                                                                                                                                                                                | Stuart Russell and Peter Norvig, "Artificial Intelligence – A Modern Approach", Fourth Edition, Pearson Education, 2021.                                                                                                                                                                                    |
| 2                                                                                                                                                                                | Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Fourth Edition, 2020.                                                                                                                                                                                                                        |
| 3                                                                                                                                                                                | Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016                                                                                                                                                                                                                            |
| <b>Reference Books:</b>                                                                                                                                                          |                                                                                                                                                                                                                                                                                                             |
| 1                                                                                                                                                                                | Charu C. Aggarwal, "Data Classification Algorithms and Applications", CRC Press, 2014                                                                                                                                                                                                                       |
| 2                                                                                                                                                                                | Angular 6 for Enterprise-Ready Web Applications, Doguhan Uluca, Packt Publishing, 2022                                                                                                                                                                                                                      |
| 3                                                                                                                                                                                | Deepak Khemani, "Artificial Intelligence", Tata McGraw Hill Education, 2013 ( <a href="http://nptel.ac.in/">http://nptel.ac.in/</a> )                                                                                                                                                                       |
| <b>Web References:</b>                                                                                                                                                           |                                                                                                                                                                                                                                                                                                             |
| 1                                                                                                                                                                                | <a href="https://cdn-dynmedia-1.microsoft.com/is/content/microsoftcorp/microsoft/final/en-us/microsoft-brand/documents/2024-wttc-introduction-to-ai.pdf">https://cdn-dynmedia-1.microsoft.com/is/content/microsoftcorp/microsoft/final/en-us/microsoft-brand/documents/2024-wttc-introduction-to-ai.pdf</a> |
| 2                                                                                                                                                                                | <a href="https://www.ed.gov/sites/ed/files/documents/ai-report/ai-report.pdf">https://www.ed.gov/sites/ed/files/documents/ai-report/ai-report.pdf</a>                                                                                                                                                       |

| Assessment based on Continuous and End Semester Examination |                       |                |                      |            |            |                          |
|-------------------------------------------------------------|-----------------------|----------------|----------------------|------------|------------|--------------------------|
| BLOOM'S TAXONOMY LEVEL                                      | CONTINUOUS ASSESSMENT |                |                      | ASSIGNMENT | ATTENDANCE | END SEMESTER EXAMINATION |
|                                                             | CIA1 (6 Marks)        | CIA2 (6 Marks) | Model Exam (8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)               |
| Remember                                                    |                       |                |                      | 10         | 10         | 60                       |
| Understand                                                  | 20                    | 20             | 20                   |            |            |                          |
| Apply                                                       | 80                    | 80             | 80                   |            |            |                          |
| Analyze                                                     |                       |                |                      |            |            |                          |
| Evaluate                                                    |                       |                |                      |            |            |                          |
| Create                                                      |                       |                |                      |            |            |                          |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>       | <b>8</b>             | <b>10</b>  | <b>10</b>  | <b>60</b>                |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|
| C453.1      | 3    | 2    | 1    | -    | 1    | -    | -    | -    | -    | -     | -     | 2     | 2     |
| C453.2      | 2    | 2    | 3    | 1    | 3    | -    | -    | -    | 1    | -     | -     | 3     | 1     |
| C453.3      | 2    | 3    | 2    | 2    | 3    | -    | -    | -    | 1    | -     | -     | 3     | 1     |
| C453.4      | 2    | 2    | 3    | 2    | 3    | -    | -    | -    | 1    | 1     | -     | 2     | 2     |
| C453.5      | 2    | 2    | 3    | 2    | 3    | -    | -    | -    | 1    | 1     | 1     | 2     | 2     |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                     | Course Name                                                                                                   | Category               | Hours/Week                |   |     | C    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|-----|------|
|                                                                                                                                                                                                                                                                                 |                                                                                                               |                        | L                         | T | P   |      |
| 24CC444                                                                                                                                                                                                                                                                         | DIGITAL COMMUNICATION TECHNIQUES                                                                              | PC                     | 3                         | 0 | 2   | 4    |
| Regulation                                                                                                                                                                                                                                                                      | Nature of the Course                                                                                          | Semester               | Data Book/Codes/Standards |   |     |      |
| 2024                                                                                                                                                                                                                                                                            | THEORY CUM PRACTICAL                                                                                          | V                      | -                         |   |     |      |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                         |                                                                                                               | Co-requisite Course(s) |                           |   |     |      |
| DIGITAL PRINCIPLES AND COMPUTER ORGANIZATION                                                                                                                                                                                                                                    |                                                                                                               | -                      |                           |   |     |      |
| Course Objectives                                                                                                                                                                                                                                                               |                                                                                                               |                        |                           |   |     |      |
| 1                                                                                                                                                                                                                                                                               | To understand the theoretical limits established by Information Theory.                                       |                        |                           |   |     |      |
| 2                                                                                                                                                                                                                                                                               | To study various waveform coding methods.                                                                     |                        |                           |   |     |      |
| 3                                                                                                                                                                                                                                                                               | To learn the different baseband transmission techniques.                                                      |                        |                           |   |     |      |
| 4                                                                                                                                                                                                                                                                               | To understand the different bandpass signalling techniques.                                                   |                        |                           |   |     |      |
| 5                                                                                                                                                                                                                                                                               | To acquire knowledge of the fundamental principles of channel coding.                                         |                        |                           |   |     |      |
| Course Outcomes                                                                                                                                                                                                                                                                 |                                                                                                               |                        |                           |   |     |      |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                         |                                                                                                               |                        |                           |   |     |      |
| CC444.1                                                                                                                                                                                                                                                                         | Understand the principles of Information Theory to determine the theoretical limits of communication systems. |                        |                           |   |     | [U]  |
| CC444.2                                                                                                                                                                                                                                                                         | Understand various waveform coding methods and their characteristics.                                         |                        |                           |   |     | [U]  |
| CC444.3                                                                                                                                                                                                                                                                         | Apply different baseband transmission techniques for signal transmission.                                     |                        |                           |   |     | [AP] |
| CC444.4                                                                                                                                                                                                                                                                         | Apply the principles of bandpass signalling techniques.                                                       |                        |                           |   |     | [AP] |
| CC444.5                                                                                                                                                                                                                                                                         | Apply channel coding principles in designing reliable communication schemes.                                  |                        |                           |   |     | [AP] |
| Course Contents                                                                                                                                                                                                                                                                 |                                                                                                               |                        |                           |   |     |      |
| Unit – 1                                                                                                                                                                                                                                                                        | INFORMATION THEORY                                                                                            |                        |                           |   | CO1 | 9+6  |
| Discrete Memoryless source, Information, Entropy, Mutual Information - Discrete Memoryless channels – Binary Symmetric Channel, Channel Capacity - Hartley - Shannon law - Source coding theorem - Shannon - Fano & Huffman codes.                                              |                                                                                                               |                        |                           |   |     |      |
| PRACTICAL:                                                                                                                                                                                                                                                                      |                                                                                                               |                        |                           |   |     |      |
| 1. Implementation of Source Coding Techniques – Huffman Coding and Shannon–Fano Coding.                                                                                                                                                                                         |                                                                                                               |                        |                           |   |     |      |
| Unit – 2                                                                                                                                                                                                                                                                        | WAVEFORM CODING & REPRESENTATION                                                                              |                        |                           |   | CO2 | 9+6  |
| Prediction filtering and DPCM - Delta Modulation - ADPCM & ADM principles – Linear Predictive Coding – Properties of line codes - Power spectral density of Unipolar and Polar RZ/NRZ, Bipolar NRZ and Manchester line codes.                                                   |                                                                                                               |                        |                           |   |     |      |
| PRACTICAL:                                                                                                                                                                                                                                                                      |                                                                                                               |                        |                           |   |     |      |
| 1. Generation and Analysis of Line Coding and Waveform Coding Techniques – DPCM and Delta Modulation.                                                                                                                                                                           |                                                                                                               |                        |                           |   |     |      |
| Unit – 3                                                                                                                                                                                                                                                                        | BASEBAND TRANSMISSION & RECEPTION                                                                             |                        |                           |   | CO3 | 9+6  |
| ISI - Nyquist criterion for distortionless transmission – Pulse shaping – Correlative coding - Eye pattern – Receiving Filters- Matched Filter, Correlation receiver, Adaptive Equalization                                                                                     |                                                                                                               |                        |                           |   |     |      |
| PRACTICAL:                                                                                                                                                                                                                                                                      |                                                                                                               |                        |                           |   |     |      |
| 1. Simulation of Eye Pattern and Matched Filter Receiver – Inter Symbol Interference (ISI).                                                                                                                                                                                     |                                                                                                               |                        |                           |   |     |      |
| Unit – 4                                                                                                                                                                                                                                                                        | DIGITAL MODULATION SCHEMES                                                                                    |                        |                           |   | CO4 | 9+6  |
| Geometric Representation of signals - Generation, detection, PSD & BER of Coherent BPSK, BFSK & QPSK - QAM - Carrier Synchronization - Structure of Non-coherent Receivers - Principle of DPSK - Introduction to Orthogonal Frequency Division Multiplexing used in 5G systems. |                                                                                                               |                        |                           |   |     |      |
| PRACTICAL:                                                                                                                                                                                                                                                                      |                                                                                                               |                        |                           |   |     |      |
| 1. Simulation of Digital Modulation Schemes – BPSK, BFSK, QPSK and QAM with BER and PSD analysis.                                                                                                                                                                               |                                                                                                               |                        |                           |   |     |      |
| Unit – 5                                                                                                                                                                                                                                                                        | ERROR CONTROL CODING                                                                                          |                        |                           |   | CO5 | 9+6  |
| Channel coding theorem - Linear Block codes - Hamming codes - Cyclic codes (systematic, non-systematic) - Convolutional codes - Viterbi Decoder.                                                                                                                                |                                                                                                               |                        |                           |   |     |      |
| PRACTICAL:                                                                                                                                                                                                                                                                      |                                                                                                               |                        |                           |   |     |      |
| 1. Simulation of Error Control Coding Techniques – Hamming Code and Convolutional Code.                                                                                                                                                                                         |                                                                                                               |                        |                           |   |     |      |
| Total Theory Hours                                                                                                                                                                                                                                                              |                                                                                                               |                        |                           |   | 45  |      |
| Total Practical Hours                                                                                                                                                                                                                                                           |                                                                                                               |                        |                           |   | 30  |      |
| Textbooks:                                                                                                                                                                                                                                                                      |                                                                                                               |                        |                           |   |     |      |
| 1                                                                                                                                                                                                                                                                               | S. Haykin, Digital Communication, John Wiley, 2005                                                            |                        |                           |   |     |      |

| <b>Reference Books:</b> |                                                                                                           |
|-------------------------|-----------------------------------------------------------------------------------------------------------|
| 1                       | B. Sklar, Digital Communication: Fundamentals and Applications, 2nd Edition, Pearson Education, 2009.     |
| 2                       | B. P. Lathi, Modern Digital and Analog Communication Systems, 3rd Edition, Oxford University Press, 2007. |
| 3                       | H. P. Hsu, Analog and Digital Communications, Schaum Outline Series, TMH, 2006.                           |
| 4                       | J.G Proakis, —Digital Communication, 4th Edition, Tata McGraw Hill Company, 2001.                         |
| <b>Web References:</b>  |                                                                                                           |
| 1                       | <a href="https://nptel.ac.in/courses/117101051">https://nptel.ac.in/courses/117101051</a>                 |

| BLOOM'S<br>TAXONOMY<br>LEVEL | ASSESSMENT-1 |          |          | ASSESSMENT-2           |                      | ASSIGNMENT | ATTENDANCE | END<br>SEMESTER<br>EXAMINATION |
|------------------------------|--------------|----------|----------|------------------------|----------------------|------------|------------|--------------------------------|
|                              | CIA1         | CIA2     | MODEL    | LAB<br>EXPERIM<br>ENTS | MODEL<br>LAB<br>EXAM |            |            |                                |
|                              | 6            | 6        | 8        | 15                     | 5                    |            |            |                                |
| Remember                     |              |          |          |                        |                      |            |            |                                |
| Understand                   | 100          | 40       | 40       | 40                     | 40                   |            |            |                                |
| Apply                        |              | 60       | 60       | 60                     | 60                   |            |            |                                |
| Analyze                      |              |          |          |                        |                      |            |            |                                |
| Evaluate                     |              |          |          |                        |                      |            |            |                                |
| Create                       |              |          |          |                        |                      |            |            |                                |
| <b>Total<br/>(100Marks)</b>  | <b>6</b>     | <b>6</b> | <b>8</b> | <b>15</b>              | <b>5</b>             | <b>10</b>  | <b>10</b>  | <b>40</b>                      |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 marks.
- Experiment wise laboratory completion 15 marks and Model lab exam will be conducted for 100 marks and the same will be converted to 5 marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO<br>10 | PO<br>11 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|-------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|
| CC444.1     | 3       | 2       | 1       | 1       | 1       | -       | -       | -       | 1       | -        | 1        | 2        | 1        | 1        |
| CC444.2     | 3       | 2       | 1       | 1       | 2       | -       | -       | -       | 1       | -        | 1        | 2        | 2        | 1        |
| CC444.3     | 2       | 3       | 2       | 2       | 2       | -       | -       | -       | 1       | -        | 1        | 2        | 2        | 1        |
| CC444.4     | 2       | 2       | 3       | 2       | 3       | -       | -       | -       | 1       | -        | 1        | 2        | 2        | 1        |
| CC444.5     | 3       | 2       | 3       | 2       | 3       | -       | -       | -       | 1       | -        | 1        | 2        | 1        | 1        |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                | Course Name                                                                                         | Category               | Hours/Week                |   |     | C    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|-----|------|
|                                                                                                                                                                                                                                                                                                                                                            |                                                                                                     |                        | L                         | T | P   |      |
| 24CS456                                                                                                                                                                                                                                                                                                                                                    | COMPUTER NETWORKS                                                                                   | PC                     | 3                         | 0 | 2   | 4    |
| Regulation                                                                                                                                                                                                                                                                                                                                                 | Nature of the Course                                                                                | Semester               | Data Book/Codes/Standards |   |     |      |
| R24                                                                                                                                                                                                                                                                                                                                                        | THEORY CUM PRACTICAL                                                                                | V                      | -                         |   |     |      |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                    |                                                                                                     | Co-requisite Course(s) |                           |   |     |      |
| -                                                                                                                                                                                                                                                                                                                                                          |                                                                                                     | PYTHON PROGRAMMING     |                           |   |     |      |
| Course Objectives                                                                                                                                                                                                                                                                                                                                          |                                                                                                     |                        |                           |   |     |      |
| 1                                                                                                                                                                                                                                                                                                                                                          | To understand the concept of layering in networks.                                                  |                        |                           |   |     |      |
| 2                                                                                                                                                                                                                                                                                                                                                          | To apply the TCP/IP protocol suite to implement the functions.                                      |                        |                           |   |     |      |
| 3                                                                                                                                                                                                                                                                                                                                                          | To implement the end-to-end flow of information.                                                    |                        |                           |   |     |      |
| 4                                                                                                                                                                                                                                                                                                                                                          | To analyze the functions of network layer and the various routing protocols.                        |                        |                           |   |     |      |
| 5                                                                                                                                                                                                                                                                                                                                                          | To analyze the functions and protocols of the Transport layer.                                      |                        |                           |   |     |      |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                            |                                                                                                     |                        |                           |   |     |      |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                                    |                                                                                                     |                        |                           |   |     |      |
| C456.1                                                                                                                                                                                                                                                                                                                                                     | Understand the basic layers of computer networks and its functions.                                 |                        |                           |   |     | [U]  |
| C456.2                                                                                                                                                                                                                                                                                                                                                     | Apply TCP/UDP protocols to implement the data flow from one node to another in the Transport Layer. |                        |                           |   |     | [AP] |
| C456.3                                                                                                                                                                                                                                                                                                                                                     | Apply various internet protocols to implement various functions in the network.                     |                        |                           |   |     | [AP] |
| C456.4                                                                                                                                                                                                                                                                                                                                                     | Analyze various routing algorithms.                                                                 |                        |                           |   |     | [AN] |
| C456.5                                                                                                                                                                                                                                                                                                                                                     | Analyze the working principles of various application layer protocols.                              |                        |                           |   |     | [AN] |
| Course Contents                                                                                                                                                                                                                                                                                                                                            |                                                                                                     |                        |                           |   |     |      |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                   | Introduction And Application Layer                                                                  |                        |                           |   | CO1 | 9    |
| Data Communication - Networks – Network Types – Protocol Layering – TCP/IP Protocol suite – OSI Model – Introduction to Sockets - Application Layer protocols: HTTP – FTP – Email protocols (SMTP - POP3 - IMAP - MIME) – DNS – SNMP                                                                                                                       |                                                                                                     |                        |                           |   |     |      |
| <b>PRACTICAL:</b><br>1. Learn to use commands like tcpdump, netstat, ifconfig, nslookup and traceroute. Capture ping and trace route PDUs using a network protocol analyzer and examine.<br>2. Write a HTTP web client program to download a web page using TCP sockets.<br>3. Applications using TCP sockets like: a) Echo client and echo server b) Chat |                                                                                                     |                        |                           |   |     |      |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                   | Transport Layer                                                                                     |                        |                           |   | CO2 | 9    |
| Introduction - Transport-Layer Protocols: UDP – TCP: Connection Management – Flow control - Congestion Control - Congestion avoidance (DECbit, RED) – SCTP – Quality of Service                                                                                                                                                                            |                                                                                                     |                        |                           |   |     |      |
| <b>PRACTICAL:</b><br>4.Simulation of DNS using UDP sockets.<br>5.Study of TCP/UDP performance using Simulation tool.<br>6.Study of Network simulator (NS) and Simulation of Congestion Control Algorithms using NS.                                                                                                                                        |                                                                                                     |                        |                           |   |     |      |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                   | Network Layer                                                                                       |                        |                           |   | CO3 | 9    |
| Switching : Packet Switching - Internet protocol - IPV4 – IP Addressing – Subnetting - IPV6, ARP, RARP, ICMP, DHCP                                                                                                                                                                                                                                         |                                                                                                     |                        |                           |   |     |      |
| <b>PRACTICAL:</b><br>7. Use a tool like Wireshark to capture packets and examine the packets.<br>8. Write a code simulating ARP / RARP protocols.                                                                                                                                                                                                          |                                                                                                     |                        |                           |   |     |      |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                   | Routing                                                                                             |                        |                           |   | CO4 | 9    |
| Routing and protocols: Unicast routing - Distance Vector Routing - RIP - Link State Routing – OSPF – Path-vector routing - BGP - Multicast Routing: DVMRP – PIM.                                                                                                                                                                                           |                                                                                                     |                        |                           |   |     |      |
| <b>PRACTICAL:</b><br>9. Simulation of Distance Vector/ Link State Routing algorithm.                                                                                                                                                                                                                                                                       |                                                                                                     |                        |                           |   |     |      |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                   | Data Link And Physical Layers                                                                       |                        |                           |   | CO5 | 9    |
| Data Link Layer – Framing – Flow control – Error control – Data-Link Layer Protocols – HDLC – PPP - Media                                                                                                                                                                                                                                                  |                                                                                                     |                        |                           |   |     |      |

|                                                                                                                                                                                        |                                                                                                                                           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Access Control – Ethernet Basics – CSMA/CD – Virtual LAN – Wireless LAN (802.11) - Physical Layer: Data and Signals - Performance – Transmission media- Switching – Circuit Switching. |                                                                                                                                           |
| <b>PRACTICAL:</b>                                                                                                                                                                      |                                                                                                                                           |
| 10. Simulation of an error correction code (like CRC).                                                                                                                                 |                                                                                                                                           |
| <b>Total Hours</b>                                                                                                                                                                     |                                                                                                                                           |
| <b>45</b>                                                                                                                                                                              |                                                                                                                                           |
| <b>Practical</b>                                                                                                                                                                       |                                                                                                                                           |
| <b>30</b>                                                                                                                                                                              |                                                                                                                                           |
| <b>Textbooks:</b>                                                                                                                                                                      |                                                                                                                                           |
| 1                                                                                                                                                                                      | James F. Kurose, Keith W. Ross, Computer Networking, A Top-Down Approach Featuring the Internet, Eighth Edition, Pearson Education, 2021. |
| 2                                                                                                                                                                                      | Behrouz A. Forouzan, Data Communications and Networking with TCP/IP Protocol Suite, Sixth Edition TMH, 2022                               |
| <b>Reference Books:</b>                                                                                                                                                                |                                                                                                                                           |
| 1                                                                                                                                                                                      | Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, Fifth Edition, Morgan Kaufmann Publishers Inc., 2012.           |
| 2                                                                                                                                                                                      | William Stallings, Data and Computer Communications, Tenth Edition, Pearson Education, 2013                                               |
| 3                                                                                                                                                                                      | Nader F. Mir, Computer and Communication Networks, Second Edition, Prentice Hall, 2014.                                                   |
| 4                                                                                                                                                                                      | Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, "Computer Networks: An Open Source Approach", McGraw Hill, 2012.                                |
| <b>Web References:</b>                                                                                                                                                                 |                                                                                                                                           |
| 1                                                                                                                                                                                      | <a href="https://onlinecourses.nptel.ac.in/noc22_cs19/preview">https://onlinecourses.nptel.ac.in/noc22_cs19/preview</a> .                 |

| BLOOM'S<br>TAXONOMY<br>LEVEL | ASSESSMENT-1 |          |          | ASSESSMENT-2           |                      | ASSIGNMENT | ATTENDANCE | END<br>SEMESTER<br>EXAMINATION |
|------------------------------|--------------|----------|----------|------------------------|----------------------|------------|------------|--------------------------------|
|                              | CIA1         | CIA2     | MODEL    | LAB<br>EXPERIM<br>ENTS | MODEL<br>LAB<br>EXAM |            |            |                                |
|                              | 6            | 6        | 8        | 10                     | 10                   |            |            |                                |
| Remember                     |              |          |          |                        |                      |            | 100%       | 100%                           |
| Understand                   | 80%          |          | 20%      | 20%                    | 20%                  | 20%        |            |                                |
| Apply                        | 20%          | 80%      | 40%      | 40%                    | 40%                  | 40%        |            |                                |
| Analyze                      |              | 20%      | 40%      | 40%                    | 40%                  | 40%        |            |                                |
| Evaluate                     |              |          |          |                        |                      |            |            |                                |
| Create                       |              |          |          |                        |                      |            |            |                                |
| <b>Total<br/>(100Marks)</b>  | <b>6</b>     | <b>6</b> | <b>8</b> | <b>10</b>              | <b>10</b>            | <b>10</b>  | <b>10</b>  | <b>40</b>                      |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 marks.
- Experiment wise laboratory completion 10 marks and Model lab exam will be conducted for 100 marks and the same will be converted to 10 marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO<br>10 | PO<br>11 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|-------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|
| C0456.1     | 3       | 3       | 3       | 3       | 2       | -       | -       | -       | -       | -        | -        | 2        | 2        | 2        |
| C0456.2     | 3       | 3       | 3       | 3       | 3       | -       | -       | -       | -       | -        | -        | 3        | 2        | 3        |
| C0456.3     | 3       | 3       | 3       | 3       | 3       | -       | -       | -       | -       | -        | -        | 2        | 2        | 2        |
| C0456.4     | 3       | 3       | 3       | 3       | 3       | -       | -       | -       | -       | -        | -        | 3        | 2        | 2        |
| C0456.5     | 3       | 3       | 3       | 3       | 3       | -       | -       | -       | -       | -        | -        | 3        | 2        | 3        |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                  | Course Name                                                                   | Category               | Hours/Week                |   |     | C    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|------------------------|---------------------------|---|-----|------|
|                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                               |                        | L                         | T | P   |      |
| 24CC456                                                                                                                                                                                                                                                                                                                                                                                                      | WIRELESS COMMUNICATION                                                        | PC                     | 3                         | 0 | 2   | 4    |
| Regulation                                                                                                                                                                                                                                                                                                                                                                                                   | Nature of the Course                                                          | Semester               | Data Book/Codes/Standards |   |     |      |
| 2024                                                                                                                                                                                                                                                                                                                                                                                                         | THEORY CUM PRACTICAL                                                          | V                      | -                         |   |     |      |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                                                      |                                                                               | Co-requisite Course(s) |                           |   |     |      |
| COMMUNICATION THEORY                                                                                                                                                                                                                                                                                                                                                                                         |                                                                               | NIL                    |                           |   |     |      |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                            |                                                                               |                        |                           |   |     |      |
| 1                                                                                                                                                                                                                                                                                                                                                                                                            | To study the characteristics of wireless channels and propagation models.     |                        |                           |   |     |      |
| 2                                                                                                                                                                                                                                                                                                                                                                                                            | To understand the design principles of cellular communication systems.        |                        |                           |   |     |      |
| 3                                                                                                                                                                                                                                                                                                                                                                                                            | To study digital signaling techniques used in wireless communication systems. |                        |                           |   |     |      |
| 4                                                                                                                                                                                                                                                                                                                                                                                                            | To learn multipath mitigation techniques such as equalization and diversity.  |                        |                           |   |     |      |
| 5                                                                                                                                                                                                                                                                                                                                                                                                            | To understand multiple antenna techniques used in modern wireless systems.    |                        |                           |   |     |      |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                              |                                                                               |                        |                           |   |     |      |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                                                                                      |                                                                               |                        |                           |   |     |      |
| CC456.1                                                                                                                                                                                                                                                                                                                                                                                                      | Understand the characteristics of wireless channels and path loss models.     |                        |                           |   |     | [U]  |
| CC456.2                                                                                                                                                                                                                                                                                                                                                                                                      | Understand the cellular architecture and multiple access techniques.          |                        |                           |   |     | [U]  |
| CC456.3                                                                                                                                                                                                                                                                                                                                                                                                      | Apply digital modulation techniques in wireless communication systems.        |                        |                           |   |     | [AP] |
| CC456.4                                                                                                                                                                                                                                                                                                                                                                                                      | Apply multipath mitigation techniques such as equalization and diversity.     |                        |                           |   |     | [AP] |
| CC456.5                                                                                                                                                                                                                                                                                                                                                                                                      | Apply multiple antenna techniques in wireless communication systems.          |                        |                           |   |     | [AP] |
| Course Contents                                                                                                                                                                                                                                                                                                                                                                                              |                                                                               |                        |                           |   |     |      |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                                                                     | WIRELESS CHANNELS                                                             |                        |                           |   | CO1 | 9+6  |
| Large scale path loss – Path loss models: Free Space and Two-Ray models -Link budget design – Small scale fading- Parameters of mobile multipath channels – Time dispersion parameters-Coherence bandwidth – Doppler spread & Coherence time, fading due to Multipath time delay spread – flat fading – frequency selective fading – Fading due to Doppler spread – fast fading – slow fading-AWGN channels. |                                                                               |                        |                           |   |     |      |
| <b>PRACTICAL:</b>                                                                                                                                                                                                                                                                                                                                                                                            |                                                                               |                        |                           |   |     |      |
| 1. Model wireless channels using Free Space, Two-Ray, and Okumura-Hata models.                                                                                                                                                                                                                                                                                                                               |                                                                               |                        |                           |   |     |      |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                                                                     | CELLULAR ARCHITECTURE                                                         |                        |                           |   | CO2 | 9+6  |
| Multiple Access techniques - FDMA, TDMA, CDMA – Capacity calculations–Cellular concept- Frequency reuse - channel assignment- hand off- interference & system capacity- trunking & grade of service – Coverage and capacity improvement.                                                                                                                                                                     |                                                                               |                        |                           |   |     |      |
| <b>PRACTICAL:</b>                                                                                                                                                                                                                                                                                                                                                                                            |                                                                               |                        |                           |   |     |      |
| 1. Simulate TDMA, FDMA, and CDMA multiple access techniques.                                                                                                                                                                                                                                                                                                                                                 |                                                                               |                        |                           |   |     |      |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                                                                     | DIGITAL SIGNALING FOR FADING CHANNELS                                         |                        |                           |   | CO3 | 9+6  |
| Structure of a wireless communication link, Principles of BPSK, QPSK, Offset-QPSK, $\pi/4$ -DQPSK, Minimum Shift Keying, Gaussian Minimum Shift Keying, Error performance in fading channels, OFDM principle – Cyclic prefix, Windowing, PAPR.                                                                                                                                                               |                                                                               |                        |                           |   |     |      |
| <b>PRACTICAL:</b>                                                                                                                                                                                                                                                                                                                                                                                            |                                                                               |                        |                           |   |     |      |
| 1. Generate and analyze BPSK and QPSK modulation schemes.                                                                                                                                                                                                                                                                                                                                                    |                                                                               |                        |                           |   |     |      |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                                                                     | MULTIPATH MITIGATION TECHNIQUES                                               |                        |                           |   | CO4 | 9+6  |
| Equalization – Adaptive equalization, Linear and Non-Linear equalization, Zero-Forcing and LMS Algorithms. Diversity – Micro and Macro diversity, Diversity combining techniques, Error probability in fading channels with diversity reception, Rake receiver.                                                                                                                                              |                                                                               |                        |                           |   |     |      |
| <b>PRACTICAL:</b>                                                                                                                                                                                                                                                                                                                                                                                            |                                                                               |                        |                           |   |     |      |
| 1. Implement wireless channel equalization using Zero-Forcing and MMSE equalizers.                                                                                                                                                                                                                                                                                                                           |                                                                               |                        |                           |   |     |      |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                                                                     | MULTIPLE ANTENNA TECHNIQUES                                                   |                        |                           |   | CO5 | 9+6  |
| MIMO systems – Spatial multiplexing – System model – Precoding – Beamforming – Transmitter diversity – Receiver diversity – Channel state information – Capacity in fading and non-fading channels.                                                                                                                                                                                                          |                                                                               |                        |                           |   |     |      |
| <b>PRACTICAL:</b>                                                                                                                                                                                                                                                                                                                                                                                            |                                                                               |                        |                           |   |     |      |
| 1. Evaluate 4G/5G wireless system performance (BER, Throughput).                                                                                                                                                                                                                                                                                                                                             |                                                                               |                        |                           |   |     |      |
| Total Theory Hours                                                                                                                                                                                                                                                                                                                                                                                           |                                                                               |                        |                           |   |     | 45   |
| Total Practical Hours                                                                                                                                                                                                                                                                                                                                                                                        |                                                                               |                        |                           |   |     | 30   |
| Textbooks:                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                               |                        |                           |   |     |      |

|                         |                                                                                                                         |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------|
| 1                       | Rappaport, T.S., –Wireless communications, Pearson Education, Second Edition, 2010.                                     |
| 2                       | Andreas.F. Molisch, –Wireless Communications, John Wiley – India, 2006.                                                 |
| <b>Reference Books:</b> |                                                                                                                         |
| 1                       | Wireless Communication –Andrea Goldsmith, Cambridge University Press, 2011                                              |
| 2                       | Van Nee, R. and Ramji Prasad, –OFDM for wireless multimedia communications, Artech House, 2000                          |
| 3                       | David Tse and Pramod Viswanath, –Fundamentals of Wireless Communication, Cambridge University Press, 2005.              |
| 4                       | Upena Dalal, –Wireless Communication, Oxford University Press, 2009.                                                    |
| <b>Web References:</b>  |                                                                                                                         |
| 1                       | <a href="https://onlinecourses.nptel.ac.in/noc21_ee66/preview">https://onlinecourses.nptel.ac.in/noc21_ee66/preview</a> |

| BLOOM'S<br>TAXONOMY<br>LEVEL | ASSESSMENT-1 |          |          | ASSESSMENT-2           |                      | ASSIGNMENT | ATTENDANCE | END<br>SEMESTER<br>EXAMINATION |
|------------------------------|--------------|----------|----------|------------------------|----------------------|------------|------------|--------------------------------|
|                              | CIA1         | CIA2     | MODEL    | LAB<br>EXPERIM<br>ENTS | MODEL<br>LAB<br>EXAM |            |            |                                |
|                              | 6            | 6        | 8        | 15                     | 5                    |            |            |                                |
| Remember                     |              |          |          |                        |                      | 10         | 10         | 40                             |
| Understand                   | 80           | 60       | 60       | 60                     | 60                   |            |            |                                |
| Apply                        | 20           | 40       | 40       | 40                     | 40                   |            |            |                                |
| Analyze                      |              |          |          |                        |                      |            |            |                                |
| Evaluate                     |              |          |          |                        |                      |            |            |                                |
| Create                       |              |          |          |                        |                      |            |            |                                |
| <b>Total<br/>(100Marks)</b>  | <b>6</b>     | <b>6</b> | <b>8</b> | <b>15</b>              | <b>5</b>             | <b>10</b>  | <b>10</b>  | <b>40</b>                      |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 marks.
- Experiment wise laboratory completion 15 marks and Model lab exam will be conducted for 100 marks and the same will be converted to 5 marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO<br>10 | PO<br>11 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|-------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|
| CC456.1     | 3       | 2       | 1       | 1       | 2       | 2       | –       | –       | 1       | –        | 1        | 2        | 1        | 1        |
| CC456.2     | 2       | 3       | 3       | 2       | 2       | 2       | –       | –       | 1       | –        | 1        | 3        | 2        | 2        |
| CC456.3     | 2       | 2       | 1       | 2       | 2       | 2       | –       | –       | 1       | –        | 1        | 2        | 2        | 2        |
| CC456.4     | 2       | 2       | 2       | 3       | 3       | 2       | –       | –       | 1       | –        | 1        | 2        | 2        | 3        |
| CC456.5     | 2       | 2       | 1       | 2       | 2       | 2       | –       | –       | 1       | –        | 1        | 2        | 2        | 3        |

1 - low, 2 - medium, 3 - high, '–' - no correlation

| Course Code                                                   | Course Name                                                          | Category               | Hours/Week                |   |   | C    |
|---------------------------------------------------------------|----------------------------------------------------------------------|------------------------|---------------------------|---|---|------|
|                                                               |                                                                      |                        | L                         | T | P |      |
| 24AM357                                                       | Artificial Intelligence and Machine Learning Laboratory              | EC                     | 0                         | 0 | 4 | 2    |
| Regulation                                                    | Nature of the Course                                                 | Semester               | Data Book/Codes/Standards |   |   |      |
| 2024                                                          | PRACTICAL                                                            | V                      | -                         |   |   |      |
| Pre-requisite Course(s)                                       |                                                                      | Co-requisite Course(s) |                           |   |   |      |
| -                                                             |                                                                      | Python Programming     |                           |   |   |      |
| Course Objectives                                             |                                                                      |                        |                           |   |   |      |
| 1                                                             | To Study about uninformed and Heuristic search techniques            |                        |                           |   |   |      |
| 2                                                             | Apply the techniques for reasoning under uncertainty                 |                        |                           |   |   |      |
| 3                                                             | Apply the Machine Learning and supervised learning algorithms        |                        |                           |   |   |      |
| 4                                                             | Construct the ensembling and unsupervised learning algorithms        |                        |                           |   |   |      |
| 5                                                             | Understand the basics of deep learning using neural networks         |                        |                           |   |   |      |
| Course Outcomes                                               |                                                                      |                        |                           |   |   |      |
| Upon completion of the course, students shall have ability to |                                                                      |                        |                           |   |   |      |
| AM357.1                                                       | Understand the appropriate search algorithms for problem solving     |                        |                           |   |   | [AP] |
| AM357.2                                                       | Apply reasoning under uncertainty                                    |                        |                           |   |   | [AP] |
| AM357.3                                                       | Demonstrate the supervised learning models                           |                        |                           |   |   | [AP] |
| AM357.4                                                       | Apply ensembling and unsupervised models                             |                        |                           |   |   | [AP] |
| AM357.5                                                       | Understand the deep learning neural network models                   |                        |                           |   |   | [AP] |
| List of Experiments:                                          |                                                                      |                        |                           |   |   | CO   |
| 1                                                             | Implementation of Uninformed search algorithms (BFS, DFS)            |                        |                           |   |   | CO1  |
| 2                                                             | Implementation of Informed search algorithms (A*, memory-bounded A*) |                        |                           |   |   | CO1  |
| 3                                                             | Implement naïve Bayes models                                         |                        |                           |   |   | CO2  |
| 4                                                             | Implement Bayesian Networks                                          |                        |                           |   |   | CO2  |
| 5                                                             | Build Regression models                                              |                        |                           |   |   | CO3  |
| 6                                                             | Build decision trees and random forests                              |                        |                           |   |   | CO3  |
| 7                                                             | Build SVM models                                                     |                        |                           |   |   | CO3  |
| 8                                                             | Implement ensembling techniques                                      |                        |                           |   |   | CO3  |
| 9                                                             | Implement clustering algorithms                                      |                        |                           |   |   | CO4  |
| 10                                                            | Implement EM for Bayesian networks                                   |                        |                           |   |   | CO4  |
| 11                                                            | Build simple NN models                                               |                        |                           |   |   | CO5  |
| 12                                                            | Build deep learning NN models                                        |                        |                           |   |   | CO5  |
| Total Hours                                                   |                                                                      |                        |                           |   |   | 60   |

| Bloom's Taxonomy Level   | ASSESSMENT            |                      | ATTENDANCE | END SEMESTER EXAMINATION |
|--------------------------|-----------------------|----------------------|------------|--------------------------|
|                          | LAB EXPERIMENTS [75%] | MODEL LAB EXAM [25%] |            |                          |
|                          | 38                    | 12                   |            |                          |
| Remember                 |                       |                      | 100%       | 100%                     |
| Understand               |                       |                      |            |                          |
| Apply                    | 100                   | 100                  |            |                          |
| Analyze                  |                       |                      |            |                          |
| Evaluate                 |                       |                      |            |                          |
| Create                   |                       |                      |            |                          |
| <b>Total (100 Marks)</b> | <b>38</b>             | <b>12</b>            | <b>10</b>  | <b>40</b>                |

[illegible]

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                              | Course Name                                                                                                                                  | Category               | Hours/Week                |   |   | C    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|---|------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                              |                        | L                         | T | P |      |
| 24MB151                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Principles of Management                                                                                                                     | HS                     | 3                         | 0 | 0 | 3    |
| Regulation                                                                                                                                                                                                                                                                                                                                                                                                                                               | Nature of the Course                                                                                                                         | Semester               | Data Book/Codes/Standards |   |   |      |
| R24                                                                                                                                                                                                                                                                                                                                                                                                                                                      | THEORY                                                                                                                                       | VI                     | -----                     |   |   |      |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                              | Co-requisite Course(s) |                           |   |   |      |
| -                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                              |                        |                           |   |   |      |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                              |                        |                           |   |   |      |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To help students gain understanding on the basic concepts and functions of management.                                                       |                        |                           |   |   |      |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To provide them with tools and techniques of planning and decision-making process.                                                           |                        |                           |   |   |      |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To enable them to understand and apply the organizing functions in the organization.                                                         |                        |                           |   |   |      |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To help students analyze various techniques to lead and motive employees                                                                     |                        |                           |   |   |      |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To acquire skills in coordination and controlling manpower and apply them in business scenario                                               |                        |                           |   |   |      |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                              |                        |                           |   |   |      |
| Upon completion of the course, students shall have ability to                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                              |                        |                           |   |   |      |
| CS151.1                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Comprehend the basic concepts of management and evolution in management.                                                                     |                        |                           |   |   | [U]  |
| CS151.2                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Demonstrate the roles and skills in planning and decision making for the business.                                                           |                        |                           |   |   | [AP] |
| CS151.3                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Execute grouping of activities via departmentation and discharge various roles and responsibilities in the organization                      |                        |                           |   |   | [AP] |
| CS151.4                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Analyze and interpret the concepts of directing the workforce, improve performance through motivation & effective leadership.                |                        |                           |   |   | [AN] |
| CS151.5                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Take effective steps in controlling & coordinating various resources in the organization                                                     |                        |                           |   |   | [AP] |
| Course Contents                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                              |                        |                           |   |   |      |
| Unit-1                                                                                                                                                                                                                                                                                                                                                                                                                                                   | INTRODUCTION TO MANAGEMENT                                                                                                                   |                        |                           |   |   | 9    |
| Management: Meaning – Definitions –Nature - Scope- Distinction between Management and Administration. Management: A science or an art – Functions of Management- Levels of Management - Roles and Skills of a Manager- The evolution of Management Theory-( Scientific, human relations, system and contingency approaches), Types of Business organization- Sole proprietorship, partnership, company-public and private sector enterprises             |                                                                                                                                              |                        |                           |   |   |      |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                                                                                                                 | PLANNING                                                                                                                                     |                        |                           |   |   | 9    |
| Planning: Definition – Nature and Characteristics of Planning – Importance –Planning process- Types of Plans – Limitations. MBO-Definition –Process of MBO- Pros & Cons. Decision making: concept of decision and decision making - Decision making process - Types of Decisions, Factors affecting decisions                                                                                                                                            |                                                                                                                                              |                        |                           |   |   |      |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ORGANISING                                                                                                                                   |                        |                           |   |   | 9    |
| Organizing: Meaning- Definition -Nature & Importance - Types of Organization - Organizational structure - Span of control. Delegation: Meaning – importance -Centralization Vs Decentralization. Departmentation: Meaning – Bases of departmentation. Staffing: Meaning – Definition -Objectives, Factors affecting staffing., recruitment and selection.                                                                                                |                                                                                                                                              |                        |                           |   |   |      |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                                                                                                                 | DIRECTING                                                                                                                                    |                        |                           |   |   | 9    |
| Directing: Meaning-Nature - Importance–principles – Elements of Directing. Motivation – Motivation theories ( Maslow, Herzberg, ERG, X and Y theories)– Motivational techniques – Job satisfaction – Job enrichment – Leadership – types and theories of leadership ( Trait, Managerial Grid, Hersey Blanchard, Fiedler’s Contingency Theories. Communication – Process of communication – Barrier in communication – Effective communication techniques |                                                                                                                                              |                        |                           |   |   |      |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                                                                                                                 | COORDINATION AND CONTROLLING                                                                                                                 |                        |                           |   |   | 9    |
| Co-ordination &Controlling: Co-ordination: Meaning- Principles & Effective Coordination Techniques- Controlling: Definition – Characteristics of control – Steps in controlling –Controlling Techniques – Computer as a management tool, Latest trends in Management.                                                                                                                                                                                    |                                                                                                                                              |                        |                           |   |   |      |
| Total Hours                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                              |                        |                           |   |   | 45   |
| Textbooks:                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                              |                        |                           |   |   |      |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                        | P.C.Tripathy, P.N.Reddy, Ashish Bajpai Principles of Management,7 <sup>th</sup> Edition, Tata McGraw Hill Education Pvt Ltd, NewDelhi (2023) |                        |                           |   |   |      |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Harold Knootz, Heinz Weinhrich, Essential of Management, 11 <sup>th</sup> Edition, Tata McGraw Hill                                          |                        |                           |   |   |      |

|                         |                                                                                                                                                                                                                                                         |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         | Education Pvt Ltd, New Delhi. (2021)                                                                                                                                                                                                                    |
| <b>Reference Books:</b> |                                                                                                                                                                                                                                                         |
| 1                       | Bhushan Y.K, Fundamentals of Business Organization and Management, Sultan Chand & Sons New Delhi(2016)                                                                                                                                                  |
| 2                       | L.M.Prasad, Principles and Practice of Management, Himalaya Publication, Mumbai.(2019)                                                                                                                                                                  |
| <b>Web References:</b>  |                                                                                                                                                                                                                                                         |
| 1                       | <a href="https://file-dhaka.portal.gov.bd/uploads/0283d03a-254c-4b8c-9db4-4060c02f16c2/629/c3c/ee6/629c3cee6adc6386614665.pdf">https://file-dhaka.portal.gov.bd/uploads/0283d03a-254c-4b8c-9db4-4060c02f16c2/629/c3c/ee6/629c3cee6adc6386614665.pdf</a> |
| 2                       | <a href="https://www.freebookcentre.net/business-books-download/Introduction-to-Principles-of-Management.html">https://www.freebookcentre.net/business-books-download/Introduction-to-Principles-of-Management.html</a>                                 |
| 3                       | <a href="https://s3.amazonaws.com/lumenlearning/success/waymaker/Waymaker-Principles-of-Management_regexified.pdf">https://s3.amazonaws.com/lumenlearning/success/waymaker/Waymaker-Principles-of-Management_regexified.pdf</a>                         |

| Assessment based on Continuous and End Semester Examination |                       |                |                      |            |            |                          |
|-------------------------------------------------------------|-----------------------|----------------|----------------------|------------|------------|--------------------------|
| Bloom's Level                                               | CONTINUOUS ASSESSMENT |                |                      | ASSIGNMENT | ATTENDANCE | END SEMESTER EXAMINATION |
|                                                             | CIA1 (6 Marks)        | CIA2 (6 Marks) | Model Exam (8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)               |
| Remember                                                    |                       |                |                      |            |            |                          |
| Understand                                                  | 60%                   |                | 20%                  |            |            |                          |
| Apply                                                       | 40%                   | 100%           | 80%                  |            |            |                          |
| Analyze                                                     |                       |                |                      |            |            |                          |
| Evaluate                                                    |                       |                |                      |            |            |                          |
| Create                                                      |                       |                |                      |            |            |                          |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>       | <b>8</b>             | <b>10</b>  | <b>10</b>  | <b>60</b>                |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PS01 | PS02 | PS03 |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CS151.1     | -   | -   | -   | -   | -   | -   | -   | 3   | 3   | -    | 3    | -    | -    | -    |
| CS151.2     | -   | -   | -   | -   | -   | -   | -   | 3   | 3   | -    | 3    | -    | -    | -    |
| CS151.3     | -   | -   | -   | -   | -   | -   | -   | 3   | 3   | -    | 3    | -    | -    | -    |
| CS151.4     | -   | -   | -   | -   | -   | -   | -   | 3   | 3   | -    | 3    | -    | -    | -    |
| CS151.5     | -   | -   | -   | -   | -   | -   | -   | 3   | 3   | -    | 3    | -    | -    | -    |

| Course Code                                                                                                                                                                                                                                                                                                                            | Course Name                                                                                                               | Category               | Hours/Week                |   |   | C    |       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|---|------|-------|
|                                                                                                                                                                                                                                                                                                                                        |                                                                                                                           |                        | L                         | T | P |      |       |
| 24CC462                                                                                                                                                                                                                                                                                                                                | MOBILE COMMUNICATION                                                                                                      | PC                     | 3                         | 0 | 0 | 3    |       |
| Regulation                                                                                                                                                                                                                                                                                                                             | Nature of the Course                                                                                                      | Semester               | Data Book/Codes/Standards |   |   |      |       |
| 2024                                                                                                                                                                                                                                                                                                                                   | THEORY                                                                                                                    | VI                     | -                         |   |   |      |       |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                |                                                                                                                           | Co-requisite Course(s) |                           |   |   |      |       |
| -                                                                                                                                                                                                                                                                                                                                      |                                                                                                                           | -                      |                           |   |   |      |       |
| Course Objectives                                                                                                                                                                                                                                                                                                                      |                                                                                                                           |                        |                           |   |   |      |       |
| 1                                                                                                                                                                                                                                                                                                                                      | To understand the fundamentals of mobile communication and mobile computing.                                              |                        |                           |   |   |      |       |
| 2                                                                                                                                                                                                                                                                                                                                      | To learn the fundamentals of mobile telecommunication systems and wireless network.                                       |                        |                           |   |   |      |       |
| 3                                                                                                                                                                                                                                                                                                                                      | To learn the architecture and services of wireless networking technologies.                                               |                        |                           |   |   |      |       |
| 4                                                                                                                                                                                                                                                                                                                                      | To be familiar with network layer protocols and Ad-Hoc networks.                                                          |                        |                           |   |   |      |       |
| 5                                                                                                                                                                                                                                                                                                                                      | To understand transport and application layer protocols in mobile networks.                                               |                        |                           |   |   |      |       |
| Course Outcomes                                                                                                                                                                                                                                                                                                                        |                                                                                                                           |                        |                           |   |   |      |       |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                |                                                                                                                           |                        |                           |   |   |      |       |
| CC462.1                                                                                                                                                                                                                                                                                                                                | Explain the fundamentals of mobile computing and multiple access techniques.                                              |                        |                           |   |   | [U]  |       |
| CC462.2                                                                                                                                                                                                                                                                                                                                | Illustrate the architecture of mobile telecommunication systems.                                                          |                        |                           |   |   | [U]  |       |
| CC462.3                                                                                                                                                                                                                                                                                                                                | Explain the architecture and service of wireless networks.                                                                |                        |                           |   |   | [U]  |       |
| CC462.4                                                                                                                                                                                                                                                                                                                                | Determine the functionality of MAC, network layer and Identify a routing protocol for a given Ad hoc network.             |                        |                           |   |   | [AP] |       |
| CC462.5                                                                                                                                                                                                                                                                                                                                | Apply mobile transport and application layer protocols to design solutions for mobile network communication scenarios.    |                        |                           |   |   | [AP] |       |
| Course Contents                                                                                                                                                                                                                                                                                                                        |                                                                                                                           |                        |                           |   |   |      |       |
| Unit – 1                                                                                                                                                                                                                                                                                                                               | INTRODUCTION TO MOBILE COMPUTING                                                                                          |                        |                           |   |   | CO1  | 9 Hrs |
| Introduction to Mobile Computing — Applications of Mobile Computing- Pervasive Computing - Generations of Mobile Communication Technologies-- Multiplexing - Medium Access Control (MAC): Motivation for a specialized MAC (Hidden and exposed terminals, Near and far terminals) – Multiple Access Techniques- SDMA- TDMA- FDMA- CDMA |                                                                                                                           |                        |                           |   |   |      |       |
| Unit – 2                                                                                                                                                                                                                                                                                                                               | MOBILE TELECOMMUNICATION SYSTEM                                                                                           |                        |                           |   |   | CO2  | 9 Hrs |
| Global System for Mobile — GSM Architecture — Protocols — Connection Establishment — Routing - Mobility Management — Security -GPRS- UMTS- 4G LTE — 5G Overview - Introduction to D2D communications in 5G Cellular networks                                                                                                           |                                                                                                                           |                        |                           |   |   |      |       |
| Unit – 3                                                                                                                                                                                                                                                                                                                               | WIRELESS NETWORKS                                                                                                         |                        |                           |   |   | CO3  | 9 Hrs |
| Wireless LANs and PANs — IEEE 802.11 Standard - Architecture - Services — Blue Tooth technology — Comparison of WLAN and Bluetooth - Wi-Fi — WiMAX.                                                                                                                                                                                    |                                                                                                                           |                        |                           |   |   |      |       |
| Unit – 4                                                                                                                                                                                                                                                                                                                               | MOBILE NETWORK LAYER                                                                                                      |                        |                           |   |   | CO4  | 9 Hrs |
| Mobile IP — Dynamic Host Configuration Protocol — Ad Hoc- Characteristics and applications; Coverage and connectivity problems- Proactive and Reactive Routing Protocols — Multicast Routing- Vehicular Ad Hoc networks ( VANET) –MANET Vs VANET — Security in MANET's                                                                 |                                                                                                                           |                        |                           |   |   |      |       |
| Unit – 5                                                                                                                                                                                                                                                                                                                               | MOBILE TRANSPORT AND APPLICATION LAYER                                                                                    |                        |                           |   |   | CO5  | 9 Hrs |
| Mobile TCP, Indirect TCP, Snooping TCP, Mobile TCP – Wireless Application Protocol (WAP) — Architecture — WDP — Wireless Transport Layer Security (WTLS) — WTP - WSP — WAE —Wireless Telephony Application (WTA) Architecture — Wireless Markup Language (WML).                                                                        |                                                                                                                           |                        |                           |   |   |      |       |
| Total Hours                                                                                                                                                                                                                                                                                                                            |                                                                                                                           |                        |                           |   |   | 45   |       |
| Textbooks:                                                                                                                                                                                                                                                                                                                             |                                                                                                                           |                        |                           |   |   |      |       |
| 1                                                                                                                                                                                                                                                                                                                                      | Jochen Schiller, –Mobile Communications, PHI, Second Edition, 2003.                                                       |                        |                           |   |   |      |       |
| 2                                                                                                                                                                                                                                                                                                                                      | Prasant Kumar Pattnaik, Rajib Mall, –Fundamentals of Mobile Computing  , PHI Learning Pvt.Ltd, New Delhi – 2012           |                        |                           |   |   |      |       |
| Reference Books:                                                                                                                                                                                                                                                                                                                       |                                                                                                                           |                        |                           |   |   |      |       |
| 1                                                                                                                                                                                                                                                                                                                                      | Dharma DharmaPrakash Agarval, Qing and An Zeng, "Introduction to Wireless and Mobile systems", Thomson Asia Pvt Ltd, 2005 |                        |                           |   |   |      |       |
| 2                                                                                                                                                                                                                                                                                                                                      | Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, “Principles of Mobile Computing”, Springer, 2003.        |                        |                           |   |   |      |       |
| 3                                                                                                                                                                                                                                                                                                                                      | William.C.Y.Lee,"Mobile Cellular Telecommunications-Analog and Digital Systems", Second                                   |                        |                           |   |   |      |       |

|                            |                                                                                                                         |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------|
|                            | Edition,Tata Mc Graw Hill Edition ,2006.                                                                                |
| 4                          | C.K.Toth, "AdHoc Mobile Wireless Networks", First Edition, Pearson Education, 2002.                                     |
| <b>Android Developers:</b> |                                                                                                                         |
| 1                          | <a href="http://developer.android.com/index.html">http://developer.android.com/index.html</a>                           |
| <b>Web References:</b>     |                                                                                                                         |
| 1                          | <a href="https://onlinecourses.nptel.ac.in/noc21_ee66/preview">https://onlinecourses.nptel.ac.in/noc21_ee66/preview</a> |
| 2                          | <a href="https://www.coursera.org/courses?query=wireless">https://www.coursera.org/courses?query=wireless</a>           |

| Assessment based on Continuous and End Semester Examination |                       |                   |                         |                              |                          |                                              |
|-------------------------------------------------------------|-----------------------|-------------------|-------------------------|------------------------------|--------------------------|----------------------------------------------|
| BLOOM'S<br>TAXONOMY<br>LEVEL                                | CONTINUOUS ASSESSMENT |                   |                         | ASSIGNMEN<br>T<br>(10 Marks) | ATTENDANCE<br>(10 Marks) | END<br>SEMESTER<br>EXAMINATION<br>(60 Marks) |
|                                                             | CIA1<br>(6 Marks)     | CIA2<br>(6 Marks) | Model Exam<br>(8 Marks) |                              |                          |                                              |
| Remember                                                    | -                     | -                 | -                       | 10                           | 10                       | 60                                           |
| Understand                                                  | 100                   | 100               | 60                      |                              |                          |                                              |
| Apply                                                       | -                     | -                 | 40                      |                              |                          |                                              |
| Analyze                                                     | -                     | -                 | -                       |                              |                          |                                              |
| Evaluate                                                    | -                     | -                 | -                       |                              |                          |                                              |
| Create                                                      | -                     | -                 | -                       | 10                           | 10                       | 60                                           |
| <b>Total<br/>(100 Marks)</b>                                | <b>6</b>              | <b>6</b>          | <b>8</b>                |                              |                          |                                              |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO<br>10 | PO<br>11 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|-------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|
| CC462.1     | 3       | 2       | 2       | 2       | 2       | -       | -       | -       | -       | -        | 3        | 3        | 3        | 3        |
| CC462.2     | 3       | 2       | 2       | 2       | 1       | -       | -       | -       | -       | -        | 3        | 2        | 3        | 3        |
| CC462.3     | 3       | 2       | 2       | 1       | 1       | -       | -       | -       | -       | -        | 3        | 2        | 3        | 2        |
| CC462.4     | 3       | 3       | 3       | 2       | 2       | -       | -       | -       | -       | -        | 3        | 3        | 2        | 2        |
| CC462.5     | 3       | 3       | 3       | 2       | 2       | -       | -       | -       | -       | -        | 2        | 2        | 2        | 2        |

**1 - Low, 2 - medium, 3 - high, '-' - no correlation**

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                 | Course Name                                                                                        | Category                      | Hours/Week                       |   |   | C          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|-------------------------------|----------------------------------|---|---|------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                    |                               | L                                | T | P |            |
| 24CS466                                                                                                                                                                                                                                                                                                                                                                                                                                     | SOFTWARE ENGINEERING<br>METHODOLOGIES                                                              | PC                            | 3                                | 0 | 2 | 4          |
| <b>Regulation</b>                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Nature of the Course</b>                                                                        | <b>Semester</b>               | <b>Data Book/Codes/Standards</b> |   |   |            |
| R24                                                                                                                                                                                                                                                                                                                                                                                                                                         | Theory cum Practical                                                                               | VI                            | -                                |   |   |            |
| <b>Pre-requisite Course(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                    | <b>Co-requisite Course(s)</b> |                                  |   |   |            |
| Object Oriented Programming                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                    | -                             |                                  |   |   |            |
| <b>Course Objectives</b>                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                    |                               |                                  |   |   |            |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                           | To understand the software life cycle models and the importance of process agility.                |                               |                                  |   |   |            |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                           | To gain proficiency in requirements elicitation and the creation of formal SRS documents.          |                               |                                  |   |   |            |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                           | To learn structured and object-oriented design principles including UML.                           |                               |                                  |   |   |            |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                           | To master software testing techniques for ensuring robust and error-free code.                     |                               |                                  |   |   |            |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                           | To explore project management, estimation techniques, and quality assurance standards.             |                               |                                  |   |   |            |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                    |                               |                                  |   |   |            |
| <b>Upon completion of the course, students will be able to</b>                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                    |                               |                                  |   |   |            |
| C466.1                                                                                                                                                                                                                                                                                                                                                                                                                                      | Select and apply appropriate software process models based on project complexity and constraints.  |                               |                                  |   |   | AP         |
| C466.2                                                                                                                                                                                                                                                                                                                                                                                                                                      | Perform requirements analysis and document them according to standard specifications.              |                               |                                  |   |   | AP         |
| C466.3                                                                                                                                                                                                                                                                                                                                                                                                                                      | Create architectural and detailed designs using abstraction and modularity principles.             |                               |                                  |   |   | AP         |
| C466.4                                                                                                                                                                                                                                                                                                                                                                                                                                      | Design and execute comprehensive test plans using white-box and black-box strategies.              |                               |                                  |   |   | AP         |
| C466.5                                                                                                                                                                                                                                                                                                                                                                                                                                      | Estimate project costs and schedules while adhering to software quality and maintenance standards. |                               |                                  |   |   | AP         |
| <b>Course Contents</b>                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                    |                               |                                  |   |   |            |
| <b>Unit – 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Software Process Models</b>                                                                     |                               |                                  |   |   | <b>9+6</b> |
| Software engineering as a layered technology-Software Development Life Cycle (SDLC) Models: Water Fall Model, Prototype Model, Spiral Model, Evolutionary Development Models, Iterative Enhancement Models- Rapid Application Development (RAD)- Agile principles- Scrum and Kanban frameworks.                                                                                                                                             |                                                                                                    |                               |                                  |   |   |            |
| <b>PRACTICAL:</b>                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                               |                                  |   |   |            |
| 1. Comparative study of SDLC models for a given case study and choosing the best fit.                                                                                                                                                                                                                                                                                                                                                       |                                                                                                    |                               |                                  |   |   |            |
| <b>Unit – 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Requirements Engineering</b>                                                                    |                               |                                  |   |   | <b>9+6</b> |
| Elicitation - Analysis - Documentation - Review and Management of User Needs - Feasibility Study - Information Modeling - Data Flow Diagrams - Entity Relationship Diagrams - Impact of Requirement Engineering in their problem, Decision Tables, SRS Document, IEEE Standards for SRS.                                                                                                                                                    |                                                                                                    |                               |                                  |   |   |            |
| <b>PRACTICAL:</b>                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                               |                                  |   |   |            |
| 1.Developing an SRS document for a web-based University Management System.                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                    |                               |                                  |   |   |            |
| <b>Unit – 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Software Design &amp; Architecture</b>                                                          |                               |                                  |   |   | <b>9+6</b> |
| Design concepts: Abstraction, Modularity, Information Hiding; Cohesion and Coupling; UML diagrams: Class, Sequence, and State charts; Interface design.                                                                                                                                                                                                                                                                                     |                                                                                                    |                               |                                  |   |   |            |
| <b>PRACTICAL:</b>                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                               |                                  |   |   |            |
| 1. Designing a system architecture and creating UML diagrams for an E-commerce platform.                                                                                                                                                                                                                                                                                                                                                    |                                                                                                    |                               |                                  |   |   |            |
| <b>Unit – 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Software Testing Tactics</b>                                                                    |                               |                                  |   |   | <b>9+6</b> |
| Testing Objectives - Unit Testing - Integration Testing - Acceptance Testing - Regression Testing - Testing for Functionality and Testing for Performance - Top-Down and Bottom-Up Testing - Software Testing Strategies - Strategies: Test Drivers and Test Stubs - Structural Testing (White Box Testing) - Functional Testing (Black Box Testing) - Testing conventional applications - object oriented applications - Web applications. |                                                                                                    |                               |                                  |   |   |            |
| <b>PRACTICAL:</b>                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                               |                                  |   |   |            |
| 1. Writing and executing test cases for a login module using automated testing tools (e.g., Selenium).                                                                                                                                                                                                                                                                                                                                      |                                                                                                    |                               |                                  |   |   |            |
| <b>Unit – 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Project Management &amp; Quality</b>                                                            |                               |                                  |   |   | <b>9+6</b> |

COCOMO model for cost estimation; Gantt charts and PERT/CPM for scheduling; Software Quality Assurance (SQA); CMMI levels; Software maintenance and Re-engineering.

**PRACTICAL:**

1. Estimating the effort and cost of a software project using the COCOMO calculator.

|                              |           |
|------------------------------|-----------|
| <b>Total Theory Hours</b>    | <b>45</b> |
| <b>Total Practical Hours</b> | <b>30</b> |

**Textbooks:**

|          |                                                                                                                               |
|----------|-------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | Roger S. Pressman and Bruce Maxim, <i>Software Engineering: A Practitioner's Approach</i> , 10th Edition, McGraw Hill (2024). |
| <b>2</b> | Ian Sommerville, <i>Software Engineering</i> , 11th Edition, Pearson Education (2020/2026 Updated Edition).                   |

**Reference Books:**

|          |                                                                                                                      |
|----------|----------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | Pankaj Jalote, <i>An Integrated Approach to Software Engineering</i> , 4th Edition, Narosa Publishing (2023).        |
| <b>2</b> | Robert C. Martin, <i>Clean Code: A Handbook of Agile Software Craftsmanship</i> , 2nd Edition, Prentice Hall (2024). |
| <b>3</b> | Grady Booch, <i>Object-Oriented Analysis and Design with Applications</i> , 4th Edition, Addison-Wesley (2025).      |

| BLOOM'S<br>TAXONOMY<br>LEVEL | ASSESSMENT-1 |      |       | ASSESSMENT-2           |                   | ASSIGNMENT | ATTENDANCE | END SEMESTER<br>EXAMINATION |
|------------------------------|--------------|------|-------|------------------------|-------------------|------------|------------|-----------------------------|
|                              | CIA1         | CIA2 | MODEL | LAB<br>EXPERIM<br>ENTS | MODEL<br>LAB EXAM |            |            |                             |
|                              | 6            | 6    | 8     | 10                     | 10                |            |            |                             |
| <b>Remember</b>              |              |      |       |                        |                   |            |            |                             |
| <b>Understand</b>            | 20           | 20   | 20    |                        |                   |            |            |                             |
| <b>Apply</b>                 | 80           | 80   | 80    | 10                     | 10                | 10         |            |                             |
| <b>Analyze</b>               |              |      |       |                        |                   |            |            |                             |
| <b>Evaluate</b>              |              |      |       |                        |                   |            |            |                             |
| <b>Create</b>                |              |      |       |                        |                   |            |            |                             |
| <b>Total<br/>(100Marks)</b>  | 6            | 6    | 8     | 10                     | 10                | 10         | 10         | 40                          |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 marks.
- Experiment wise laboratory completion 10 marks and Model lab exam will be conducted for 100 marks and the same will be converted to 10 marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/ POs      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 | PSO 3 |
|---------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| <b>C466.1</b> | 3    | 2    |      |      | 2    |      |      |      | 2    | 2     | 3     | 3     | 2     |       |
| <b>C466.2</b> | 3    | 3    | 2    | 2    |      |      |      |      | 2    | 3     |       | 3     | 2     |       |
| <b>C466.3</b> | 3    | 3    | 3    |      | 3    |      |      |      |      |       |       | 3     | 2     |       |
| <b>C466.4</b> | 3    | 3    |      | 3    | 3    |      |      |      |      |       |       | 3     | 2     |       |
| <b>C466.5</b> | 3    |      |      | 2    | 2    |      |      | 3    | 3    | 2     | 3     | 3     | 2     |       |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                   | Course Name                                                                                  | Category                      | Hours/Week                       |   |   | C          |          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|-------------------------------|----------------------------------|---|---|------------|----------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                              |                               | L                                | T | P |            |          |
| 24AD467                                                                                                                                                                                                                                                                                                                                                                                                                                       | BIG DATA ANALYTICS                                                                           | PC                            | 3                                | 0 | 2 | 4          |          |
| <b>Regulation</b>                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Nature of the Course</b>                                                                  | <b>Semester</b>               | <b>Data Book/Codes/Standards</b> |   |   |            |          |
| 2024                                                                                                                                                                                                                                                                                                                                                                                                                                          | THEORY CUM PRACTICAL                                                                         | VI                            |                                  |   |   |            |          |
| <b>Pre-requisite Course(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                              | <b>Co-requisite Course(s)</b> |                                  |   |   |            |          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                              |                               |                                  |   |   |            |          |
| <b>Course Objectives</b>                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                              |                               |                                  |   |   |            |          |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                             | Understand Big Data concepts, 5V's, technologies, and applications.                          |                               |                                  |   |   |            |          |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                             | Explain NoSQL, distribution models, and Cassandra for scalable data management.              |                               |                                  |   |   |            |          |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                             | Apply data preprocessing and MapReduce for large-scale data processing.                      |                               |                                  |   |   |            |          |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                             | Use Hadoop ecosystem and HiveQL for scalable data analysis.                                  |                               |                                  |   |   |            |          |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                             | Implement Hadoop tools like HBase, Pig, and Spark for distributed data processing.           |                               |                                  |   |   |            |          |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                              |                               |                                  |   |   |            |          |
| <b>Upon completion of the course, students will be able to</b>                                                                                                                                                                                                                                                                                                                                                                                |                                                                                              |                               |                                  |   |   |            |          |
| C467.1                                                                                                                                                                                                                                                                                                                                                                                                                                        | Explain Big Data characteristics, tools, and applications.                                   |                               |                                  |   |   | [U]        |          |
| C467.2                                                                                                                                                                                                                                                                                                                                                                                                                                        | Describe NoSQL databases and distributed data models.                                        |                               |                                  |   |   | [U]        |          |
| C467.3                                                                                                                                                                                                                                                                                                                                                                                                                                        | Apply preprocessing techniques and execute MapReduce programs                                |                               |                                  |   |   | [AP]       |          |
| C467.4                                                                                                                                                                                                                                                                                                                                                                                                                                        | Use Hadoop framework, HiveQL, and related components for big data processing.                |                               |                                  |   |   | [AP]       |          |
| C467.5                                                                                                                                                                                                                                                                                                                                                                                                                                        | Implement Hadoop tools such as HBase, Pig, and Spark for scalable data storage and analysis. |                               |                                  |   |   | [AP]       |          |
| <b>Course Contents</b>                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                              |                               |                                  |   |   |            |          |
| <b>Unit – 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Fundamentals of Big Data</b>                                                              |                               |                                  |   |   | <b>C01</b> | <b>9</b> |
| Introduction to Big Data -Definition-Characteristics of Big Data (Volume, Variety, Velocity, Veracity, Value), Convergence of key trends , Domain-specific examples of big data, web analytics, Tools and technologies for big data analytics,Big Data applications– Big Data technologies – introduction to Hadoop – open source technologies – cloud and Big Data – mobile business intelligence – Crowd sourcing analytics- Big Data Stack |                                                                                              |                               |                                  |   |   |            |          |
| <b>PRACTICAL:</b>                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                              |                               |                                  |   |   |            |          |
| 1.Downloading and installing Hadoop; Understanding different Hadoop modes. Startup scripts, Configuration files.                                                                                                                                                                                                                                                                                                                              |                                                                                              |                               |                                  |   |   |            |          |
| <b>Unit – 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>NoSQL Databases and Cassandra Architecture</b>                                            |                               |                                  |   |   | <b>C02</b> | <b>9</b> |
| Introduction to NoSQL, Types of NoSQL Databases (Document, Column, Graph, Key-Value), and popular NoSQL databases, schemaless databases, distribution models – master– slave replication – consistency – Cassandra – Cassandra data model – Cassandra clients.                                                                                                                                                                                |                                                                                              |                               |                                  |   |   |            |          |
| <b>PRACTICAL:</b>                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                              |                               |                                  |   |   |            |          |
| 2.Hadoop Implementation of file management tasks, such as Adding files and directories, retrieving files and Deleting files.                                                                                                                                                                                                                                                                                                                  |                                                                                              |                               |                                  |   |   |            |          |
| <b>Unit – 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Data Preprocessing and MAP REDUCE APPLICATIONS</b>                                        |                               |                                  |   |   | <b>C03</b> | <b>9</b> |
| Data Preprocessing: Data cleaning, transformation, and integration techniques in Big Data. MapReduce workflows - anatomy of MapReduce job run – classic Map– reduce – YARN – failures in classic Map– reduce and YARN – job scheduling – shuffle and sort – task execution – MapReduce types – input formats – output formats.                                                                                                                |                                                                                              |                               |                                  |   |   |            |          |
| <b>PRACTICAL:</b>                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                              |                               |                                  |   |   |            |          |
| 3. Implementation of Matrix Multiplication with Hadoop Map Reduce.                                                                                                                                                                                                                                                                                                                                                                            |                                                                                              |                               |                                  |   |   |            |          |
| 4. Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm.                                                                                                                                                                                                                                                                                                                                                               |                                                                                              |                               |                                  |   |   |            |          |
| 5. Develop a MapReduce program to find the maximum temperature in each year.                                                                                                                                                                                                                                                                                                                                                                  |                                                                                              |                               |                                  |   |   |            |          |
| 6. Develop a MapReduce to find the maximum electrical consumption in each year given electrical consumption for each month in each year.                                                                                                                                                                                                                                                                                                      |                                                                                              |                               |                                  |   |   |            |          |
| 7. Develop a MapReduce to analyze weather data set and print whether the day is shinny or cool day.                                                                                                                                                                                                                                                                                                                                           |                                                                                              |                               |                                  |   |   |            |          |
| <b>Unit – 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>BASICS OF HADOOP AND HIVE FRAMEWORK</b>                                                   |                               |                                  |   |   | <b>C04</b> | <b>9</b> |
| Data format – analyzing data with Hadoop – scaling out – design of Hadoop distributed file system (HDFS) – HDFS concepts – data flow – Hadoop I/O – data integrity – compression – serialization – Hive – data types and file formats - Avro – file– based data structures – HiveQL data definition – HiveQL data manipulation – HiveQL queries.                                                                                              |                                                                                              |                               |                                  |   |   |            |          |
| <b>PRACTICAL:</b>                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                              |                               |                                  |   |   |            |          |
| 8.Installation of Hive along with practice examples.                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                              |                               |                                  |   |   |            |          |
| <b>Unit – 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>HADOOP RELATED TOOLS</b>                                                                  |                               |                                  |   |   | <b>C05</b> | <b>9</b> |
| Hbase – data model and implementations – Hbase clients – Hbase examples – praxis.Pig – Grunt – pig data model – Pig Latin – developing and testing Pig Latin scripts-Spark Architecture, Hadoop vs Spark ,Spark Cluster                                                                                                                                                                                                                       |                                                                                              |                               |                                  |   |   |            |          |
| <b>PRACTICAL:</b>                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                              |                               |                                  |   |   |            |          |

|                                                                                                                                                                                            |                                                                                                                                                                                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9.Installation of HBase, Installing thrift along with Practice examples                                                                                                                    |                                                                                                                                                                                 |
| 10.Write a spark program to compute and measure the runtime and study its scaling behaviour for the following: Box-plots and histograms of all the numerical variables in a large dataset. |                                                                                                                                                                                 |
| <b>Total Hours</b>                                                                                                                                                                         |                                                                                                                                                                                 |
| <b>45</b>                                                                                                                                                                                  |                                                                                                                                                                                 |
| <b>Practical</b>                                                                                                                                                                           |                                                                                                                                                                                 |
| <b>30</b>                                                                                                                                                                                  |                                                                                                                                                                                 |
| <b>Textbooks:</b>                                                                                                                                                                          |                                                                                                                                                                                 |
| 1                                                                                                                                                                                          | Michael Minelli, Michelle Chambers, and AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.        |
| 2.                                                                                                                                                                                         | Rathinaraja Jeyaraj,Ganesh Kumar Pugalandhi, Anand Paul, "Big Data with Hadoop Map Reduce A Classroom Approach", Apple Academic Press, CRC Press, Taylor & Francis Group, 2021. |
| 3.                                                                                                                                                                                         | Ganesh Chadra Deka, "Nosql: database for Storage and Retrieval of Data in Cloud", CRC Press, 2017.                                                                              |
|                                                                                                                                                                                            | Fru Nde, "The Ultimate Guide to Programming Apache Hive", NextGen Publishing, 2015.                                                                                             |
| <b>Reference Books:</b>                                                                                                                                                                    |                                                                                                                                                                                 |
| 1                                                                                                                                                                                          | Seema Acharya, Subhashini Chellappan, "Big Data and Analytics", 2nd Edition, Wiley, 2019.                                                                                       |
| 2                                                                                                                                                                                          | Nathan Marz and James Warren, Big Data: Principles and Best Practices of Scalable Real-Time Data Systems, 1st Edition, Manning Publications, 2023.                              |
| 3                                                                                                                                                                                          | Tom White, "Hadoop: The Definitive Guide", 4th Edition, O'Reilly Media, 2023.                                                                                                   |
| <b>Web References:</b>                                                                                                                                                                     |                                                                                                                                                                                 |
| 1                                                                                                                                                                                          | <a href="#">Big Data Analytics Referencing Guide - Big Data Analytics citation (updated Feb 11 2026) - Citationsy</a>                                                           |

| BLOOM'S<br>TAXONO<br>MY<br>LEVEL | ASSESMET-1 |          |           | ASSESMET-2             |                       | ASSIGNMEN<br>T | ATTENDANC<br>E | END<br>SEMESTER<br>EXAMINATIO<br>N |
|----------------------------------|------------|----------|-----------|------------------------|-----------------------|----------------|----------------|------------------------------------|
|                                  | CIA<br>1   | CIA2     | MODE<br>L | LAB<br>EXPERI<br>MENTS | MODE<br>L LAB<br>EXAM |                |                |                                    |
|                                  | 6          | 6        | 8         | 10                     | 10                    |                |                |                                    |
| Remember                         |            |          |           |                        |                       |                |                |                                    |
| Understand                       | 70         | 70       | 30        |                        |                       |                |                |                                    |
| Apply                            | 30         | 30       | 70        |                        |                       |                |                |                                    |
| Analyze                          |            |          |           |                        |                       |                |                |                                    |
| Evaluate                         |            |          |           |                        |                       |                |                |                                    |
| Create                           |            |          |           |                        |                       |                |                |                                    |
| <b>Total<br/>(100Marks)</b>      | <b>6</b>   | <b>6</b> | <b>8</b>  | <b>15</b>              | <b>5</b>              | <b>10</b>      | <b>10</b>      | <b>40</b>                          |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 marks.
- Experiment wise laboratory completion 15 marks and Model lab exam will be conducted for 100 marks and the same will be converted to 5 marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO<br>10 | PO<br>11 | PSO<br>1 | PS<br>O 2 | PSO<br>3 |
|-------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|-----------|----------|
| C467.1      | 3       | 2       | 1       | -       | 2       | 1       | 1       | -       | 1       | -        | 2        | 2        | 2         | 1        |
| C467.2      | 3       | 2       | 2       | 1       | 2       | -       | -       | -       | 1       | -        | 2        | 2        | 3         | 2        |
| C467.3      | 3       | 2       | 3       | 2       | 3       | -       | -       | 1       | 1       | 1        | 2        | 2        | 3         | 3        |
| C467.4      | 3       | 2       | 3       | 2       | 3       | 1       | -       | 1       | 1       | 1        | 2        | 2        | 3         | 3        |
| C467.5      | 3       | 2       | 3       | 2       | 3       | 1       | -       | 1       | 1       | 1        | 2        | 3        | 3         | 3        |

1 - low, 2 - medium, 3 - high, '-' - no correlation

**SYLLABI**  
**PROFESSIONAL ELECTIVES**  
**(APPLICABLE FOR STUDENTS ADMITTED FROM 2024-2025)**

| Course Code                                                                                                                                                                                                                                                                                                                                                                                       | Course Name                                                                                                    | Category               | Hours/Week                |   |   | C    |      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|---|------|------|
|                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                |                        | L                         | T | P |      |      |
| 24AD501                                                                                                                                                                                                                                                                                                                                                                                           | EXPLORATORY DATA ANALYSIS                                                                                      | PE                     | 3                         | 0 | 0 | 3    |      |
| Regulation                                                                                                                                                                                                                                                                                                                                                                                        | Nature of the Course                                                                                           | Semester               | Data Book/Codes/Standards |   |   |      |      |
| 2024                                                                                                                                                                                                                                                                                                                                                                                              | THEORY                                                                                                         | -                      | -                         |   |   |      |      |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                | Co-requisite Course(s) |                           |   |   |      |      |
| DATA EXPLORATION AND VISUALIZATION                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                | -                      |                           |   |   |      |      |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                |                        |                           |   |   |      |      |
| 1                                                                                                                                                                                                                                                                                                                                                                                                 | To introduce the concepts and importance of Exploratory Data Analysis in the data science workflow             |                        |                           |   |   |      |      |
| 2                                                                                                                                                                                                                                                                                                                                                                                                 | To enable students to understand different types of data and statistical measures used for analyzing datasets  |                        |                           |   |   |      |      |
| 3                                                                                                                                                                                                                                                                                                                                                                                                 | To analyze relationships among variables using statistical and visualization techniques                        |                        |                           |   |   |      |      |
| 4                                                                                                                                                                                                                                                                                                                                                                                                 | To apply various graphical methods and visualization techniques for interpreting data patterns.                |                        |                           |   |   |      |      |
| 5                                                                                                                                                                                                                                                                                                                                                                                                 | To perform exploratory analysis on real-world datasets and derive meaningful insights.                         |                        |                           |   |   |      |      |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                |                        |                           |   |   |      |      |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                                                                           |                                                                                                                |                        |                           |   |   |      |      |
| C501.1                                                                                                                                                                                                                                                                                                                                                                                            | Understand the concepts, data types and statistical measures used in exploratory data analysis.                |                        |                           |   |   | [U]  |      |
| C501.2                                                                                                                                                                                                                                                                                                                                                                                            | Apply techniques to analyze relationships between variables using statistical measures and contingency tables. |                        |                           |   |   | [AP] |      |
| C501.3                                                                                                                                                                                                                                                                                                                                                                                            | Apply visualization principles to represent relationships and patterns in datasets.                            |                        |                           |   |   | [AP] |      |
| C501.4                                                                                                                                                                                                                                                                                                                                                                                            | Explore datasets using statistical graphs and visualization techniques                                         |                        |                           |   |   | [AP] |      |
| C501.5                                                                                                                                                                                                                                                                                                                                                                                            | Predict exploratory analysis on real-world datasets and interpret results for decision making.                 |                        |                           |   |   | [AP] |      |
| Course Contents                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                |                        |                           |   |   |      |      |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                                                          | INTRODUCTION TO EXPLORATORY DATA ANALYSIS                                                                      |                        |                           |   |   | C01  | 9Hrs |
| Introduction to Exploratory Data Analysis (EDA) – Importance of EDA in data science – Types of data: numerical and categorical data – Discrete and continuous variables – Distribution of variables – Numerical summaries of data: measures of central tendency and dispersion – Scaling and standardizing data – Inequality measures – Introduction to smoothing techniques in time series data. |                                                                                                                |                        |                           |   |   |      |      |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                                                          | ANALYSIS OF RELATIONSHIPS IN DATA                                                                              |                        |                           |   |   | C02  | 9Hrs |
| Relationships between two variables – Scatter plots and correlation – Percentage tables and contingency tables – Analysing relationships in categorical data – Handling multiple datasets – Transformations of variables – Introducing a third variable – Basic causal interpretation – Three-variable contingency tables – Introduction to longitudinal data analysis.                           |                                                                                                                |                        |                           |   |   |      |      |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                                                          | DATA VISUALIZATION PRINCIPLES                                                                                  |                        |                           |   |   | C03  | 9Hrs |
| Principles of data visualization – Stages of visualizing data – Mapping data to visual elements – Visualizing relationships and correlations – Scatterplot maps – Visualization of hierarchies and trees – Network and graph visualization – Data acquisition and parsing for visualization.                                                                                                      |                                                                                                                |                        |                           |   |   |      |      |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                                                          | STATISTICAL GRAPHS AND VISUAL ANALYSIS                                                                         |                        |                           |   |   | C04  | 9Hrs |
| Histograms and density curves – Frequency polygons – Box plots and violin plots – Dot plots for grouped data – Two-dimensional density plots – Correlation matrix visualization – Heat maps – Three-dimensional scatter plots – Dendrograms – Q-Q plots and mosaic plots.                                                                                                                         |                                                                                                                |                        |                           |   |   |      |      |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                                                          | APPLICATIONS OF DATA EXPLORATION                                                                               |                        |                           |   |   | C05  | 9Hrs |
| Applications of EDA in real-world datasets – Data handling and preprocessing – Loading and transforming datasets – Creating tidy data – Basic exploratory analysis workflow – Visualization for decision making – Case study: Analysis of student academic performance data.                                                                                                                      |                                                                                                                |                        |                           |   |   |      |      |

|                         |                                                                                                            | Total Hours | 45 |
|-------------------------|------------------------------------------------------------------------------------------------------------|-------------|----|
| <b>Textbooks:</b>       |                                                                                                            |             |    |
| 1                       | Suresh Kumar Mukhiya, Usman Ahmed, Hands-On Exploratory Data Analysis with Python, Packt Publishing, 2020. |             |    |
| 2                       | W. Martinez, A. Martinez, J. L. Solka, Exploratory Data Analysis with MATLAB, CRC Press, 3rd Edition, 2017 |             |    |
| <b>Reference Books:</b> |                                                                                                            |             |    |
| 1                       | Michael Jambu, Exploratory and Multivariate Data Analysis, Academic Press                                  |             |    |
| 2                       | Charu C. Aggarwal, Data Mining: The Textbook, Springer, 2015                                               |             |    |
|                         | Craig K. Enders, Applied Missing Data Analysis, The Guilford Press, 2010.                                  |             |    |
| <b>Web References:</b>  |                                                                                                            |             |    |
| 1                       | Kaggle – <a href="https://www.kaggle.com/learn">https://www.kaggle.com/learn</a>                           |             |    |
| 2                       | Towards Data Science – <a href="https://towardsdatascience.com">https://towardsdatascience.com</a>         |             |    |
| 3                       | Scikit-learn Documentation – <a href="https://scikit-learn.org">https://scikit-learn.org</a>               |             |    |
| 4                       | Pandas Documentation – <a href="https://pandas.pydata.org">https://pandas.pydata.org</a>                   |             |    |
| 5                       | Matplotlib Documentation – <a href="https://matplotlib.org">https://matplotlib.org</a>                     |             |    |
| 6                       | Seaborn Documentation – <a href="https://seaborn.pydata.org">https://seaborn.pydata.org</a>                |             |    |

| Assessment based on Continuous and End Semester Examination |                       |                |                      |            |            |                          |
|-------------------------------------------------------------|-----------------------|----------------|----------------------|------------|------------|--------------------------|
| BLOOM'S TAXONOMY LEVEL                                      | CONTINUOUS ASSESSMENT |                |                      | ASSIGNMENT | ATTENDANCE | END SEMESTER EXAMINATION |
|                                                             | CIA1 (6 Marks)        | CIA2 (6 Marks) | Model Exam (8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)               |
| Remember                                                    |                       |                |                      | 10         | 10         | 60                       |
| Understand                                                  | 60%                   |                | 20%                  |            |            |                          |
| Apply                                                       | 40%                   | 100%           | 80%                  |            |            |                          |
| Analyze                                                     |                       |                |                      |            |            |                          |
| Evaluate                                                    |                       |                |                      |            |            |                          |
| Create                                                      |                       |                |                      |            |            |                          |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>       | <b>8</b>             | <b>10</b>  | <b>10</b>  | <b>60</b>                |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/ POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 | PSO 3 |
|----------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| C501.1   | 3    | 2    | -    | -    | 1    | -    | -    | -    | -    | -     | 2     | 2     | 2     | 2     |
| C501.2   | 3    | 3    | 1    | 2    | 2    | -    | -    | -    | -    | -     | 2     | 2     | 2     | 2     |
| C501.3   | 2    | 3    | 2    | 2    | 3    | -    | -    | -    | -    | -     | 2     | 3     | 2     | 2     |
| C501.4   | 2    | 3    | 2    | 3    | 3    | -    | -    | -    | -    | -     | 2     | 3     | 2     | 2     |
| C501.5   | 2    | 3    | 3    | 3    | 3    | -    | -    | -    | -    | -     | 2     | 3     | 3     | 2     |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                           | Course Name                                                                                                                                  | Category               | Hours/Week                |   |   | C    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|---|------|
|                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                              |                        | L                         | T | P |      |
| 24AD502                                                                                                                                                                                                                                                                                                                               | Image and Video Analytics                                                                                                                    | PE                     | 3                         | 0 | 0 | 3    |
| Regulation                                                                                                                                                                                                                                                                                                                            | Nature of the Course                                                                                                                         | Semester               | Data Book/Codes/Standards |   |   |      |
| 2024                                                                                                                                                                                                                                                                                                                                  | Theory                                                                                                                                       | -                      | -----                     |   |   |      |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                               |                                                                                                                                              | Co-requisite Course(s) |                           |   |   |      |
| -                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                              | -                      |                           |   |   |      |
| Course Objectives                                                                                                                                                                                                                                                                                                                     |                                                                                                                                              |                        |                           |   |   |      |
| 1                                                                                                                                                                                                                                                                                                                                     | To understand the basics of image processing techniques for computer vision.                                                                 |                        |                           |   |   |      |
| 2                                                                                                                                                                                                                                                                                                                                     | To learn the techniques used for image pre-processing.                                                                                       |                        |                           |   |   |      |
| 3                                                                                                                                                                                                                                                                                                                                     | To discuss the various object detection techniques.                                                                                          |                        |                           |   |   |      |
| 4                                                                                                                                                                                                                                                                                                                                     | To understand the various Object recognition mechanisms.                                                                                     |                        |                           |   |   |      |
| 5                                                                                                                                                                                                                                                                                                                                     | To elaborate on the video analytics techniques.                                                                                              |                        |                           |   |   |      |
| Course Outcomes                                                                                                                                                                                                                                                                                                                       |                                                                                                                                              |                        |                           |   |   |      |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                               |                                                                                                                                              |                        |                           |   |   |      |
| C502.1                                                                                                                                                                                                                                                                                                                                | Understand the basics of image processing techniques for computer vision and video analysis.                                                 |                        |                           |   |   | [U]  |
| C502.2                                                                                                                                                                                                                                                                                                                                | Explain the techniques used for image pre-processing.                                                                                        |                        |                           |   |   | [U]  |
| C502.3                                                                                                                                                                                                                                                                                                                                | Apply Various object detection techniques to solve real world image analysis problems.                                                       |                        |                           |   |   | [AP] |
| C502.4                                                                                                                                                                                                                                                                                                                                | Apply various face recognition mechanisms to develop and implement real world recognition systems.                                           |                        |                           |   |   | [AP] |
| C502.5                                                                                                                                                                                                                                                                                                                                | Apply deep learning techniques to analyze and interpret video data for real world video analytics applications.                              |                        |                           |   |   | [AP] |
| Course Contents                                                                                                                                                                                                                                                                                                                       |                                                                                                                                              |                        |                           |   |   |      |
| Unit – 1                                                                                                                                                                                                                                                                                                                              | INTRODUCTION TO IMAGE ANALYTICS                                                                                                              |                        |                           |   |   | 9    |
| Computer Vision – Image representation and image analysis tasks - Image representations – digitization – properties – color images – Data structures for Image Analysis - Levels of image data representation - Traditional and Hierarchical image data structures.                                                                   |                                                                                                                                              |                        |                           |   |   |      |
| Unit – 2                                                                                                                                                                                                                                                                                                                              | IMAGE PRE-PROCESSING                                                                                                                         |                        |                           |   |   | 9    |
| Local pre-processing - Image smoothing - Edge detectors - Zero-crossings of the second derivative - Scale in image processing - Canny edge detection - Parametric edge models - Edges in multi-speralct images - Local pre-processing in the frequency domain - Line detection by local pre-processing operators - Image restoration. |                                                                                                                                              |                        |                           |   |   |      |
| Unit – 3                                                                                                                                                                                                                                                                                                                              | OBJECT DETECTION USING MACHINE LEARNING                                                                                                      |                        |                           |   |   | 9    |
| Object detection– Object detection methods – Deep Learning framework for Object detection– bounding box approach-Intersection over Union (IoU) –Deep Learning Architectures-R-CNN-Faster R-CNN-You Only Look Once(YOLO)-Salient features-Loss Functions-YOLO architectures                                                            |                                                                                                                                              |                        |                           |   |   |      |
| Unit – 4                                                                                                                                                                                                                                                                                                                              | FACE RECOGNITION AND GESTURE RECOGNITION                                                                                                     |                        |                           |   |   | 9    |
| Face Recognition-Introduction-Applications of Face Recognition-Process of Face Recognition- DeepFace solution by Facebook-FaceNet for Face Recognition- Implementation using FaceNet- Gesture Recognition.                                                                                                                            |                                                                                                                                              |                        |                           |   |   |      |
| Unit – 5                                                                                                                                                                                                                                                                                                                              | VIDEO ANALYTICS                                                                                                                              |                        |                           |   |   | 9    |
| Video Processing – use cases of video analytics-Vanishing Gradient and exploding gradient problem- RestNet architecture-RestNet and skip connections-Inception Network-GoogleNet architecture- Improvement in Inception v2-Video analytics-RestNet and Inception v3.                                                                  |                                                                                                                                              |                        |                           |   |   |      |
| Total Hours                                                                                                                                                                                                                                                                                                                           |                                                                                                                                              |                        |                           |   |   | 45   |
| Textbooks:                                                                                                                                                                                                                                                                                                                            |                                                                                                                                              |                        |                           |   |   |      |
| 1                                                                                                                                                                                                                                                                                                                                     | Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis, and Machine Vision”, 4nd edition, Thomson Learning, 2013.              |                        |                           |   |   |      |
| 2                                                                                                                                                                                                                                                                                                                                     | Vaibhav Verdhan,(2021, Computer Vision Using Deep Learning Neural Network Architectures with Python and Keras,Apress 2021(UNIT-III,IV and V) |                        |                           |   |   |      |
| Reference Books:                                                                                                                                                                                                                                                                                                                      |                                                                                                                                              |                        |                           |   |   |      |
| 1                                                                                                                                                                                                                                                                                                                                     | Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer Verlag London Limited,2011.                                       |                        |                           |   |   |      |
| 2                                                                                                                                                                                                                                                                                                                                     | Caifeng Shan, FatihPorikli, Tao Xiang, Shaogang Gong, “Video Analytics for Business Intelligence”, Springer, 2012.                           |                        |                           |   |   |      |
| 3                                                                                                                                                                                                                                                                                                                                     | D. A. Forsyth, J. Ponce, “Computer Vision: A Modern Approach”, Pearson Education, 2003.                                                      |                        |                           |   |   |      |
| 4                                                                                                                                                                                                                                                                                                                                     | E. R. Davies, (2012), “Computer & Machine Vision”, Fourth Edition, Academic Press.                                                           |                        |                           |   |   |      |
| Web References:                                                                                                                                                                                                                                                                                                                       |                                                                                                                                              |                        |                           |   |   |      |
| 1                                                                                                                                                                                                                                                                                                                                     | <a href="https://nptel.ac.in/courses/106101061">https://nptel.ac.in/courses/106101061</a>                                                    |                        |                           |   |   |      |

|   |                                                                                           |
|---|-------------------------------------------------------------------------------------------|
| 2 | <a href="https://nptel.ac.in/courses/106105087">https://nptel.ac.in/courses/106105087</a> |
| 3 | <a href="https://nptel.ac.in/courses/106105182">https://nptel.ac.in/courses/106105182</a> |

| Assessment based on Continuous and End Semester Examination |                   |                   |                         |                |                |                             |
|-------------------------------------------------------------|-------------------|-------------------|-------------------------|----------------|----------------|-----------------------------|
| Bloom's Level                                               | CIA1<br>(6 Marks) | CIA2<br>(6 Marks) | Model Exam<br>(8 Marks) | Assignm<br>ent | Attenda<br>nce | End Semester<br>Examination |
| Remember                                                    |                   |                   |                         | (10<br>Marks)  | (10<br>Marks)  | (60 Marks)                  |
| Understand                                                  | 100%              | 20%               | 30%                     |                |                |                             |
| Apply                                                       |                   | 80%               | 70%                     |                |                |                             |
| Analyze                                                     |                   |                   |                         |                |                |                             |
| Evaluate                                                    |                   |                   |                         |                |                |                             |
| Create                                                      |                   |                   |                         |                |                |                             |
| Total (100 Marks)                                           | 6                 | 6                 | 8                       | 10             | 10             | 60                          |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO1<br>0 | PO1<br>1 | PSO<br>1 | PSO<br>2 | PSO3 |
|-------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|------|
| C502.1      | 3       | 1       | 2       | 2       | -       | -       | -       | -       | -       | -        | 2        | 2        | 2        | 3    |
| C502.2      | 2       | 2       | 3       | 3       | -       | -       | -       | -       | -       | -        | 2        | 2        | 2        | 2    |
| C502.3      | 1       | 2       | 2       | 2       | -       | -       | -       | -       | -       | -        | 2        | 2        | 2        | 3    |
| C502.4      | 1       | 2       | 3       | 2       | -       | -       | -       | -       | -       | -        | 2        | 2        | 2        | 2    |
| C502.5      | 3       | 2       | 1       | 3       | -       | -       | -       | -       | -       | -        | 2        | 3        | 2        | 2    |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                                                   | Course Name                                                                                                                | Category               | Hours/Week                |   |             | C  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|-------------|----|
|                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                            |                        | L                         | T | P           |    |
| 24AD503                                                                                                                                                                                                                                                                                                                                                                                       | HEALTHCARE ANALYTICS                                                                                                       | PE                     | 3                         | 0 | 0           | 3  |
| Regulation                                                                                                                                                                                                                                                                                                                                                                                    | Nature of the Course                                                                                                       | Semester               | Data Book/Codes/Standards |   |             |    |
| 2024                                                                                                                                                                                                                                                                                                                                                                                          | Theory                                                                                                                     |                        |                           |   |             |    |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                            | Co-requisite Course(s) |                           |   |             |    |
|                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                            |                        |                           |   |             |    |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                            |                        |                           |   |             |    |
| 1                                                                                                                                                                                                                                                                                                                                                                                             | Understand the health data formats, health care policy and standards                                                       |                        |                           |   |             |    |
| 2                                                                                                                                                                                                                                                                                                                                                                                             | Learn the significance and need of data analysis and data visualization                                                    |                        |                           |   |             |    |
| 3                                                                                                                                                                                                                                                                                                                                                                                             | Understand the health data management frameworks                                                                           |                        |                           |   |             |    |
| 4                                                                                                                                                                                                                                                                                                                                                                                             | Learn the use of machine learning and deep learning algorithms in healthcare                                               |                        |                           |   |             |    |
| 5                                                                                                                                                                                                                                                                                                                                                                                             | Apply healthcare analytics for critical care applications                                                                  |                        |                           |   |             |    |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                            |                        |                           |   |             |    |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                                                                       |                                                                                                                            |                        |                           |   |             |    |
| C503.1                                                                                                                                                                                                                                                                                                                                                                                        | Understand machine learning and deep learning algorithms for health data analysis                                          |                        |                           |   |             | U  |
| C503.2                                                                                                                                                                                                                                                                                                                                                                                        | Apply the data management techniques for healthcare data                                                                   |                        |                           |   |             | AP |
| C503.3                                                                                                                                                                                                                                                                                                                                                                                        | Examine the need of healthcare data analysis in e-healthcare, telemedicine and other critical care applications            |                        |                           |   |             | AP |
| C503.4                                                                                                                                                                                                                                                                                                                                                                                        | Design health data analytics for real time applications                                                                    |                        |                           |   |             | AP |
| C503.5                                                                                                                                                                                                                                                                                                                                                                                        | Use emergency care system using health data analysis                                                                       |                        |                           |   |             | AP |
| Course Contents                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                            |                        |                           |   |             |    |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                                                      | INTRODUCTION TO HEALTHCARE ANALYSIS                                                                                        |                        |                           |   | C01         | 9  |
| Overview - History of Healthcare Analysis Parameters on medical care systems- Need for Healthcare Analytics - Foundations of Healthcare Analytics - Health care policy- Standardized code sets – Machine Learning Foundations: Tree Like reasoning , Probabilistic reasoning and Bayes Theorem                                                                                                |                                                                                                                            |                        |                           |   |             |    |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                                                      | ANALYTICS ON MACHINE LEARNING                                                                                              |                        |                           |   | C02         | 9  |
| Machine Learning Pipeline – Pre-processing –Visualization – Feature Selection – Training model parameter – Evaluation model : Sensitivity , Specificity , PPV ,NPV, FPR ,Accuracy , ROC , Precision Recall Curves , Valued target variables –Python: Variables and types, Data Structures and containers , Pandas Data Frame :Operations – Scikit –Learn : Pre-processing , Feature Selection |                                                                                                                            |                        |                           |   |             |    |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                                                      | HEALTH CARE MANAGEMENT                                                                                                     |                        |                           |   | C03         | 9  |
| IOT- Smart Sensors –Decision Support System – Medicare value-based programs- Matrix block Cipher System – Semantic Framework Analysis – Histogram bin Shifting and Rc6 Encryption – Clinical Prediction Models – Visual Analytics for Healthcare.                                                                                                                                             |                                                                                                                            |                        |                           |   |             |    |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                                                      | HEALTHCARE AND DEEP LEARNING                                                                                               |                        |                           |   | C04         | 9  |
| Introduction on Deep Learning – DFF network CNN- RNN for Sequences – Biomedical Image and Signal Analysis – Natural Language Processing and Data Mining for Clinical Data – Mobile Imaging and Analytics – Clinical Decision Support System.                                                                                                                                                  |                                                                                                                            |                        |                           |   |             |    |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                                                      | HEALTHCARE ANALYSTICS APPLICATIONS& CASE STUDIES                                                                           |                        |                           |   | C05         | 9  |
| Introduction - Descriptive Analytics Applications - Predictive Analytics Applications - Prescriptive Analytics Application                                                                                                                                                                                                                                                                    |                                                                                                                            |                        |                           |   |             |    |
| Predicting Mortality for cardiology Practice –Smart Ambulance System using IOT –Hospital Acquired Conditions (HAC) program- Healthcare and Emerging Technologies – ECG Data Analysis.                                                                                                                                                                                                         |                                                                                                                            |                        |                           |   |             |    |
|                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                            |                        |                           |   | Total Hours | 45 |
| Textbooks:                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                            |                        |                           |   |             |    |
| 1                                                                                                                                                                                                                                                                                                                                                                                             | Chandan K.Reddy, Charu C. Aggarwal, “Health Care data Analysis”, First edition, CRC, 2015.                                 |                        |                           |   |             |    |
| 2                                                                                                                                                                                                                                                                                                                                                                                             | Hui Jang, Eva K.Lee, “HealthCare Analysis : From Data to Knowledge to Healthcare Improvement”, First Edition, Wiley, 2016. |                        |                           |   |             |    |
| 3                                                                                                                                                                                                                                                                                                                                                                                             | Vikas Kumar, “Health Care Analysis Made Simple”, Packt Publishing, 2018.                                                   |                        |                           |   |             |    |
| Reference Books:                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                            |                        |                           |   |             |    |

|                        |                                                                                                                                                                                              |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                      | Nilanjan Dey, Amira Ashour , Simon James Fong, Chintan Bhatl, "Health Care Data Analysis and Management, First Edition, Academic Press, 2018.                                                |
| 2                      | Kulkarni , Siarry, Singh ,Abraham, Zhang, Zomaya , Baki, "Big Data Analytics in HealthCare", Springer, 2020.                                                                                 |
| 3                      | Dinov, Ivo D. "Data Science and Predictive Analytics." Springer, Ann Arbor, MI, USA<br><a href="https://doi.org/10.1007/978-1-4939-9888-8_1">https://doi.org/10.1007/978-1-4939-9888-8_1</a> |
| 4                      | El Morr, Christo, and Hossam Ali-Hassan. Analytics in healthcare: a practical introduction. Springer, 2019.                                                                                  |
| <b>Web References:</b> |                                                                                                                                                                                              |
| 1                      | <a href="https://scikit-learn.org/stable">https://scikit-learn.org/stable</a>                                                                                                                |
| 2                      | <a href="https://www.tensorflow.org/">https://www.tensorflow.org/</a>                                                                                                                        |

| Assessment based on Continuous and End Semester Examination |                       |                   |                         |            |            |                                |
|-------------------------------------------------------------|-----------------------|-------------------|-------------------------|------------|------------|--------------------------------|
| BLOOM'S<br>TAXONOMY<br>LEVEL                                | CONTINUOUS ASSESSMENT |                   |                         | ASSIGNMENT | ATTENDANCE | END<br>SEMESTER<br>EXAMINATION |
|                                                             | CIA1<br>(6 Marks)     | CIA2<br>(6 Marks) | Model Exam<br>(8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)                     |
| Remember                                                    |                       |                   |                         | 10         | 10         | 60                             |
| Understand                                                  | 80%                   | 100%              | 20%                     |            |            |                                |
| Apply                                                       | 20%                   |                   | 80%                     |            |            |                                |
| Analyze                                                     |                       |                   |                         |            |            |                                |
| Evaluate                                                    |                       |                   |                         |            |            |                                |
| Create                                                      |                       |                   |                         |            |            |                                |
| <b>Total<br/>(100 Marks)</b>                                | <b>6</b>              | <b>6</b>          | <b>8</b>                | <b>10</b>  | <b>10</b>  | <b>60</b>                      |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO<br>10 | PO<br>11 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|-------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|
| C503.1      | 3       | 3       | 3       | 1       | -       | -       | -       | -       | -       | -        | 1        | 2        | 2        | 2        |
| C503.2      | 3       | 1       | 1       | 3       | -       | -       | -       | -       | -       | -        | 3        | 3        | 3        | 3        |
| C503.3      | 2       | 1       | 2       | 1       | -       | -       | -       | -       | -       | -        | 1        | 3        | 2        | 2        |
| C503.4      | 2       | 2       | 3       | 3       | -       | -       | -       | -       | -       | -        | 1        | 3        | 2        | 2        |
| C503.5      | 1       | 2       | 2       | 1       | -       | -       | -       | -       | -       | -        | 3        | 2        | 2        | 2        |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                              | Course Name                                                                                                                                                                                    | Category               | Hours/Week                |   |             | C     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|-------------|-------|
|                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                |                        | L                         | T | P           |       |
| 24AD504                                                                                                                                                                                                                                                                                                                                                  | TEXT AND SPEECH ANALYSIS                                                                                                                                                                       | PE                     | 3                         | 0 | 0           | 3     |
| Regulation                                                                                                                                                                                                                                                                                                                                               | Nature of the Course                                                                                                                                                                           | Semester               | Data Book/Codes/Standards |   |             |       |
| 2024                                                                                                                                                                                                                                                                                                                                                     | THEORY                                                                                                                                                                                         |                        | NIL                       |   |             |       |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                | Co-requisite Course(s) |                           |   |             |       |
| Machine Learning                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                | Deep Learning          |                           |   |             |       |
| Course Objectives                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                                                                                                        | To understand fundamental NLP concepts and text representation techniques.                                                                                                                     |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                                                                                                        | To apply embeddings and deep learning models for text classification and analysis.                                                                                                             |                        |                           |   |             |       |
| 3                                                                                                                                                                                                                                                                                                                                                        | To design and evaluate question answering and dialogue systems.                                                                                                                                |                        |                           |   |             |       |
| 4                                                                                                                                                                                                                                                                                                                                                        | To study techniques for text-to-speech synthesis using signal processing and deep learning methods.                                                                                            |                        |                           |   |             |       |
| 5                                                                                                                                                                                                                                                                                                                                                        | To develop automatic speech recognition systems and evaluate their performance.                                                                                                                |                        |                           |   |             |       |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                |                        |                           |   |             |       |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                |                        |                           |   |             |       |
| C504.1                                                                                                                                                                                                                                                                                                                                                   | Explain existing and emerging deep learning architectures for text and speech Processing                                                                                                       |                        |                           |   |             | [U]   |
| C504.2                                                                                                                                                                                                                                                                                                                                                   | Implement text classification using embeddings and deep learning.                                                                                                                              |                        |                           |   |             | [AP]  |
| C504.3                                                                                                                                                                                                                                                                                                                                                   | Apply question answering and dialogue systems.                                                                                                                                                 |                        |                           |   |             | [AP]  |
| C504.4                                                                                                                                                                                                                                                                                                                                                   | Apply text-to-speech synthesis systems.                                                                                                                                                        |                        |                           |   |             | [AP]  |
| C504.5                                                                                                                                                                                                                                                                                                                                                   | Use speech recognition systems.                                                                                                                                                                |                        |                           |   |             | [AP]  |
| Course Contents                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                |                        |                           |   |             |       |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                 | NATURAL LANGUAGE BASICS                                                                                                                                                                        |                        |                           |   | C01         | 9 Hrs |
| Foundations of natural language processing – Language Syntax and Structure- Text Preprocessing and Wrangling – Text tokenization – Stemming – Lemmatization – Removing stop words – Feature Engineering for Text representation – Bag of Words model- Bag of N-Grams model – TF-IDF model – Text Similarity (Similarity Metrics used in Text Analytics). |                                                                                                                                                                                                |                        |                           |   |             |       |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                 | TEXT CLASSIFICATION                                                                                                                                                                            |                        |                           |   | C02         | 9 Hrs |
| Vector Semantics and Embeddings -Word Embeddings - Word2Vec model – Glove model – FastText model – Overview of Deep Learning models – RNN – Transformers – Overview of Text summarization and Topic Models.                                                                                                                                              |                                                                                                                                                                                                |                        |                           |   |             |       |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                 | QUESTION ANSWERING AND DIALOGUE SYSTEMS                                                                                                                                                        |                        |                           |   | C03         | 9 Hrs |
| Information retrieval – IR-based question answering – knowledge-based question answering – language models for QA – classic QA models – chatbots – Design of dialogue systems -- evaluating dialogue systems.                                                                                                                                            |                                                                                                                                                                                                |                        |                           |   |             |       |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                 | TEXT-TO-SPEECH SYNTHESIS                                                                                                                                                                       |                        |                           |   | C04         | 9 Hrs |
| SYNTHESIS Text normalization. Letter-to-sound. Prosody, Evaluation. Signal processing - Concatenative and parametric approaches, WaveNet and other deep learning-based TTS systems.                                                                                                                                                                      |                                                                                                                                                                                                |                        |                           |   |             |       |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                 | AUTOMATIC SPEECH RECOGNITION                                                                                                                                                                   |                        |                           |   | C05         | 9 Hrs |
| Speech recognition: Feature Extraction - Acoustic modeling – HMM, HMM-DNN systems – Language Models – LSTM – Decoding Strategies – Evaluation of ASR systems – Word Error rate, Recognition accuracy.                                                                                                                                                    |                                                                                                                                                                                                |                        |                           |   |             |       |
|                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                |                        |                           |   | Total Hours | 45    |
| Textbooks:                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                                                                                                        | Daniel Jurafsky and James H. Martin, “Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Third Edition, 2022. |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                                                                                                        | Natural Language Processing with Python,Steven Bird, Ewan Klein and Edward Loper,O'Reilly Media, 1st Edition, 2009.                                                                            |                        |                           |   |             |       |
| Reference Books:                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                                                                                                        | Lewis Tunstall, Leandro von Werra, and Thomas Wolf, Natural Language Processing with Transformers: Building Language Applications with Hugging Face, O'Reilly Media, 2021.                     |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                                                                                                        | Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, The MIT Press, 2016 (latest widely used edition).                                                                           |                        |                           |   |             |       |
| 3                                                                                                                                                                                                                                                                                                                                                        | Lawrence Rabiner and Biing-Hwang Juang, Fundamentals of Speech Recognition, Prentice Hall, 1993 (classic foundational edition).                                                                |                        |                           |   |             |       |

|   |                                                                                                                                           |
|---|-------------------------------------------------------------------------------------------------------------------------------------------|
| 4 | Christopher D. Manning, Prabhakar Raghavan, and Hinrich Schütze, Introduction to Information Retrieval, Cambridge University Press, 2020. |
| 5 | Paul Taylor, Text-to-Speech Synthesis, Cambridge University Press, 2009 (standard reference for TTS).                                     |

**Web References:**

|   |                                                                                                                                                           |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <a href="https://onlinecourses.nptel.ac.in/noc26_cs45/preview?">https://onlinecourses.nptel.ac.in/noc26_cs45/preview?</a>                                 |
| 2 | <a href="https://www.coursera.org/specializations/natural-language-processing?">https://www.coursera.org/specializations/natural-language-processing?</a> |

**Assessment based on Continuous and End Semester Examination**

| BLOOM'S TAXONOMY LEVEL   | CONTINUOUS ASSESSMENT |                |                      | ASSIGNMENT | ATTENDANCE | END SEMESTER EXAMINATION |
|--------------------------|-----------------------|----------------|----------------------|------------|------------|--------------------------|
|                          | CIA1 (6 Marks)        | CIA2 (6 Marks) | Model Exam (8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)               |
| Remember                 |                       |                |                      | 10         | 10         | 60                       |
| Understand               | 80%                   |                | 20%                  |            |            |                          |
| Apply                    | 20%                   | 100%           | 80%                  |            |            |                          |
| Analyze                  |                       |                |                      |            |            |                          |
| Evaluate                 |                       |                |                      |            |            |                          |
| Create                   |                       |                |                      |            |            |                          |
| <b>Total (100 Marks)</b> | <b>6</b>              | <b>6</b>       | <b>8</b>             | <b>10</b>  | <b>10</b>  | <b>60</b>                |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 | PSO 3 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| C504.1      | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 2     | 2     | 2     | 2     |
| C504.2      | 3    | 3    | 2    | 2    | -    | -    | -    | -    | -    | -     | 2     | 3     | 3     | 2     |
| C504.3      | 3    | 3    | 3    | 2    | -    | -    | -    | -    | -    | -     | 2     | 3     | 3     | 2     |
| C504.4      | 3    | 2    | 2    | 2    | -    | -    | -    | -    | -    | -     | 2     | 2     | 3     | 2     |
| C504.5      | 3    | 3    | 2    | 3    | -    | -    | -    | -    | -    | -     | 2     | 3     | 3     | 2     |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                              | Course Name                                                                                                               | Category               | Hours/Week                |   |     | C     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|-----|-------|
|                                                                                                                                                                                                                                                                                          |                                                                                                                           |                        | L                         | T | P   |       |
| 24AD505                                                                                                                                                                                                                                                                                  | BUSINESS ANALYTICS                                                                                                        | PE                     | 3                         | 0 | 0   | 3     |
| Regulation                                                                                                                                                                                                                                                                               | Nature of the Course                                                                                                      | Semester               | Data Book/Codes/Standards |   |     |       |
| 2024                                                                                                                                                                                                                                                                                     | THEORY                                                                                                                    | -                      | -                         |   |     |       |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                  |                                                                                                                           | Co-requisite Course(s) |                           |   |     |       |
| Fundamentals of Data Science / Data Analytics                                                                                                                                                                                                                                            |                                                                                                                           | -                      |                           |   |     |       |
| Course Objectives                                                                                                                                                                                                                                                                        |                                                                                                                           |                        |                           |   |     |       |
| 1                                                                                                                                                                                                                                                                                        | To understand the Analytics Life Cycle.                                                                                   |                        |                           |   |     |       |
| 2                                                                                                                                                                                                                                                                                        | To comprehend the process of acquiring Business Intelligence                                                              |                        |                           |   |     |       |
| 3                                                                                                                                                                                                                                                                                        | To understand various types of analytics for Business Forecasting                                                         |                        |                           |   |     |       |
| 4                                                                                                                                                                                                                                                                                        | To model the supply chain management for Analytics.                                                                       |                        |                           |   |     |       |
| 5                                                                                                                                                                                                                                                                                        | To apply analytics for different functions of a business                                                                  |                        |                           |   |     |       |
| Course Outcomes                                                                                                                                                                                                                                                                          |                                                                                                                           |                        |                           |   |     |       |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                  |                                                                                                                           |                        |                           |   |     |       |
| C505.1                                                                                                                                                                                                                                                                                   | Explain the real-world business problems and model with analytical solutions.                                             |                        |                           |   |     | [U]   |
| C505.2                                                                                                                                                                                                                                                                                   | Outline the business processes for extracting Business Intelligence                                                       |                        |                           |   |     | [U]   |
| C505.3                                                                                                                                                                                                                                                                                   | Apply predictive analytics for business fore-casting                                                                      |                        |                           |   |     | [AP]  |
| C505.4                                                                                                                                                                                                                                                                                   | Apply analytics for supply chain and logistics management                                                                 |                        |                           |   |     | [AP]  |
| C505.5                                                                                                                                                                                                                                                                                   | Use analytics for marketing and sales.                                                                                    |                        |                           |   |     | [AP]  |
| Course Contents                                                                                                                                                                                                                                                                          |                                                                                                                           |                        |                           |   |     |       |
| Unit – 1                                                                                                                                                                                                                                                                                 | INTRODUCTION TO BUSINESS ANALYTICS                                                                                        |                        |                           |   | C01 | 9 Hrs |
| Analytics and Data Science – Analytics Life Cycle – Types of Analytics – Business Problem Definition– Data Collection – Data Preparation – Hypothesis Generation – Modeling – Validation and Evaluation – Interpretation – Deployment and Iteration                                      |                                                                                                                           |                        |                           |   |     |       |
| Unit – 2                                                                                                                                                                                                                                                                                 | BUSINESS INTELLIGENCE                                                                                                     |                        |                           |   | C02 | 9 Hrs |
| Data Warehouses and Data Mart - Knowledge Management –Types of Decisions - Decision Making Process - Decision Support Systems – Business Intelligence –OLAP – Analytic functions                                                                                                         |                                                                                                                           |                        |                           |   |     |       |
| Unit – 3                                                                                                                                                                                                                                                                                 | BUSINESS FORECASTING                                                                                                      |                        |                           |   | C03 | 9 Hrs |
| Introduction to Business Forecasting and Predictive analytics - Logic and Data Driven Models –Data Mining and Predictive Analysis Modelling –Machine Learning for Predictive analytics.                                                                                                  |                                                                                                                           |                        |                           |   |     |       |
| Unit – 4                                                                                                                                                                                                                                                                                 | HR & SUPPLY CHAIN ANALYTICS                                                                                               |                        |                           |   | C04 | 9 Hrs |
| Human Resources – Planning and Recruitment – Training and Development - Supply chain network- Planning Demand, Inventory and Supply – Logistics – Analytics applications in HR & Supply Chain- Applying HR Analytics to make a prediction of the demand for hourly employees for a year. |                                                                                                                           |                        |                           |   |     |       |
| Unit – 5                                                                                                                                                                                                                                                                                 | MARKETING & SALES ANALYTICS                                                                                               |                        |                           |   | C05 | 9 Hrs |
| Marketing Strategy, Marketing Mix, Customer Behaviour –selling Process – Sales Planning –Analytics applications in Marketing and Sales - predictive analytics for customers' behaviour in marketing and sales.                                                                           |                                                                                                                           |                        |                           |   |     |       |
| Total Hours                                                                                                                                                                                                                                                                              |                                                                                                                           |                        |                           |   |     | 45    |
| Textbooks:                                                                                                                                                                                                                                                                               |                                                                                                                           |                        |                           |   |     |       |
| 1                                                                                                                                                                                                                                                                                        | James R. Evans, Business Analytics, 3rd Edition, Pearson Education, 2020.                                                 |                        |                           |   |     |       |
| 2                                                                                                                                                                                                                                                                                        | R. N. Prasad and Seema Acharya, Fundamentals of Business Analytics, 2nd Edition, Wiley, 2016.                             |                        |                           |   |     |       |
| 3                                                                                                                                                                                                                                                                                        | Deanne Larson, Modern Business Analytics, O'Reilly, 2024.                                                                 |                        |                           |   |     |       |
| Reference Books:                                                                                                                                                                                                                                                                         |                                                                                                                           |                        |                           |   |     |       |
| 1                                                                                                                                                                                                                                                                                        | Philip Kotler, Kevin Lane Keller, Marketing Management, 17th Edition, Pearson Education, 2025.                            |                        |                           |   |     |       |
| 2                                                                                                                                                                                                                                                                                        | VSP RAO, Human Resource Management, 3rd Edition, Excel Books, 2010.                                                       |                        |                           |   |     |       |
| 3                                                                                                                                                                                                                                                                                        | Amar Sahay, Business Analytics, Business Expert Press, 2019.                                                              |                        |                           |   |     |       |
| Web References:                                                                                                                                                                                                                                                                          |                                                                                                                           |                        |                           |   |     |       |
| 1                                                                                                                                                                                                                                                                                        | <a href="https://onlinecourses.nptel.ac.in/noc26_cs64/preview?">https://onlinecourses.nptel.ac.in/noc26_cs64/preview?</a> |                        |                           |   |     |       |
| 2                                                                                                                                                                                                                                                                                        | <a href="https://www.ibm.com/topics/business-analytics">https://www.ibm.com/topics/business-analytics</a>                 |                        |                           |   |     |       |

| Assessment based on Continuous and End Semester Examination |                       |                   |                         |            |            |                                |
|-------------------------------------------------------------|-----------------------|-------------------|-------------------------|------------|------------|--------------------------------|
| BLOOM'S<br>TAXONOMY<br>LEVEL                                | CONTINUOUS ASSESSMENT |                   |                         | ASSIGNMENT | ATTENDANCE | END<br>SEMESTER<br>EXAMINATION |
|                                                             | CIA1<br>(6 Marks)     | CIA2<br>(6 Marks) | Model Exam<br>(8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)                     |
| Remember                                                    |                       |                   |                         | 10         | 10         | 60                             |
| Understand                                                  | 100%                  | 50%               | 40%                     |            |            |                                |
| Apply                                                       |                       | 50%               | 60%                     |            |            |                                |
| Analyze                                                     |                       |                   |                         |            |            |                                |
| Evaluate                                                    |                       |                   |                         |            |            |                                |
| Create                                                      |                       |                   |                         |            |            |                                |
| <b>Total<br/>(100 Marks)</b>                                | <b>6</b>              | <b>6</b>          | <b>8</b>                | <b>10</b>  | <b>10</b>  | <b>60</b>                      |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO<br>10 | PO<br>11 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|-------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|
| C505.1      | 3       | 3       | 2       | 2       | -       | -       | -       | -       | -       | 2        | 2        | 2        | 3        | 2        |
| C505.2      | 2       | 3       | 1       | 2       | -       | -       | -       | -       | -       | 2        | 2        | 3        | 3        | 2        |
| C505.3      | 2       | 3       | 2       | 2       | -       | -       | -       | -       | -       | 2        | 2        | 3        | 3        | 2        |
| C505.4      | 2       | 3       | 2       | 2       | -       | 2       | -       | -       | -       | 2        | 2        | 3        | 3        | 2        |
| C505.5      | 2       | 3       | 2       | 2       | -       | 1       | -       | -       | -       | 2        | 2        | 3        | 3        | 2        |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                               | Course Name                                                                                                                                                                                                                                                               | Category                      | Hours/Week                       |   |   | C    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|----------------------------------|---|---|------|
|                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                           |                               | L                                | T | P |      |
| 24AD506                                                                                                                                                                                                                                   | ETHICS AND ARTIFICIAL INTELLIGENCE                                                                                                                                                                                                                                        | PE                            | 3                                | 0 | 0 | 3    |
| <b>Regulation</b>                                                                                                                                                                                                                         | <b>Nature of the Course</b>                                                                                                                                                                                                                                               | <b>Semester</b>               | <b>Data Book/Codes/Standards</b> |   |   |      |
| 2024                                                                                                                                                                                                                                      | Theory                                                                                                                                                                                                                                                                    |                               | -----                            |   |   |      |
| <b>Pre-requisite Course(s)</b>                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                           | <b>Co-requisite Course(s)</b> |                                  |   |   |      |
| Artificial Intelligence – 1                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                           | -                             |                                  |   |   |      |
| <b>Course Objectives</b>                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                           |                               |                                  |   |   |      |
| 1                                                                                                                                                                                                                                         | Study the morality and ethics in AI                                                                                                                                                                                                                                       |                               |                                  |   |   |      |
| 2                                                                                                                                                                                                                                         | Learn about the Ethical initiatives in the field of artificial intelligence                                                                                                                                                                                               |                               |                                  |   |   |      |
| 3                                                                                                                                                                                                                                         | Study about AI standards and Regulations                                                                                                                                                                                                                                  |                               |                                  |   |   |      |
| 4                                                                                                                                                                                                                                         | Study about social and ethical issues of Robot Ethics                                                                                                                                                                                                                     |                               |                                  |   |   |      |
| 5                                                                                                                                                                                                                                         | Study about AI and Ethics- challenges and opportunities                                                                                                                                                                                                                   |                               |                                  |   |   |      |
| <b>Course Outcomes</b>                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                           |                               |                                  |   |   |      |
| <b>Upon completion of the course, students will be able to</b>                                                                                                                                                                            |                                                                                                                                                                                                                                                                           |                               |                                  |   |   |      |
| <b>C506.1</b>                                                                                                                                                                                                                             | Understand the concepts of morality, ethics, and ethical harms in Artificial Intelligence.                                                                                                                                                                                |                               |                                  |   |   | [U]  |
| <b>C506.2</b>                                                                                                                                                                                                                             | Apply knowledge of real-time AI applications to identify and address associated ethical issues and implementation challenges in practical scenarios.                                                                                                                      |                               |                                  |   |   | [AP] |
| <b>C506.3</b>                                                                                                                                                                                                                             | Examine AI standards and regulations                                                                                                                                                                                                                                      |                               |                                  |   |   | [AP] |
| <b>C506.4</b>                                                                                                                                                                                                                             | Illustrate roboethics including AI agents and the safe design of autonomous and semi-autonomous systems.                                                                                                                                                                  |                               |                                  |   |   | [AP] |
| <b>C506.5</b>                                                                                                                                                                                                                             | Use the principles of roboethics, morality, and professional responsibilities in AI development and deployment.                                                                                                                                                           |                               |                                  |   |   | [AP] |
| <b>Course Contents</b>                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                           |                               |                                  |   |   |      |
| <b>Unit – 1</b>                                                                                                                                                                                                                           | <b>INTRODUCTION TO ETHICAL INITIATIVES IN AI</b>                                                                                                                                                                                                                          |                               |                                  |   |   | 9    |
| Definition of morality and ethics in AI-Impact on society-Impact on human psychology-Impact on the legal system-Impact on the environment and the planet-Impact on trust                                                                  |                                                                                                                                                                                                                                                                           |                               |                                  |   |   |      |
| <b>Unit – 2</b>                                                                                                                                                                                                                           | <b>ETHICAL HARMS AND APPLICATIONS</b>                                                                                                                                                                                                                                     |                               |                                  |   |   | 9    |
| International ethical initiatives-Ethical harms and concerns-Case study: healthcare robots, Autonomous Vehicles, Warfare and weaponization.                                                                                               |                                                                                                                                                                                                                                                                           |                               |                                  |   |   |      |
| <b>Unit – 3</b>                                                                                                                                                                                                                           | <b>AI STANDARDS AND REGULATION</b>                                                                                                                                                                                                                                        |                               |                                  |   |   | 9    |
| Model Process for Addressing Ethical Concerns During System Design - Transparency of Autonomous Systems-Data Privacy Process- Algorithmic Bias Considerations - Ontological Standard for Ethically Driven Robotics and Automation Systems |                                                                                                                                                                                                                                                                           |                               |                                  |   |   |      |
| <b>Unit – 4</b>                                                                                                                                                                                                                           | <b>ROBOETHICS: SOCIAL AND ETHICAL IMPLICATION OF ROBOTICS</b>                                                                                                                                                                                                             |                               |                                  |   |   | 9    |
| Robot-Roboethics- Ethics and Morality- Moral Theories-Ethics in Science and Technology - Ethical Issues in an ICT Society- Harmonization of Principles- Ethics and Professional Responsibility- Roboethics Taxonomy.                      |                                                                                                                                                                                                                                                                           |                               |                                  |   |   |      |
| <b>Unit – 5</b>                                                                                                                                                                                                                           | <b>AI AND ETHICS- CHALLENGES AND OPPORTUNITIES</b>                                                                                                                                                                                                                        |                               |                                  |   |   | 9    |
| Challenges - Opportunities- ethical issues in artificial intelligence- Societal Issues Concerning the Application of Artificial Intelligence in Medicine- decision-making role in industries-National and International Strategies on AI. |                                                                                                                                                                                                                                                                           |                               |                                  |   |   |      |
| <b>Total Hours</b>                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                           |                               |                                  |   |   | 45   |
| <b>Textbooks:</b>                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                           |                               |                                  |   |   |      |
| 1                                                                                                                                                                                                                                         | y. Eleanor Bird, Jasmin Fox-Skelly, Nicola Jenner, Ruth Larbey, Emma Weitkamp and Alan Winfield ,”The ethics of artificial intelligence: Issues and initiatives”, EPRS   European Parliamentary Research Service Scientific Foresight Unit (STOA) PE 634.452 – March 2020 |                               |                                  |   |   |      |
| 2                                                                                                                                                                                                                                         | Patrick Lin, Keith Abney, George A Bekey,” Robot Ethics: The Ethical and Social Implications of Robotics”, The MIT Press- January 2014.                                                                                                                                   |                               |                                  |   |   |      |
| <b>Reference Books:</b>                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                           |                               |                                  |   |   |      |
| 1                                                                                                                                                                                                                                         | Towards a Code of Ethics for Artificial Intelligence (Artificial Intelligence: Foundations, Theory, and Algorithms) by Paula Boddington, November 2017                                                                                                                    |                               |                                  |   |   |      |
| 2                                                                                                                                                                                                                                         | Mark Coeckelbergh,” AI Ethics”, The MIT Press Essential Knowledge series, April 2020                                                                                                                                                                                      |                               |                                  |   |   |      |
| <b>Web References:</b>                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                           |                               |                                  |   |   |      |

|   |                                                                                                                                                                                                                                                         |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <a href="https://sci-hub.mkksa.top/10.1007/978-3-540-30301-5_65">https://sci-hub.mkksa.top/10.1007/978-3-540-30301-5_65</a>                                                                                                                             |
| 2 | <a href="https://www.scu.edu/ethics/all-about-ethics/artificial-intelligence-and-ethics-sixteen-challenges-and-opportunities/">https://www.scu.edu/ethics/all-about-ethics/artificial-intelligence-and-ethics-sixteen-challenges-and-opportunities/</a> |
| 3 | <a href="https://www.weforum.org/agenda/2016/10/top-10-ethical-issues-in-artificial-intelligence/">https://www.weforum.org/agenda/2016/10/top-10-ethical-issues-in-artificial-intelligence/</a>                                                         |
| 4 | <a href="https://sci-hub.mkksa.top/10.1159/000492428">https://sci-hub.mkksa.top/10.1159/000492428</a>                                                                                                                                                   |

| Assessment based on Continuous and End Semester Examination |                       |                   |                         |                |                |                                |
|-------------------------------------------------------------|-----------------------|-------------------|-------------------------|----------------|----------------|--------------------------------|
| Bloom's Level                                               | Continuous Assessment |                   |                         | Assign<br>ment | Attend<br>ance | End<br>Semester<br>Examination |
|                                                             | CIA1<br>(6 Marks)     | CIA2<br>(6 Marks) | Model Exam<br>(8 Marks) |                |                |                                |
| Remember                                                    |                       |                   |                         | (10<br>Marks)  | (10<br>Marks)  | (60 Marks)                     |
| Understand                                                  | 80%                   |                   | 20%                     |                |                |                                |
| Apply                                                       | 20%                   | 100%              | 80%                     |                |                |                                |
| Analyze                                                     |                       |                   |                         |                |                |                                |
| Evaluate                                                    |                       |                   |                         |                |                |                                |
| Create                                                      |                       |                   |                         |                |                |                                |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>          | <b>8</b>                | <b>10</b>      | <b>10</b>      | <b>60</b>                      |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO1<br>0 | PO1<br>1 | PSO<br>1 | PSO<br>2 | PSO3 |
|-------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|------|
| C506.1      | 3       | 2       | 3       | 3       | -       | -       | -       | -       | -       | -        | 1        | 3        | 2        | 2    |
| C506.2      | 2       | 1       | 1       | 2       | -       | -       | -       | -       | -       | -        | 1        | 3        | 3        | 2    |
| C506.3      | 2       | 3       | 1       | 1       | -       | -       | -       | -       | -       | -        | 1        | 3        | 2        | 2    |
| C506.4      | 3       | 1       | 3       | 3       | -       | -       | -       | -       | -       | -        | 3        | 2        | 2        | 3    |
| C506.5      | 3       | 1       | 1       | 3       | -       | -       | -       | -       | -       | -        | 3        | 2        | 3        | 3    |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                   | Course Name                                                                                                                                     | Category               | Hours/Week                |   |   | C    |       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|---|------|-------|
|                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                 |                        | L                         | T | P |      |       |
| 24CC501                                                                                                                                                                                                                                                                                                                       | WEB TECHNOLOGY                                                                                                                                  | PE                     | 3                         | 0 | 0 | 3    |       |
| Regulation                                                                                                                                                                                                                                                                                                                    | Nature of the Course                                                                                                                            | Semester               | Data Book/Codes/Standards |   |   |      |       |
| 2024                                                                                                                                                                                                                                                                                                                          | THEORY                                                                                                                                          | -                      | -                         |   |   |      |       |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                       |                                                                                                                                                 | Co-requisite Course(s) |                           |   |   |      |       |
| -                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                 | -                      |                           |   |   |      |       |
| Course Objectives                                                                                                                                                                                                                                                                                                             |                                                                                                                                                 |                        |                           |   |   |      |       |
| 1                                                                                                                                                                                                                                                                                                                             | To understand the fundamentals of web technologies and develop basic web pages using HTML and CSS.                                              |                        |                           |   |   |      |       |
| 2                                                                                                                                                                                                                                                                                                                             | To learn client-side scripting using JavaScript for creating dynamic web pages with validation and event handling mechanisms.                   |                        |                           |   |   |      |       |
| 3                                                                                                                                                                                                                                                                                                                             | To understand server-side web programming concepts and develop web applications using Servlets and JSP.                                         |                        |                           |   |   |      |       |
| 4                                                                                                                                                                                                                                                                                                                             | To learn PHP programming and XML technologies for creating dynamic web pages and representing structured data.                                  |                        |                           |   |   |      |       |
| 5                                                                                                                                                                                                                                                                                                                             | To develop interactive web applications using modern web application frameworks and technologies.                                               |                        |                           |   |   |      |       |
| Course Outcomes                                                                                                                                                                                                                                                                                                               |                                                                                                                                                 |                        |                           |   |   |      |       |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                       |                                                                                                                                                 |                        |                           |   |   |      |       |
| CC501.1                                                                                                                                                                                                                                                                                                                       | Understand basic web pages using HTML and CSS fundamental web design concepts.                                                                  |                        |                           |   |   | [U]  |       |
| CC501.2                                                                                                                                                                                                                                                                                                                       | Build dynamic web pages using JavaScript with validation techniques and different event handling mechanisms.                                    |                        |                           |   |   | [AP] |       |
| CC501.3                                                                                                                                                                                                                                                                                                                       | Develop server-side web applications using Servlets and JSP.                                                                                    |                        |                           |   |   | [AP] |       |
| CC501.4                                                                                                                                                                                                                                                                                                                       | Construct simple web pages using PHP and represent data using XML technologies.                                                                 |                        |                           |   |   | [AP] |       |
| CC501.5                                                                                                                                                                                                                                                                                                                       | Develop interactive web applications using modern web application frameworks and tools.                                                         |                        |                           |   |   | [AP] |       |
| Course Contents                                                                                                                                                                                                                                                                                                               |                                                                                                                                                 |                        |                           |   |   |      |       |
| Unit – 1                                                                                                                                                                                                                                                                                                                      | WEB ESSENTIALS                                                                                                                                  |                        |                           |   |   | CO1  | 9 Hrs |
| Evolution of web - Web architecture - HTML5: Text tags, Graphics, Form elements, Semantic tags - CSS3: Selectors, Backgrounds and borders, Text effects, Cascading and inheritance of style properties, Box Model, Positioning - Introduction to responsive design-Bootstrap: Containers, Grids, Typography, Flex, and Forms. |                                                                                                                                                 |                        |                           |   |   |      |       |
| Unit – 2                                                                                                                                                                                                                                                                                                                      | CLIENT SIDE PROGRAMMING                                                                                                                         |                        |                           |   |   | CO2  | 9 Hrs |
| Java Script: An introduction to JavaScript-JavaScript DOM Model-Exception Handling-Validation-Built-in objects-Event Handling- DHTML with JavaScript- JSON introduction – Syntax – Function -Files.                                                                                                                           |                                                                                                                                                 |                        |                           |   |   |      |       |
| Unit – 3                                                                                                                                                                                                                                                                                                                      | SERVER SIDE PROGRAMMING                                                                                                                         |                        |                           |   |   | CO3  | 9 Hrs |
| Web servers – IIS (XAMPP, LAMPP) and Tomcat Servers ,Servlets: Java Servlet Architecture- Servlet Life Cycle-Form GET and POST actions- Session Handling- Understanding Cookies- Data Base Connectivity: JDBC.                                                                                                                |                                                                                                                                                 |                        |                           |   |   |      |       |
| Unit – 4                                                                                                                                                                                                                                                                                                                      | PHP and XML                                                                                                                                     |                        |                           |   |   | CO4  | 9 Hrs |
| An introduction to PHP: PHP- Using PHP- Variables- Program control- Built-in functions- Form -Validation. XML: Basic XML- Document Type Definition- XML Schema, XML Parsers and Validation,XSL                                                                                                                                |                                                                                                                                                 |                        |                           |   |   |      |       |
| Unit – 5                                                                                                                                                                                                                                                                                                                      | WEB APPLICATION AND ANGULAR JS                                                                                                                  |                        |                           |   |   | CO5  | 9 Hrs |
| Web applications- Web application frameworks: MVC framework-Angular JS: Introduction, Data binding, Directives, Modules, Scopes, Controllers, Expressions, Filters, Events, Form- Single Page Application-Multiple Views and Routing – Service.                                                                               |                                                                                                                                                 |                        |                           |   |   |      |       |
| Total Hours                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                 |                        |                           |   |   | 45   |       |
| Textbooks:                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                 |                        |                           |   |   |      |       |
| 1                                                                                                                                                                                                                                                                                                                             | Brad Dayley, Brendan Dayley, Caleb Dayley, “Node.js, Mongo DB and Angular JS Web Development”, 2017, 2nd Edition, Addison Wesley- Oreilly, USA. |                        |                           |   |   |      |       |
| 2                                                                                                                                                                                                                                                                                                                             | Jessica Minnick, Responsive, “Web Design with HTML 5 & CSS, Cengage Learning”, 2020, 9th Edition.                                               |                        |                           |   |   |      |       |
| 3                                                                                                                                                                                                                                                                                                                             | Deitel and Deitel and Nieto, Internet and World Wide Web - How to Program, Prentice Hall, 5th Edition, 2011.                                    |                        |                           |   |   |      |       |
| Reference Books:                                                                                                                                                                                                                                                                                                              |                                                                                                                                                 |                        |                           |   |   |      |       |

|                        |                                                                                                                                                              |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                      | Angular 6 for Enterprise-Ready Web Applications, Doguhan Uluca, 1st edition, Packt Publishing                                                                |
| 2                      | Stephen Wynkoop and John Burke "Running a Perfect Website", QUE, 2nd Edition, 1999.                                                                          |
| 3                      | Chris Bates, Web Programming – Building Intranet Applications, 3rd Edition, Wiley Publications, 2009.                                                        |
| 4                      | Gopalan N.P. and Akilandeswari J., "Web Technology", Prentice Hall of India, 2011.                                                                           |
| <b>Web References:</b> |                                                                                                                                                              |
| 1                      | <a href="https://nptel.ac.in/courses/106105084">https://nptel.ac.in/courses/106105084</a> - web architecture, HTTP, web protocols, and internet fundamentals |
| 2                      | <a href="https://developer.mozilla.org">https://developer.mozilla.org</a> - documentation for HTML, CSS, JavaScript, and web APIs                            |

| Assessment based on Continuous and End Semester Examination |                       |                |                      |            |            |                          |
|-------------------------------------------------------------|-----------------------|----------------|----------------------|------------|------------|--------------------------|
| BLOOM'S TAXONOMY LEVEL                                      | CONTINUOUS ASSESSMENT |                |                      | ASSIGNMENT | ATTENDANCE | END SEMESTER EXAMINATION |
|                                                             | CIA1 (6 Marks)        | CIA2 (6 Marks) | Model Exam (8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)               |
| Remember                                                    |                       |                |                      | 10         | 10         | 60                       |
| Understand                                                  | 80                    |                | 20                   |            |            |                          |
| Apply                                                       | 20                    | 100            | 80                   |            |            |                          |
| Analyze                                                     |                       |                |                      |            |            |                          |
| Evaluate                                                    |                       |                |                      |            |            |                          |
| Create                                                      |                       |                |                      |            |            |                          |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>       | <b>8</b>             | <b>10</b>  | <b>10</b>  | <b>60</b>                |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 | PSO 3 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CC501.1     | 3    | 2    | 1    | 1    | 2    | -    | -    | -    | -    | -     | 1     | 1     | 2     | 2     |
| CC501.2     | 3    | 2    | 1    | 1    | 3    | -    | -    | -    | -    | -     | 1     | 1     | 2     | 3     |
| CC501.3     | 3    | 2    | 2    | 1    | 3    | -    | -    | -    | -    | -     | 1     | 2     | 2     | 3     |
| CC501.4     | 2    | 2    | 1    | 1    | 2    | -    | -    | -    | -    | -     | 1     | 1     | 2     | 2     |
| CC501.5     | 2    | 2    | 3    | 1    | 3    | -    | -    | -    | -    | -     | 1     | 2     | 2     | 3     |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                               | Course Name                                                                                                                                                                                       | Category               | Hours/Week                |   |             | C     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|-------------|-------|
|                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                   |                        | L                         | T | P           |       |
| 24CC502                                                                                                                                                                                                                                                                                                                   | APP DEVELOPMENT                                                                                                                                                                                   | PE                     | 3                         | 0 | 0           | 3     |
| Regulation                                                                                                                                                                                                                                                                                                                | Nature of the Course                                                                                                                                                                              | Semester               | Data Book/Codes/Standards |   |             |       |
| 2024                                                                                                                                                                                                                                                                                                                      | THEORY                                                                                                                                                                                            | -                      | -                         |   |             |       |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                   | Co-requisite Course(s) |                           |   |             |       |
| -                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                   | --                     |                           |   |             |       |
| Course Objectives                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                   |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                                                                         | To understand Fundamentals of Mobile and Web Applications                                                                                                                                         |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                                                                         | To develop Native Applications                                                                                                                                                                    |                        |                           |   |             |       |
| 3                                                                                                                                                                                                                                                                                                                         | To build Hybrid Applications                                                                                                                                                                      |                        |                           |   |             |       |
| 4                                                                                                                                                                                                                                                                                                                         | To implement Cross-Platform Applications                                                                                                                                                          |                        |                           |   |             |       |
| 5                                                                                                                                                                                                                                                                                                                         | To evaluate Non-Functional Characteristics of App Frameworks                                                                                                                                      |                        |                           |   |             |       |
| Course Outcomes                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                   |                        |                           |   |             |       |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                   |                        |                           |   |             |       |
| CC502.1                                                                                                                                                                                                                                                                                                                   | Explain the fundamentals of mobile and web application development including native, hybrid, cross-platform, progressive web applications and responsive web design.                              |                        |                           |   |             | [U]   |
| CC502.2                                                                                                                                                                                                                                                                                                                   | Develop basic native mobile applications using Java/Kotlin for Android and Swift/Objective-C for iOS.                                                                                             |                        |                           |   |             | [AP]  |
| CC502.3                                                                                                                                                                                                                                                                                                                   | Build hybrid mobile applications using frameworks such as Ionic and Apache Cordova.                                                                                                               |                        |                           |   |             | [AP]  |
| CC502.4                                                                                                                                                                                                                                                                                                                   | Implement cross-platform applications using frameworks like React Native, Flutter, and Xamarin with concepts of JSX, state, and props.                                                            |                        |                           |   |             | [AP]  |
| CC502.5                                                                                                                                                                                                                                                                                                                   | Apply the non-functional characteristics such as build performance, debugging capability, maintainability, UI/UX, and reusability to compare and select appropriate mobile application frameworks |                        |                           |   |             | [AP]  |
| Course Contents                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                   |                        |                           |   |             |       |
| Unit – 1                                                                                                                                                                                                                                                                                                                  | FUNDAMENTALS OF MOBILE & WEB APPLICATION DEVELOPMENT                                                                                                                                              |                        |                           |   | C01         | 9 Hrs |
| Basics of Web and Mobile application development, Android architecture and Flutter framework overview,Native App, Hybrid App, Cross-platform App, What is Progressive Web App, Responsive Web design.                                                                                                                     |                                                                                                                                                                                                   |                        |                           |   |             |       |
| Unit – 2                                                                                                                                                                                                                                                                                                                  | NATIVE APP DEVELOPMENT USING JAVA                                                                                                                                                                 |                        |                           |   | C02         | 9 Hrs |
| Native Web App, Benefits of Native App, Scenarios to create Native App, Tools for creating Native App, Cons of Native App, Popular Native App Development Frameworks, Java & Kotlin for Android, Swift & Objective-C for iOS, Basics of React Native, Native Components, JSX, State, Props.                               |                                                                                                                                                                                                   |                        |                           |   |             |       |
| Unit – 3                                                                                                                                                                                                                                                                                                                  | HYBRID APP DEVELOPMENT                                                                                                                                                                            |                        |                           |   | C03         | 9 Hrs |
| Hybrid Web App, Benefits of Hybrid App, Criteria for creating Native App, Tools for creating Hybrid App, Cons of Hybrid App, Popular Hybrid App Development Frameworks, Ionic, Apache Cordova.                                                                                                                            |                                                                                                                                                                                                   |                        |                           |   |             |       |
| Unit – 4                                                                                                                                                                                                                                                                                                                  | CROSS-PLATFORM APP DEVELOPMENT USING REACT-NATIVE                                                                                                                                                 |                        |                           |   | C04         | 9 Hrs |
| What is Cross-platform App, Benefits of Cross-platform App, Criteria for creating Cross-platform App, Tools for creating Cross-platform App, Cons of Cross-platform App, Popular Cross platform App Development Frameworks, Flutter, Xamarin, React-Native, Basics of React Native, Native Components, JSX, State, Props. |                                                                                                                                                                                                   |                        |                           |   |             |       |
| Unit – 5                                                                                                                                                                                                                                                                                                                  | NON-FUNCTIONAL CHARACTERISTICS OF APP FRAMEWORKS                                                                                                                                                  |                        |                           |   | C05         | 9 Hrs |
| Comparison of different App frameworks, Build Performance, App Performance, Debugging capabilities, Time to Market, Maintainability, Ease of Development, UI/UX, Reusability .                                                                                                                                            |                                                                                                                                                                                                   |                        |                           |   |             |       |
|                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                   |                        |                           |   | Total Hours | 45    |
| Textbooks:                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                   |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                                                                         | Head First Android Development, Dawn Griffiths, O'Reilly, 1st edition                                                                                                                             |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                                                                         | Apache Cordova in Action, Raymond K. Camden, Manning. 2015                                                                                                                                        |                        |                           |   |             |       |
| 3                                                                                                                                                                                                                                                                                                                         | Beginning Flutter: A Hands On Guide to App Development , Marco L. Napoli , ISBN: 978-1-119-55082-2, October 2019                                                                                  |                        |                           |   |             |       |
| Reference Books:                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                   |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                                                                         | Android Programming for Beginners, John Horton, Packt Publishing, 2nd Edition                                                                                                                     |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                                                                         | Building Cross-Platform Mobile and Web Apps for Engineers and Scientists: An Active Learning Approach, Pawan Lingras, Matt Triff, Rucha Lingras                                                   |                        |                           |   |             |       |
| 3                                                                                                                                                                                                                                                                                                                         | Beginning App Development with Flutter: Create Cross-Platform Mobile Apps 1st ed. Edition, by                                                                                                     |                        |                           |   |             |       |

|                        |                                                                                                                                                                                            |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                        | Rap Payne, 2019, Publisher(s): Apress, ISBN: 978-1484251805                                                                                                                                |
| 4                      | Programming Android with Kotlin, by Pierre-Olivier Laurence, Amanda Hinchman -Dominguez, Mike Dunn, G. Blake Meike, December 2021, Publisher(s): O'Reilly Media, Inc., ISBN: 9781492063001 |
| <b>Web References:</b> |                                                                                                                                                                                            |
| 1                      | Android Developer Documentation: <a href="https://developer.android.com/docs">https://developer.android.com/docs</a>                                                                       |
| 2                      | Flutter Documentation: <a href="https://flutter.dev/docs">https://flutter.dev/docs</a>                                                                                                     |

| <b>Assessment based on Continuous and End Semester Examination</b> |                              |                       |                             |                   |                   |                                 |
|--------------------------------------------------------------------|------------------------------|-----------------------|-----------------------------|-------------------|-------------------|---------------------------------|
| <b>BLOOM'S TAXONOMY LEVEL</b>                                      | <b>CONTINUOUS ASSESSMENT</b> |                       |                             | <b>ASSIGNMENT</b> | <b>ATTENDANCE</b> | <b>END SEMESTER EXAMINATION</b> |
|                                                                    | <b>CIA1 (6 Marks)</b>        | <b>CIA2 (6 Marks)</b> | <b>Model Exam (8 Marks)</b> | <b>(10 Marks)</b> | <b>(10 Marks)</b> | <b>(60 Marks)</b>               |
| Remember                                                           |                              |                       |                             | <b>10</b>         | <b>10</b>         | <b>60</b>                       |
| Understand                                                         | 80                           |                       | 20                          |                   |                   |                                 |
| Apply                                                              | 20                           | 100                   | 80                          |                   |                   |                                 |
| Analyze                                                            |                              |                       |                             |                   |                   |                                 |
| Evaluate                                                           |                              |                       |                             |                   |                   |                                 |
| Create                                                             |                              |                       |                             |                   |                   |                                 |
| <b>Total (100 Marks)</b>                                           | <b>6</b>                     | <b>6</b>              | <b>8</b>                    | <b>10</b>         | <b>10</b>         | <b>60</b>                       |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| <b>COs/ POs</b> | <b>PO 1</b> | <b>PO 2</b> | <b>PO 3</b> | <b>PO 4</b> | <b>PO 5</b> | <b>PO 6</b> | <b>PO 7</b> | <b>PO 8</b> | <b>PO 9</b> | <b>PO 10</b> | <b>PO 11</b> | <b>PSO 1</b> | <b>PSO 2</b> | <b>PSO 3</b> |
|-----------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|--------------|--------------|--------------|
| CC502.1         | 3           | 2           | 1           | 1           | 2           | -           | -           | -           | -           | -            | 1            | 1            | 2            | 2            |
| CC502.2         | 3           | 2           | 2           | 1           | 3           | -           | -           | -           | -           | -            | 1            | 2            | 2            | 3            |
| CC502.3         | 2           | 2           | 2           | 1           | 3           | -           | -           | -           | -           | -            | 1            | 1            | 2            | 3            |
| CC502.4         | 2           | 2           | 3           | 1           | 3           | -           | -           | -           | -           | -            | 1            | 2            | 2            | 3            |
| CC502.5         | 2           | 2           | 2           | 1           | 2           | -           | -           | -           | -           | -            | 2            | 2            | 2            | 2            |

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Course Name                                                                                                            | Category               | Hours/Week                |   |             | C     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|-------------|-------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                        |                        | L                         | T | P           |       |
| 24CC503                                                                                                                                                                                                                                                                                                                                                                                                                                                     | SOFTWARE TESTING AND AUTOMATION                                                                                        | PE                     | 3                         | 0 | 0           | 3     |
| Regulation                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Nature of the Course                                                                                                   | Semester               | Data Book/Codes/Standards |   |             |       |
| 2024                                                                                                                                                                                                                                                                                                                                                                                                                                                        | THEORY                                                                                                                 | -                      | -----                     |   |             |       |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                        | Co-requisite Course(s) |                           |   |             |       |
| -                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                        | -                      |                           |   |             |       |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                        |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                           | To understand the basics of software testing.                                                                          |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                           | To learn how to do testing, plan and design.                                                                           |                        |                           |   |             |       |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                           | To learn how to execute the testcases.                                                                                 |                        |                           |   |             |       |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                           | To focus on wide aspects of testing and understanding multiple facets of testing.                                      |                        |                           |   |             |       |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                           | To get an insight about the test automation and tools used for test automation.                                        |                        |                           |   |             |       |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                        |                        |                           |   |             |       |
| Upon completion of the course, students shall have ability to                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                        |                        |                           |   |             |       |
| CC503.1                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Understand the basic concepts of software testing and the need for software testing.                                   |                        |                           |   |             | [U]   |
| CC503.2                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Apply concepts of test planning and test design for the software systems.                                              |                        |                           |   |             | [AP]  |
| CC503.3                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Apply effective test cases that can uncover critical defects in the application.                                       |                        |                           |   |             | [AP]  |
| CC503.4                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Apply the software systems using advanced testing methods.                                                             |                        |                           |   |             | [AP]  |
| CC503.5                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Automate the software testing using Selenium and TestNG.                                                               |                        |                           |   |             | [AP]  |
| Course Contents                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                        |                        |                           |   |             |       |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                                                                                                                    | INTRODUCTION                                                                                                           |                        |                           |   | C01         | 9 Hrs |
| Need of software test-Black-Box Testing and White-Box Testing, Software Testing Life Cycle, V-model of Software Testing, Program Correctness and Verification, Reliability versus Safety, Failures, Errors and Faults , Software Testing Principles, Program Inspections, Stages of Testing: Unit Testing, Integration Testing, System Testing. Test Strategies: Top-Down Testing, Bottom-Up Testing, Thread testing, Stress testing, Back-to-back testing; |                                                                                                                        |                        |                           |   |             |       |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                                                                                                                    | TEST PLANNING AND DESIGN                                                                                               |                        |                           |   | C02         | 9 Hrs |
| TEST PLANNING:The Goal of Test Planning, High Level Expectations, Intergroup Responsibilities, Test Phases, Test Strategy, Resource Requirements, Tester Assignments, Test Schedule, Test Cases, Bug Reporting, Metrics and Statistics. TEST DESIGN:Test Objective Identification, Test Design Factors & Requirements, Modeling a Test Design Process,                                                                                                      |                                                                                                                        |                        |                           |   |             |       |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                                                                                                                    | TEST EXECUTION                                                                                                         |                        |                           |   | C03         | 9 Hrs |
| Modeling Test Results, Boundary Value Testing, Equivalence Class Testing, Path Testing, Data Flow Testing, Test Design Preparedness Metrics, Test Case Design Effectiveness, Model-Driven Test Design, Test Procedures, Test Case Organization and Tracking, Bug Reporting, Bug Life Cycle.                                                                                                                                                                 |                                                                                                                        |                        |                           |   |             |       |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                                                                                                                    | ADVANCED TESTING CONCEPTS                                                                                              |                        |                           |   | C04         | 9 Hrs |
| Performance Testing: Load Testing, Stress Testing, Volume Testing, Fail-Over Testing, Recovery Testing, Configuration Testing, Compatibility Testing, Usability Testing, Testing the Documentation, Security testing, Testing in the Agile Environment, Testing Web and Mobile Applications.                                                                                                                                                                |                                                                                                                        |                        |                           |   |             |       |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                                                                                                                    | TEST AUTOMATION AND TOOLS                                                                                              |                        |                           |   | C05         | 9 Hrs |
| Automated Software Testing, Automate Testing of Web Applications, Selenium: Introducing Web Driver and Web Elements, Locating Web Elements, Actions on Web Elements, Different Web 120 Drivers, Understanding Web Driver Events, Testing: Understanding Testing.xml, Adding Classes, Packages, Methods to Test, Test Reports                                                                                                                                |                                                                                                                        |                        |                           |   |             |       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                        |                        |                           |   | Total Hours | 45    |
| Textbooks:                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                        |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Yogesh Singh, “Software Testing”, Cambridge University Press, 2012.                                                    |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Unmesh Gundecha, Satya Avasarala, "Selenium WebDriver 3 Practical Guide" - Second Edition 2018.                        |                        |                           |   |             |       |
| Reference Books:                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                        |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Glenford J. Myers, Corey Sandler, Tom Badgett, The Art of Software Testing, 3rd Edition, 2012, John Wiley & Sons, Inc. |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Paul C. Jorgensen, Software Testing: A Craftsman’s Approach, Fourth Edition, 2014, Taylor & Francis Group.             |                        |                           |   |             |       |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Carl Cocchiario, Selenium Framework Design in Data-Driven Testing, 2018, Packt Publishing.                             |                        |                           |   |             |       |

|   |                                                                                                                     |
|---|---------------------------------------------------------------------------------------------------------------------|
| 4 | Elfriede Dustin, Thom Garrett, Bernie Gaurf, Implementing Automated Software Testing, 2009, Pearson Education, Inc. |
|---|---------------------------------------------------------------------------------------------------------------------|

**Web References:**

|   |                                                                                                                                                                             |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <a href="https://onlinecourses.nptel.ac.in/noc25_cs66/preview">https://onlinecourses.nptel.ac.in/noc25_cs66/preview</a>                                                     |
| 2 | <a href="https://www.udemy.com/course/automation-testing-online-course-with-certificate">https://www.udemy.com/course/automation-testing-online-course-with-certificate</a> |

**Assessment based on Continuous and End Semester Examination**

| BLOOM'S LEVEL            | CONTINUOUS ASSESSMENT |                   |                         | ASSIGNMENT<br>(10 Marks) | ATTENDANCE<br>(10 Marks) | END SEMESTER EXAMINATION<br>(60 Marks) |
|--------------------------|-----------------------|-------------------|-------------------------|--------------------------|--------------------------|----------------------------------------|
|                          | CIA1<br>(6 MARKS)     | CIA2<br>(6 MARKS) | MODEL EXAM<br>(8 MARKS) |                          |                          |                                        |
| Remember                 |                       |                   |                         | 10                       | 10                       | 60                                     |
| Understand               | 80                    |                   | 20                      |                          |                          |                                        |
| Apply                    | 20                    | 100               | 80                      |                          |                          |                                        |
| Analyze                  |                       |                   |                         |                          |                          |                                        |
| Evaluate                 |                       |                   |                         |                          |                          |                                        |
| Create                   |                       |                   |                         |                          |                          |                                        |
| <b>Total (100 Marks)</b> | <b>6</b>              | <b>6</b>          | <b>8</b>                | <b>10</b>                | <b>10</b>                | <b>60</b>                              |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 | PSO 3 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CC503.1     | 3    | 3    | 2    | 1    | 2    | -    | -    | -    | -    | -     | 2     | 3     | 2     | 3     |
| CC503.2     | 2    | 3    | 1    | 1    | 1    | -    | -    | -    | -    | -     | 2     | 1     | 2     | 3     |
| CC503.3     | 2    | 2    | 1    | 3    | 1    | -    | -    | -    | -    | -     | 2     | 2     | 3     | 2     |
| CC503.4     | 2    | 1    | 3    | 2    | 1    | -    | -    | -    | -    | -     | 3     | 3     | 1     | 2     |
| CC503.5     | 2    | 2    | 1    | 3    | 1    | -    | -    | -    | -    | -     | 1     | 2     | 1     | 3     |

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

| Course Code                                                                                                                                                                                                                                                                                                                                                                        | Course Name                                                                                                                                               | Category               | Hours/Week                |   |   | C    |       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|---|------|-------|
|                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                           |                        | L                         | T | P |      |       |
| 24CC504                                                                                                                                                                                                                                                                                                                                                                            | WEB APPLICATION SECURITY                                                                                                                                  | PE                     | 3                         | 0 | 0 | 3    |       |
| Regulation                                                                                                                                                                                                                                                                                                                                                                         | Nature of the Course                                                                                                                                      | Semester               | Data Book/Codes/Standards |   |   |      |       |
| 2024                                                                                                                                                                                                                                                                                                                                                                               | THEORY                                                                                                                                                    | -                      | -                         |   |   |      |       |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                           | Co-requisite Course(s) |                           |   |   |      |       |
| -                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                           | -                      |                           |   |   |      |       |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                           |                        |                           |   |   |      |       |
| 1                                                                                                                                                                                                                                                                                                                                                                                  | To provide a strong foundation in the fundamental concepts and principles of Web Application Security.                                                    |                        |                           |   |   |      |       |
| 2                                                                                                                                                                                                                                                                                                                                                                                  | To enable learners to understand secure design practices and the implementation of security mechanisms during web application development and deployment. |                        |                           |   |   |      |       |
| 3                                                                                                                                                                                                                                                                                                                                                                                  | To impart knowledge on designing and implementing secure Application Programming Interfaces (APIs).                                                       |                        |                           |   |   |      |       |
| 4                                                                                                                                                                                                                                                                                                                                                                                  | To introduce the methodologies, tools, and techniques used in vulnerability assessment and penetration testing.                                           |                        |                           |   |   |      |       |
| 5                                                                                                                                                                                                                                                                                                                                                                                  | To acquire basic insight into ethical hacking techniques and commonly used security tools.                                                                |                        |                           |   |   |      |       |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                           |                        |                           |   |   |      |       |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                           |                        |                           |   |   |      |       |
| CC504.1                                                                                                                                                                                                                                                                                                                                                                            | Understanding the fundamental concepts and principles of web application security.                                                                        |                        |                           |   |   | [U]  |       |
| CC504.2                                                                                                                                                                                                                                                                                                                                                                            | Apply secure design and development practices in building and deploying web applications.                                                                 |                        |                           |   |   | [AP] |       |
| CC504.3                                                                                                                                                                                                                                                                                                                                                                            | Develop and implement secure APIs by incorporating appropriate authentication and authorization mechanisms.                                               |                        |                           |   |   | [AP] |       |
| CC504.4                                                                                                                                                                                                                                                                                                                                                                            | Apply vulnerability assessment and penetration testing tools to detect security weaknesses in web applications.                                           |                        |                           |   |   | [AP] |       |
| CC504.5                                                                                                                                                                                                                                                                                                                                                                            | Demonstrate the use of security tools and ethical hacking techniques to detect vulnerabilities and apply corrective actions.                              |                        |                           |   |   | [AP] |       |
| Course Contents                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                           |                        |                           |   |   |      |       |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                                           | FUNDAMENTALS OF WEB APPLICATION SECURITY                                                                                                                  |                        |                           |   |   | C01  | 9 Hrs |
| The history of Software Security-Recognizing Web Application Security Threats, Web Application Security, Authentication and Authorization, Secure Socket layer, Transport layer Security, Session Management-Input Validation                                                                                                                                                      |                                                                                                                                                           |                        |                           |   |   |      |       |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                                           | SECURE DEVELOPMENT AND DEPLOYMENT                                                                                                                         |                        |                           |   |   | C02  | 9 Hrs |
| Web Applications Security - Security Testing, Security Incident Response Planning,The Microsoft Security Development Lifecycle (SDL), OWASP Comprehensive Lightweight Application Security Process (CLASP), The Software Assurance Maturity Model (SAMM)                                                                                                                           |                                                                                                                                                           |                        |                           |   |   |      |       |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                                           | SECURE API DEVELOPMENT                                                                                                                                    |                        |                           |   |   | C03  | 9 Hrs |
| API Security- Session Cookies, Token Based Authentication, Securing Natter APIs: Addressing threats with Security Controls, Rate Limiting for Availability, Encryption, Audit logging, Securing service-to-service APIs: API Keys , OAuth2, Securing Microservice APIs: Service Mesh, Locking Down Network Connections, Securing Incoming Requests.                                |                                                                                                                                                           |                        |                           |   |   |      |       |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                                           | VULNERABILITY ASSESSMENT AND PENETRATION TESTING                                                                                                          |                        |                           |   |   | C04  | 9 Hrs |
| Vulnerability Assessment Lifecycle, Vulnerability Assessment Tools: Cloud-based vulnerability scanners, Host-based vulnerability scanners, Network-based vulnerability scanners, Database based vulnerability scanners, Types of Penetration Tests: External Testing, Web Application Testing, Internal Penetration Testing, SSID or Wireless Testing, Mobile Application Testing. |                                                                                                                                                           |                        |                           |   |   |      |       |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                                           | HACKING TECHNIQUES AND TOOLS                                                                                                                              |                        |                           |   |   | C05  | 9 Hrs |
| Social Engineering, Injection, Cross-Site Scripting(XSS), Broken Authentication and Session Management, Cross-Site Request Forgery(CSRF), Web 3.0 Architecture and security. Security Misconfiguration, Insecure Cryptographic Storage, Failure to Restrict URL Access, Tools: Comodo, OpenVAS, Nexpose, Nikto, Burp Suite,etc.                                                    |                                                                                                                                                           |                        |                           |   |   |      |       |
| Total Hours                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                           |                        |                           |   |   | 45   |       |
| Textbooks:                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                           |                        |                           |   |   |      |       |
| 1                                                                                                                                                                                                                                                                                                                                                                                  | Andrew Hoffman, Web Application Security: Exploitation and Countermeasures for Modern Web                                                                 |                        |                           |   |   |      |       |

|                         |                                                                                                                                                                                            |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         | Applications, First Edition, 2020, O'Reilly Media, Inc.                                                                                                                                    |
| 2                       | Bryan Sullivan, Vincent Liu, Web Application Security: A Beginners Guide, 2012, The McGraw Hill Companies.                                                                                 |
| 3                       | Neil Madden, API Security in Action, 2020, Manning Publications Co., NY, USA.                                                                                                              |
| <b>Reference Books:</b> |                                                                                                                                                                                            |
| 1                       | Michael Cross, Developer's Guide to Web Application Security, 2007, Syngress Publishing, Inc.                                                                                              |
| 2                       | Ravi Das and Greg Johnson, Testing and Securing Web Applications, 2021, Taylor & Francis Group, LLC.                                                                                       |
| 3                       | Prabath Siriwardena, Advanced API Security, 2020, Apress Media LLC, USA.                                                                                                                   |
| 4                       | Allen Harper, Shon Harris, Jonathan Ness, Chris Eagle, Gideon Lenkey, and Terron Williams Grey Hat Hacking: The Ethical Hacker's Handbook, Third Edition, 2011, The McGraw-Hill Companies. |
| <b>Web References:</b>  |                                                                                                                                                                                            |
| 1                       | <a href="https://www.udemy.com/topic/web-application-security-tester/">https://www.udemy.com/topic/web-application-security-tester/</a>                                                    |
| 2                       | <a href="https://onlinecourses.nptel.ac.in/noc26_cs83/preview">https://onlinecourses.nptel.ac.in/noc26_cs83/preview</a>                                                                    |

| Assessment based on Continuous and End Semester Examination |                       |                |                      |            |            |                          |
|-------------------------------------------------------------|-----------------------|----------------|----------------------|------------|------------|--------------------------|
| BLOOM'S TAXONOMY LEVEL                                      | CONTINUOUS ASSESSMENT |                |                      | ASSIGNMENT | ATTENDANCE | END SEMESTER EXAMINATION |
|                                                             | CIA1 (6 Marks)        | CIA2 (6 Marks) | Model Exam (8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)               |
| Remember                                                    |                       |                |                      | 10         | 10         | 60                       |
| Understand                                                  | 60                    |                | 20                   |            |            |                          |
| Apply                                                       | 40                    | 100            | 80                   |            |            |                          |
| Analyze                                                     |                       |                |                      |            |            |                          |
| Evaluate                                                    |                       |                |                      |            |            |                          |
| Create                                                      |                       |                |                      |            |            |                          |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>       | <b>8</b>             | <b>10</b>  | <b>10</b>  | <b>60</b>                |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 | PSO 3 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CC504.1     | 1    | 2    | 2    | 1    | 3    | -    | -    | -    | -    | -     | 1     | 2     | 2     | 3     |
| CC504.2     | 2    | 1    | 2    | 1    | 3    | -    | -    | -    | -    | -     | 2     | 2     | 2     | 3     |
| CC504.3     | 1    | 1    | 1    | 2    | 3    | -    | -    | -    | -    | -     | 1     | 2     | 3     | 3     |
| CC504.4     | 1    | 2    | 1    | 1    | 2    | -    | -    | -    | -    | -     | 1     | 2     | 2     | 3     |
| CC504.5     | 1    | 2    | 2    | 2    | 2    | -    | -    | -    | -    | -     | 1     | 2     | 2     | 3     |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Course Name                                                                                                                  | Category                      | Hours/Week                       |   |            | C            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|-------------------------------|----------------------------------|---|------------|--------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                              |                               | L                                | T | P          |              |
| 24CC505                                                                                                                                                                                                                                                                                                                                                                                                                                                                | PRINCIPLES OF PROGRAMMING LANGUAGES                                                                                          | PE                            | 3                                | 0 | 0          | 3            |
| <b>Regulation</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Nature of the Course</b>                                                                                                  | <b>Semester</b>               | <b>Data Book/Codes/Standards</b> |   |            |              |
| 2024                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | THEORY                                                                                                                       | -                             | -                                |   |            |              |
| <b>Pre-requisite Course(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                              | <b>Co-requisite Course(s)</b> |                                  |   |            |              |
| Programming in C , Object Oriented Programming and Java                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                              | -                             |                                  |   |            |              |
| <b>Course Objectives</b>                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                              |                               |                                  |   |            |              |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To comprehend and explain the syntax and semantics of programming languages.                                                 |                               |                                  |   |            |              |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To gain knowledge of data, data types, and fundamental programming statements.                                               |                               |                                  |   |            |              |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To understand the call-return mechanism and various approaches to its implementation.                                        |                               |                                  |   |            |              |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To acquire knowledge of object-oriented concepts, concurrency, and event-driven programming in modern languages.             |                               |                                  |   |            |              |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To develop programs using non-procedural programming paradigms.                                                              |                               |                                  |   |            |              |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                              |                               |                                  |   |            |              |
| <b>Upon completion of the course, students will be able to</b>                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                              |                               |                                  |   |            |              |
| CC505.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Describe syntax and semantics of programming languages                                                                       |                               |                                  |   |            | [U]          |
| CC505.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Implement suitable data types and basic programming constructs in solving computational problems.                            |                               |                                  |   |            | [AP]         |
| CC505.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Apply call-return mechanisms and their implementation techniques in programming languages.                                   |                               |                                  |   |            | [AP]         |
| CC505.4                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Apply object-oriented, concurrency, and event handling programming constructs and develop programs in Scheme, ML, and Prolog |                               |                                  |   |            | [AP]         |
| CC505.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Develop programs using non-procedural programming paradigms.                                                                 |                               |                                  |   |            | [AP]         |
| <b>Course Contents</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                              |                               |                                  |   |            |              |
| <b>Unit – 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>SYNTAX AND SEMANTICS</b>                                                                                                  |                               |                                  |   | <b>C01</b> | <b>9 Hrs</b> |
| Evolution of programming languages – describing syntax – context-free grammars – attribute grammars – describing semantics – lexical analysis – parsing – recursive-descent – bottom up parsing                                                                                                                                                                                                                                                                        |                                                                                                                              |                               |                                  |   |            |              |
| <b>Unit – 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>DATA, DATA TYPES, AND BASIC STATEMENTS</b>                                                                                |                               |                                  |   | <b>C02</b> | <b>9 Hrs</b> |
| Names – variables – binding – type checking – scope – scope rules – lifetime and garbage collection – primitive data types – strings – array types – associative arrays – record types – union types – pointers and references – Arithmetic expressions – overloaded operators – type conversions – relational and boolean expressions – assignment statements – mixed mode assignments – control structures – selection – iterations – branching – guarded statements |                                                                                                                              |                               |                                  |   |            |              |
| <b>Unit – 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>SUBPROGRAMS AND IMPLEMENTATIONS</b>                                                                                       |                               |                                  |   | <b>C03</b> | <b>9 Hrs</b> |
| Subprograms – design issues – local referencing – parameter passing – overloaded methods – generic methods – design issues for functions – semantics of call and return – implementing simple subprograms – stack and dynamic local variables – nested subprograms – blocks – dynamic scoping                                                                                                                                                                          |                                                                                                                              |                               |                                  |   |            |              |
| <b>Unit – 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>OBJECT-ORIENTATION, CONCURRENCY, AND EVENT HANDLING</b>                                                                   |                               |                                  |   | <b>C04</b> | <b>9 Hrs</b> |
| Object-orientation – design issues for OOP languages – implementation of object-oriented constructs – concurrency – semaphores – monitors – message passing – threads – statement level concurrency – exception handling – event handling                                                                                                                                                                                                                              |                                                                                                                              |                               |                                  |   |            |              |
| <b>Unit – 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>FUNCTIONAL AND LOGIC PROGRAMMING LANGUAGES</b>                                                                            |                               |                                  |   | <b>C05</b> | <b>9 Hrs</b> |
| Introduction to lambda calculus – fundamentals of functional programming languages – Programming with Scheme – Programming with ML – Introduction to logic and logic programming – Programming with Prolog – multi-paradigm languages                                                                                                                                                                                                                                  |                                                                                                                              |                               |                                  |   |            |              |
| <b>Total Hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                              |                               |                                  |   |            | <b>45</b>    |
| <b>Textbooks:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                              |                               |                                  |   |            |              |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Robert W. Sebesta, “Concepts of Programming Languages”, Twelfth Edition (Global Edition), Pearson, 2022.                     |                               |                                  |   |            |              |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Michael L. Scott, “Programming Language Pragmatics”, Fourth Edition, Elsevier, 2018.                                         |                               |                                  |   |            |              |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | R. Kent Dybvig, “The Scheme programming language”, Fourth Edition, Prentice Hall, 2011.                                      |                               |                                  |   |            |              |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                              |                               |                                  |   |            |              |

|                        |                                                                                                                         |
|------------------------|-------------------------------------------------------------------------------------------------------------------------|
| 1                      | Jeffrey D. Ullman, "Elements of ML programming", Second Edition, Pearson, 1997.                                         |
| 2                      | W. F. Clocksin and C. S. Mellish, "Programming in Prolog: Using the ISO Standard", Fifth Edition, Springer, 2003.       |
| 3                      | Programming Languages: Principles and Paradigms – Maurizio Gabbriellini & Simone Martini, 2010.                         |
| 4                      | Concepts in Programming Languages – John C. Mitchell, Cambridge University, 2002 (first edition).                       |
| <b>Web References:</b> |                                                                                                                         |
| 1                      | <a href="https://www.nptel.ac.in/courses/106102067">https://www.nptel.ac.in/courses/106102067</a> .                     |
| 2                      | <a href="https://www.nptelprep.in/courses/106102067/materials">https://www.nptelprep.in/courses/106102067/materials</a> |

| Assessment based on Continuous and End Semester Examination |                       |                |                      |            |            |                          |
|-------------------------------------------------------------|-----------------------|----------------|----------------------|------------|------------|--------------------------|
| BLOOM'S TAXONOMY LEVEL                                      | CONTINUOUS ASSESSMENT |                |                      | ASSIGNMENT | ATTENDANCE | END SEMESTER EXAMINATION |
|                                                             | CIA1 (6 Marks)        | CIA2 (6 Marks) | Model Exam (8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)               |
| Remember                                                    |                       |                |                      | 10         | 10         | 60                       |
| Understand                                                  | 60                    |                | 20                   |            |            |                          |
| Apply                                                       | 40                    | 100            | 80                   |            |            |                          |
| Analyze                                                     |                       |                |                      |            |            |                          |
| Evaluate                                                    |                       |                |                      |            |            |                          |
| Create                                                      |                       |                |                      |            |            |                          |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>       | <b>8</b>             | <b>10</b>  | <b>10</b>  | <b>60</b>                |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO 1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PS01 | PS02 | PS0 3 |
|-------------|------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|------|------|-------|
| CC505.1     | 2    | 2   | 3   | 2   | 1   | -   | -   | -   | -   | -     | 3     | 2    | 3    | 2     |
| CC505.2     | 3    | 3   | 3   | 2   | 2   | -   | -   | -   | -   | -     | 3     | 2    | 3    | 3     |
| CC505.3     | 3    | 3   | 3   | 2   | 2   | -   | -   | -   | -   | -     | 3     | 2    | 3    | 3     |
| CC505.4     | 3    | 3   | 3   | 3   | 2   | -   | -   | -   | -   | -     | 2     | 3    | 2    | 2     |
| CC505.5     | 3    | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -     | 3     | 3    | 3    | 3     |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Course Name                                                                                                                           | Category               | Hours/Week                |   |   | C    |   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|---|------|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                       |                        | L                         | T | P |      |   |
| 24CC506                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | ADVANCED DATABASES                                                                                                                    | PE                     | 3                         | 0 | 0 | 3    |   |
| Regulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Nature of the Course                                                                                                                  | Semester               | Data Book/Codes/Standards |   |   |      |   |
| 2024                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | THEORY                                                                                                                                | -                      | -                         |   |   |      |   |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                       | Co-requisite Course(s) |                           |   |   |      |   |
| Database Management Systems                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                       | -                      |                           |   |   |      |   |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                       |                        |                           |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | To provide knowledge on parallel and distributed database architectures.                                                              |                        |                           |   |   |      |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | To introduce intelligent database concepts and their applications.                                                                    |                        |                           |   |   |      |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | To apply XML data models, XML querying, and graph database concepts for managing semi-structured and connected data.                  |                        |                           |   |   |      |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | To know the challenges and techniques involved in mobile database management.                                                         |                        |                           |   |   |      |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | To impart knowledge on multimedia database design, multidimensional data structures, and emerging database technologies.              |                        |                           |   |   |      |   |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                       |                        |                           |   |   |      |   |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                       |                        |                           |   |   |      |   |
| CC506.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Understand various database system architectures and other concepts related to it.                                                    |                        |                           |   |   | [U]  |   |
| CC506.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Apply intelligent database concepts and spatial database models in real-world applications.                                           |                        |                           |   |   | [AP] |   |
| CC506.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Evaluate XML and graph database models for managing semi-structured and connected data in comparison with relational databases.       |                        |                           |   |   | [AP] |   |
| CC506.4                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Apply the mobile database management issues including mobility impact, transaction models, concurrency control, and commit protocols. |                        |                           |   |   | [AP] |   |
| CC506.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Apply multimedia database systems using multidimensional data structures for image, text, audio, and video data.                      |                        |                           |   |   | [AP] |   |
| Course Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                       |                        |                           |   |   |      |   |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | PARALLEL AND DISTRIBUTED DATABASES                                                                                                    |                        |                           |   |   | CO1  | 9 |
| Database System Architectures: Centralized and Client-Server Architectures – Server System Architectures – Parallel Systems- Distributed Systems – Parallel Databases: I/O Parallelism – Inter and Intra Query Parallelism – Inter and Intra operation Parallelism – Design of Parallel Systems Distributed Database Concepts - Distributed Data Storage – Distributed Transactions – Commit Protocols – Concurrency Control – Distributed Query Processing – Case Studies |                                                                                                                                       |                        |                           |   |   |      |   |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | INTELLIGENT DATABASES                                                                                                                 |                        |                           |   |   | CO2  | 9 |
| Active Databases: Syntax and Semantics (Starburst, Oracle, DB2)- Taxonomy- Applications- Design Principles for Active Rules- Temporal Databases: Overview of Temporal Databases TSQL2- Deductive Databases-Recursive Queries in SQL- Spatial Databases- Spatial Data Types - Spatial Relationships- Spatial Data Structures-Spatial Access Methods- Spatial DB Implementation.                                                                                             |                                                                                                                                       |                        |                           |   |   |      |   |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | XML AND GRAPH DATABASES                                                                                                               |                        |                           |   |   | CO3  | 9 |
| XML Databases: XML Data Model – DTD – XML Schema – XML Querying – Web Databases – Open Database Connectivity.Graph Databases: Introduction-Comparison with relational modeling,Graph Databases, Consistency, Transactions, Availability, Query Features, Scaling.                                                                                                                                                                                                          |                                                                                                                                       |                        |                           |   |   |      |   |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | MOBILE DATABASES                                                                                                                      |                        |                           |   |   | C04  | 9 |
| Mobile Databases: Location and Handoff Management - Effect of Mobility on Data Management - Location Dependent Data Distribution - Mobile Transaction Models - Concurrency Control - Transaction Commit Protocols                                                                                                                                                                                                                                                          |                                                                                                                                       |                        |                           |   |   |      |   |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | MULTIMEDIA DATABASES AND EMERGING DATABASE TECHNOLOGIES                                                                               |                        |                           |   |   | C05  | 9 |
| Multidimensional Data Structures – Image Databases – Text / Document Databases – Video Databases – Audio Databases – Multimedia Database Design.Emerging Technologies: Active database – Detective database- Object database - Temporal database - Streaming databases.                                                                                                                                                                                                    |                                                                                                                                       |                        |                           |   |   |      |   |
| Total Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                       |                        |                           |   |   | 45   |   |
| Textbooks:                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                       |                        |                           |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”, Seventh Edition, Tata McGraw Hill, 2019.             |                        |                           |   |   |      |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | RamezElmasri, Shamkant B. Navathe, “Fundamentals of Database Systems”, Seventh Edition, Pearson Education, 2016.                      |                        |                           |   |   |      |   |

|                         |                                                                                                                                                                                         |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3                       | C.J.Date, A.Kannan, S.Swamynathan, –An Introduction to Database Systems, Eighth Edition, Pearson Education, 2006                                                                        |
| <b>Reference Books:</b> |                                                                                                                                                                                         |
| 1                       | Raghu Ramakrishnan, Database Management Systems, ,4th edition, Mcgraw-Hill,2015                                                                                                         |
| 2                       | Carlo Zaniolo, Stefano Ceri, Christos Faloutsos, Richard T.Snodgrass, V.S.Subrahmanian, Roberto Zicari, –Advanced Database Systems, Morgan Kaufmann publishers,2006.                    |
| 3                       | Vijay Kumar, –Mobile Database Systems, John Wiley & Sons, 2006.                                                                                                                         |
| 4                       | S.K.Singh, Database Systems: Concepts, Design & Applications, 2nd Edition, Pearson education, 2011.                                                                                     |
| <b>Web References:</b>  |                                                                                                                                                                                         |
| 1                       | <a href="https://www.coursera.org/learn/modern-databases-odc?utm_source=chatgpt.com">https://www.coursera.org/learn/modern-databases-odc?utm_source=chatgpt.com</a>                     |
| 2                       | <a href="https://www.udemy.com/course/certified-nosql-graph-databases/?utm_source=chatgpt.com">https://www.udemy.com/course/certified-nosql-graph-databases/?utm_source=chatgpt.com</a> |

| Assessment based on Continuous and End Semester Examination |                       |                |                      |            |            |                          |
|-------------------------------------------------------------|-----------------------|----------------|----------------------|------------|------------|--------------------------|
| BLOOM'S TAXONOMY LEVEL                                      | CONTINUOUS ASSESSMENT |                |                      | ASSIGNMENT | ATTENDANCE | END SEMESTER EXAMINATION |
|                                                             | CIA1 (6 Marks)        | CIA2 (6 Marks) | Model Exam (8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)               |
| Remember                                                    |                       |                |                      | 10         | 10         | 60                       |
| Understand                                                  | 80                    |                | 20                   |            |            |                          |
| Apply                                                       | 20                    | 100            | 80                   |            |            |                          |
| Analyze                                                     |                       |                |                      |            |            |                          |
| Evaluate                                                    |                       |                |                      |            |            |                          |
| Create                                                      |                       |                |                      |            |            |                          |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>       | <b>8</b>             | <b>10</b>  | <b>10</b>  | <b>60</b>                |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 | PSO 3 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CC506.1     | 3    | 3    | 2    | 2    | 3    | -    | -    | -    | -    | -     | 2     | 3     | 2     | 2     |
| CC506.2     | 3    | 2    | 3    | 2    | 3    | -    | -    | -    | -    | -     | 1     | 3     | 2     | 3     |
| CC506.3     | 3    | 3    | 2    | 2    | 3    | -    | -    | -    | -    | -     | 2     | 3     | 2     | 3     |
| CC506.4     | 3    | 3    | 2    | 2    | 3    | -    | -    | -    | -    | -     | 2     | 2     | 3     | 2     |
| CC506.5     | 3    | 2    | 3    | 2    | 3    | -    | -    | -    | -    | -     | 1     | 3     | 2     | 3     |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Course Name                                                                                                                                                          | Category                                | Hours/Week                       |   |            | C         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|----------------------------------|---|------------|-----------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                      |                                         | L                                | T | P          |           |
| 24CS501                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | CLOUD COMPUTING ESSENTIALS                                                                                                                                           | PE                                      | 3                                | 0 | 0          | 3         |
| <b>Regulation</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Nature of the Course</b>                                                                                                                                          | <b>Semester</b>                         | <b>Data Book/Codes/Standards</b> |   |            |           |
| 2024                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Theory                                                                                                                                                               | VI                                      | Nil                              |   |            |           |
| <b>Pre-requisite Course(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                      | <b>Co-requisite Course(s)</b>           |                                  |   |            |           |
| Computer Networks, Operating Systems                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                      | Distributed Systems, Big Data Analytics |                                  |   |            |           |
| <b>Course Objectives</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                      |                                         |                                  |   |            |           |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | To understand the principles of cloud architecture, models and infrastructure                                                                                        |                                         |                                  |   |            |           |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | To understand the concepts of virtualization and virtual machines.                                                                                                   |                                         |                                  |   |            |           |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | To gain knowledge about virtualization Infrastructure.                                                                                                               |                                         |                                  |   |            |           |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | To explore and experiment with various Cloud deployment environments.                                                                                                |                                         |                                  |   |            |           |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | To learn about the security issues in the cloud environment.                                                                                                         |                                         |                                  |   |            |           |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                      |                                         |                                  |   |            |           |
| <b>Upon completion of the course, students will be able to</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                      |                                         |                                  |   |            |           |
| C501.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Understand the design challenges in the cloud.                                                                                                                       |                                         |                                  |   |            | U         |
| C501.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Apply the concept of virtualization and its types.                                                                                                                   |                                         |                                  |   |            | AP        |
| C501.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Experiment with virtualization of hardware resources and Docker.                                                                                                     |                                         |                                  |   |            | AP        |
| C501.4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Develop and deploy services on the cloud and set up a cloud environment.                                                                                             |                                         |                                  |   |            | AP        |
| C501.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Apply security challenges in the cloud environment.                                                                                                                  |                                         |                                  |   |            | AP        |
| <b>Course Contents</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                      |                                         |                                  |   |            |           |
| <b>Unit – 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>CLOUD ARCHITECTURE MODELS AND INFRASTRUCTURE</b>                                                                                                                  |                                         |                                  |   | <b>CO1</b> | <b>9</b>  |
| Cloud Architecture: System Models for Distributed and Cloud Computing – NIST Cloud Computing Reference Architecture – Cloud deployment models – Cloud service models; Cloud Infrastructure: Architectural Design of Compute and Storage Clouds – Design Challenges                                                                                                                                                                                                                                                                               |                                                                                                                                                                      |                                         |                                  |   |            |           |
| <b>Unit – 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>VIRTUALIZATION BASICS</b>                                                                                                                                         |                                         |                                  |   | <b>CO2</b> | <b>9</b>  |
| Virtual Machine Basics – Taxonomy of Virtual Machines – Hypervisor – Key Concepts – Virtualization structure – Implementation levels of virtualization – Virtualization Types: Full Virtualization – Para Virtualization – Hardware Virtualization – Virtualization of CPU, Memory and I/O devices - Issues with virtualization, virtualization technologies and architectures, virtualization of data centers, and Issues with Multi-tenancy.                                                                                                   |                                                                                                                                                                      |                                         |                                  |   |            |           |
| <b>Unit – 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>VIRTUALIZATION INFRASTRUCTURE AND DOCKER</b>                                                                                                                      |                                         |                                  |   | <b>CO3</b> | <b>9</b>  |
| Desktop Virtualization – Network Virtualization – Storage Virtualization – System-level of Operating Virtualization – Application Virtualization – Virtual clusters and Resource Management – Containers vs. Virtual Machines – Introduction to Docker – Docker Components – Docker Container – Docker Images and Repositories.                                                                                                                                                                                                                  |                                                                                                                                                                      |                                         |                                  |   |            |           |
| <b>Unit – 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>CLOUD DEPLOYMENT ENVIRONMENT</b>                                                                                                                                  |                                         |                                  |   | <b>CO4</b> | <b>9</b>  |
| Google App Engine – Amazon AWS – Microsoft Azure; Cloud Software Environments – Eucalyptus – OpenStack – Implementation: Study of Cloud computing Systems like Amazon EC2 and S3, Google App Engine, and Microsoft Azure, Build Private/Hybrid Cloud using open source tools, Deployment of Web Services from Inside and Outside a Cloud Architecture. MapReduce and its extensions to Cloud Computing, HDFS, and GFS.                                                                                                                           |                                                                                                                                                                      |                                         |                                  |   |            |           |
| <b>Unit – 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>CLOUD SECURITY AND OPEN SOURCE SUPPORT FOR CLOUD</b>                                                                                                              |                                         |                                  |   | <b>CO5</b> | <b>9</b>  |
| Introduction to Cloud Security – Challenges and Risks – Software-as-a-Service Security – Security Governance – Risk Management – Security Monitoring – Security Architecture Design – Data Security – Application Security – Virtual Machine Security – Identity Management and Access Control – Autonomic security. Introduction – Open Source Tools for IaaS : Eucalyptus, OpenStack. Open Source Tools for PaaS: Paasmaker, Cloudify. Open Source Tools for SaaS: Google Drive, Dropbox. OpenSource Tools for Research: CloudSim, GreenCloud. |                                                                                                                                                                      |                                         |                                  |   |            |           |
| <b>Total Hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                      |                                         |                                  |   |            | <b>45</b> |
| <b>Textbooks:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                      |                                         |                                  |   |            |           |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | "Essentials of Cloud Computing: A Holistic, Cloud-Native Perspective" by Chellammal Surianarayanan and Pethuru Raj ,Springer,2nd Ed., 2023.                          |                                         |                                  |   |            |           |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Cloud Computing Essentials by Dr.S.Saravana Kumar, Dr.Rubini.P, Banupriya.M,1 <sup>st</sup> Ed.,2024.                                                                |                                         |                                  |   |            |           |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                      |                                         |                                  |   |            |           |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Kai Hwang, Geoffrey C Fox, Jack G Dongarra, “Distributed and Cloud Computing, From Parallel Processing to the Internet of Things”, Morgan Kaufmann Publishers, 2012. |                                         |                                  |   |            |           |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | James Turnbull, “The Docker Book”, O’Reilly Publishers, 2014.                                                                                                        |                                         |                                  |   |            |           |
| <b>Web References:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                      |                                         |                                  |   |            |           |

|   |                                                                                                                                                                                                                                               |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <a href="https://www.startertutorials.com/blog/cloud-computing-essentials.html">https://www.startertutorials.com/blog/cloud-computing-essentials.html</a>                                                                                     |
| 2 | <a href="https://www.linkedin.com/top-content/training-development/digital-literacy-training/cloud-computing-essentials/">https://www.linkedin.com/top-content/training-development/digital-literacy-training/cloud-computing-essentials/</a> |

| Assessment based on Continuous and End Semester Examination |                       |                |                      |            |            |                          |
|-------------------------------------------------------------|-----------------------|----------------|----------------------|------------|------------|--------------------------|
| BLOOM'S TAXONOMY LEVEL                                      | CONTINUOUS ASSESSMENT |                |                      | ASSIGNMENT | ATTENDANCE | END SEMESTER EXAMINATION |
|                                                             | CIA1 (6 Marks)        | CIA2 (6 Marks) | Model Exam (8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)               |
| Remember                                                    |                       |                |                      | 10         | 10         | 60                       |
| Understand                                                  | 40%                   |                | 20%                  |            |            |                          |
| Apply                                                       | 60%                   | 100%           | 80%                  |            |            |                          |
| Analyze                                                     |                       |                |                      |            |            |                          |
| Evaluate                                                    |                       |                |                      |            |            |                          |
| Create                                                      |                       |                |                      |            |            |                          |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>       | <b>8</b>             | <b>10</b>  | <b>10</b>  | <b>60</b>                |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>Pos | P01 | P02 | P03 | P04 | P05 | P06 | P07 | P08 | P09 | P010 | P011 | PS01 | PS02 |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| C501.1      | 3   | 2   | 2   | 2   | 2   | -   | -   | -   | 2   | 3    | 2    | -    | 2    |
| C501.2      | 3   | 2   | 2   | 2   | 2   | -   | -   | -   | 1   | 2    | 2    | -    | 2    |
| C501.3      | 2   | 3   | 2   | 3   | 2   | -   | -   | -   | 3   | 1    | 2    | -    | 2    |
| C501.4      | 2   | 2   | 3   | 3   | 3   | -   | -   | -   | 3   | 3    | 2    | -    | 3    |
| C501.5      | 2   | 3   | 3   | 2   | 3   | -   | -   | -   | 2   | 2    | 2    | -    | 2    |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                                                   | Course Name                                                                                                                                     | Category               | Hours/Week                |   |   | C    |   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|---|------|---|
|                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                 |                        | L                         | T | P |      |   |
| 24CS502                                                                                                                                                                                                                                                                                                                                                                                       | CLOUD SERVICES MANAGEMENT                                                                                                                       | PE                     | 3                         | 0 | 0 | 3    |   |
| Regulation                                                                                                                                                                                                                                                                                                                                                                                    | Nature of the Course                                                                                                                            | Semester               | Data Book/Codes/Standards |   |   |      |   |
| 2024                                                                                                                                                                                                                                                                                                                                                                                          | Theory                                                                                                                                          | V                      | Nil                       |   |   |      |   |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                 | Co-requisite Course(s) |                           |   |   |      |   |
| Operating Systems,Database management system                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                 | Computer Networks      |                           |   |   |      |   |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                 |                        |                           |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                             | Introduce Cloud Service Management terminology, definition & concepts                                                                           |                        |                           |   |   |      |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                             | Compare and contrast cloud service management with traditional IT service management                                                            |                        |                           |   |   |      |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                             | Identify strategies to reduce risk and eliminate issues associated with adoption of cloud services                                              |                        |                           |   |   |      |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                             | Select appropriate structures for designing, deploying and running cloud-based services in a business environment                               |                        |                           |   |   |      |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                             | Illustrate the benefits and drive the adoption of cloud-based services to solve real world problems                                             |                        |                           |   |   |      |   |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                 |                        |                           |   |   |      |   |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                 |                        |                           |   |   |      |   |
| C502.1                                                                                                                                                                                                                                                                                                                                                                                        | Explain the fundamental concepts of cloud service management including cloud ecosystem, characteristics, service models, and deployment models. |                        |                           |   |   | [U]  |   |
| C502.2                                                                                                                                                                                                                                                                                                                                                                                        | Describe cloud service strategies and management frameworks for effective adoption and implementation of cloud services.                        |                        |                           |   |   | [U]  |   |
| C502.3                                                                                                                                                                                                                                                                                                                                                                                        | Apply cloud service management techniques such as service lifecycle, capacity planning, migration, and operational management.                  |                        |                           |   |   | [AP] |   |
| C502.4                                                                                                                                                                                                                                                                                                                                                                                        | Apply cloud service economic models to analyze pricing strategies, billing mechanisms, and cost management in cloud environments.               |                        |                           |   |   | [AP] |   |
| C502.5                                                                                                                                                                                                                                                                                                                                                                                        | Demonstrate cloud governance frameworks and risk management practices to evaluate the value and effectiveness of cloud services.                |                        |                           |   |   | [AP] |   |
| Course Contents                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                 |                        |                           |   |   |      |   |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                                                      | CLOUD SERVICE MANAGEMENT FUNDAMENTALS                                                                                                           |                        |                           |   |   | CO1  | 9 |
| Cloud Ecosystem, The Essential Characteristics, Basics of Information Technology Service Management and Cloud Service Management, Service Perspectives, Cloud Service Models, Cloud Service Deployment Models Cloud Computing Architecture-Virtualization Technologies-Cloud Service Level Agreements (SLA) and Quality of Service (QoS)                                                      |                                                                                                                                                 |                        |                           |   |   |      |   |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                                                      | CLOUD SERVICES STRATEGY                                                                                                                         |                        |                           |   |   | CO2  | 9 |
| Cloud Strategy Fundamentals, Cloud Strategy Management Framework, Cloud Policy, Key Driver for Adoption, Risk Management, IT Capacity and Utilization, Demand and Capacity matching, Demand Queueing, Change Management,Cloud Service Architecture- Cloud Governance – Cloud Migration Strategy – Cloud Security Management – Cloud Service Level Agreement (SLA) – Cloud Resource Allocation |                                                                                                                                                 |                        |                           |   |   |      |   |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                                                      | CLOUD SERVICE MANAGEMENT                                                                                                                        |                        |                           |   |   | CO3  | 9 |
| Cloud Service Reference Model, Cloud Service Life Cycle, Basics of Cloud Service Design, Dealing with Legacy Systems and Services, Benchmarking of Cloud Services, Cloud Service Capacity Planning, Cloud Service Deployment and Migration, Cloud Marketplace, Cloud Service Operations Management-Cloud Governance and Compliance-Cloud Design Patterns                                      |                                                                                                                                                 |                        |                           |   |   |      |   |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                                                      | CLOUD SERVICE ECONOMICS                                                                                                                         |                        |                           |   |   | CO4  | 9 |
| Pricing models for Cloud Services, Freemium, Pay Per Reservation, Pay per User, Subscription based Charging, Procurement of Cloud-based Services, Capex vs Opex Shift, Cloud service Charging, Cloud Cost Models-Cloud Service Billing and Metering-Cloud Financial Management-Resource Allocation and Cost Efficiency                                                                        |                                                                                                                                                 |                        |                           |   |   |      |   |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                                                      | CLOUD SERVICE GOVERNANCE & VALUE                                                                                                                |                        |                           |   |   | CO5  | 9 |

IT Governance Definition, Cloud Governance Definition, Cloud Governance Framework, Cloud Governance Structure, Cloud Governance Considerations, Cloud Service Model Risk Matrix, Understanding Value of Cloud Services, Measuring the value of Cloud Services, Balanced Scorecard, Total Cost of Ownership-Cloud Cost Management and Optimization-Cloud Security and Risk Management

**Total Hours** 45

**Textbooks:**

|   |                                                                                                                         |
|---|-------------------------------------------------------------------------------------------------------------------------|
| 1 | Cloud Service Management and Governance: Smart Service Management in Cloud Era by Enamul Haque, Enel Publications, 2023 |
| 2 | Cloud Computing: Concepts, Technology & Architecture by Thomas Erl, Ricardo Puttini, Zaigham Mohammad 2024              |

**Reference Books:**

|   |                                                                                                                                                               |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | James E. Smith, Ravi Nair, "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.                                 |
| 2 | Tim Mather, Subra Kumaraswamy, and Shahed Latif, "Cloud Security and Privacy: an enterprise perspective on risks and compliance", O'Reilly Media, Inc., 2009. |

**Web References:**

|   |                                                                                                                                                                                                                                               |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <a href="https://www.startertutorials.com/blog/cloud-computing-essentials.html">https://www.startertutorials.com/blog/cloud-computing-essentials.html</a>                                                                                     |
| 2 | <a href="https://www.linkedin.com/top-content/training-development/digital-literacy-training/cloud-computing-essentials/">https://www.linkedin.com/top-content/training-development/digital-literacy-training/cloud-computing-essentials/</a> |

**Assessment based on Continuous and End Semester Examination**

| BLOOM'S TAXONOMY LEVEL   | CONTINUOUS ASSESSMENT |                |                      | ASSIGNMENT | ATTENDANCE | END SEMESTER EXAMINATION |
|--------------------------|-----------------------|----------------|----------------------|------------|------------|--------------------------|
|                          | CIA1 (6 Marks)        | CIA2 (6 Marks) | Model Exam (8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)               |
| Remember                 |                       |                |                      |            |            |                          |
| Understand               | 100                   | 20             | 20                   |            |            |                          |
| Apply                    |                       | 80             | 80                   |            |            |                          |
| Analyze                  |                       |                |                      |            |            |                          |
| Evaluate                 |                       |                |                      |            |            |                          |
| Create                   |                       |                |                      |            |            |                          |
| <b>Total (100 Marks)</b> | 6                     | 6              | 8                    | 10         | 10         | 60                       |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| C502.1      | 3   | 2   |     |     | 2   |     |     |     |     |      | 1    | 2    | 3    |
| C502.2      | 3   | 3   | 1   |     | 2   |     |     |     |     | 1    | 1    | 2    | 3    |
| C502.3      | 2   | 2   | 3   | 1   | 3   |     |     |     |     | 2    | 1    | 3    | 3    |
| C502.4      | 1   | 3   | 1   |     | 2   |     |     |     |     | 3    | 1    | 3    | 2    |
| C502.5      | 1   | 2   | 1   | 1   | 2   | 3   | 2   |     |     | 1    | 2    | 1    | 2    |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                       | Course Name                                                                                                                      | Category               | Hours/Week                |   |             | C     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|-------------|-------|
|                                                                                                                                                                                                                                                                                                                   |                                                                                                                                  |                        | L                         | T | P           |       |
| 24CS503                                                                                                                                                                                                                                                                                                           | VIRTUALIZATION                                                                                                                   | PE                     | 3                         | 0 | 0           | 3     |
| Regulation                                                                                                                                                                                                                                                                                                        | Nature of the Course                                                                                                             | Semester               | Data Book/Codes/Standards |   |             |       |
| R24                                                                                                                                                                                                                                                                                                               | Theory                                                                                                                           | V                      | -                         |   |             |       |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                           |                                                                                                                                  | Co-requisite Course(s) |                           |   |             |       |
| Foundation of Cloud Computing                                                                                                                                                                                                                                                                                     |                                                                                                                                  | Computer Networks      |                           |   |             |       |
| Course Objectives                                                                                                                                                                                                                                                                                                 |                                                                                                                                  |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                                                                 | To understand the fundamentals and need for virtualization in modern computing.                                                  |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                                                                 | To explore server and desktop virtualization techniques and their applications.                                                  |                        |                           |   |             |       |
| 3                                                                                                                                                                                                                                                                                                                 | To learn concepts and tools related to network virtualization.                                                                   |                        |                           |   |             |       |
| 4                                                                                                                                                                                                                                                                                                                 | To understand storage and memory virtualization techniques.                                                                      |                        |                           |   |             |       |
| 5                                                                                                                                                                                                                                                                                                                 | To analyze security challenges and solutions in virtualization environments.                                                     |                        |                           |   |             |       |
| Course Outcomes                                                                                                                                                                                                                                                                                                   |                                                                                                                                  |                        |                           |   |             |       |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                           |                                                                                                                                  |                        |                           |   |             |       |
| C503.1                                                                                                                                                                                                                                                                                                            | Explain the fundamentals, need, and types of virtualization.                                                                     |                        |                           |   |             | [U]   |
| C503.2                                                                                                                                                                                                                                                                                                            | Analyze server and desktop virtualization techniques and their applications.                                                     |                        |                           |   |             | [AP]  |
| C503.3                                                                                                                                                                                                                                                                                                            | Understand and apply network virtualization concepts and tools.                                                                  |                        |                           |   |             | [AP]  |
| C503.4                                                                                                                                                                                                                                                                                                            | Apply storage and memory virtualization techniques to configure and manage efficient storage systems in real-world environments. |                        |                           |   |             | [AP]  |
| C503.5                                                                                                                                                                                                                                                                                                            | Apply security issues and implement protection mechanisms in virtualization environments.                                        |                        |                           |   |             | [AP]  |
| Course Contents                                                                                                                                                                                                                                                                                                   |                                                                                                                                  |                        |                           |   |             |       |
| Unit – 1                                                                                                                                                                                                                                                                                                          | INTRODUCTION TO VIRTUALIZATION                                                                                                   |                        |                           |   | C01         | 9 Hrs |
| Virtualization and cloud computing - Need of virtualization - cost, administration, fast deployment, reduce infrastructure cost - limitations - Types of hardware virtualization : Full virtualization - partial virtualization - Paravirtualization - Types of Hypervisors.                                      |                                                                                                                                  |                        |                           |   |             |       |
| Unit – 2                                                                                                                                                                                                                                                                                                          | SERVER AND DESKTOP VIRTUALIZATION                                                                                                |                        |                           |   | C02         | 9 Hrs |
| Virtual machine basics - Types of virtual machines - Understanding Server Virtualization - types of server virtualization - Business Cases for Server Virtualization - Uses of Virtual Server Consolidation - Selecting Server Virtualization Platform - Desktop Virtualization -Types of Desktop Virtualization. |                                                                                                                                  |                        |                           |   |             |       |
| Unit – 3                                                                                                                                                                                                                                                                                                          | NETWORK VIRTUALIZATION                                                                                                           |                        |                           |   | C03         | 9 Hrs |
| Introduction to Network Virtualization-Advantages - Functions - Tools for Network Virtualization - VLAN - WAN Architecture -WAN Virtualization.                                                                                                                                                                   |                                                                                                                                  |                        |                           |   |             |       |
| Unit – 4                                                                                                                                                                                                                                                                                                          | STORAGE VIRTUALIZATION                                                                                                           |                        |                           |   | C04         | 9 Hrs |
| Memory Virtualization -Types of Storage Virtualization - Block, File - Address space Remapping - Risks of Storage Virtualization-SAN-NAS-RAID.                                                                                                                                                                    |                                                                                                                                  |                        |                           |   |             |       |
| Unit – 5                                                                                                                                                                                                                                                                                                          | VIRTUALIZATION SECURITY                                                                                                          |                        |                           |   | C05         | 9 Hrs |
| Fundamentals of Virtualization Security – Securing Hypervisors – Designing Virtual networks for security – comparing virtual and physical networks – Security recommendations for management platforms – virtual machine threats and vulnerabilities – logging and auditing.                                      |                                                                                                                                  |                        |                           |   |             |       |
|                                                                                                                                                                                                                                                                                                                   |                                                                                                                                  |                        |                           |   | Total Hours | 45    |
| Textbooks:                                                                                                                                                                                                                                                                                                        |                                                                                                                                  |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                                                                 | William von Hagen, <i>Professional Xen Virtualization</i> , Wiley Publishing.                                                    |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                                                                 | Chris Wolf and Erick M. Halter, <i>Virtualization: From the Desktop to the Enterprise</i> , Apress.                              |                        |                           |   |             |       |
| Reference Books:                                                                                                                                                                                                                                                                                                  |                                                                                                                                  |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                                                                 | James E. Smith and Ravi Nair, <i>Virtual Machines: Versatile Platforms for Systems and Processes</i> , Morgan Kaufmann.          |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                                                                 | Bernard Golden, <i>Virtualization for Dummies</i> , Wiley Publishing.                                                            |                        |                           |   |             |       |
| Web References:                                                                                                                                                                                                                                                                                                   |                                                                                                                                  |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                                                                 | <a href="https://www.vmware.com">https://www.vmware.com</a>                                                                      |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                                                                 | <a href="https://learn.microsoft.com/en-us/virtualization/">https://learn.microsoft.com/en-us/virtualization/</a>                |                        |                           |   |             |       |

| Assessment based on Continuous and End Semester Examination |                       |                   |                            |            |            |                                |
|-------------------------------------------------------------|-----------------------|-------------------|----------------------------|------------|------------|--------------------------------|
| BLOOM'S<br>TAXONOMY<br>LEVEL                                | CONTINUOUS ASSESSMENT |                   |                            | ASSIGNMENT | ATTENDANCE | END<br>SEMESTER<br>EXAMINATION |
|                                                             | CIA1<br>(6 Marks)     | CIA2<br>(6 Marks) | Model<br>Exam<br>(8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)                     |
| Remember                                                    |                       |                   |                            | 10         | 10         |                                |
| Understand                                                  | 20                    | 20                | 20                         |            |            |                                |
| Apply                                                       | 80                    | 80                | 80                         |            |            |                                |
| Analyze                                                     |                       |                   |                            |            |            |                                |
| Evaluate                                                    |                       |                   |                            |            |            |                                |
| Create                                                      |                       |                   |                            |            |            |                                |
| <b>Total<br/>(100 Marks)</b>                                | <b>6</b>              | <b>6</b>          | <b>8</b>                   | <b>10</b>  | <b>10</b>  | <b>60</b>                      |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO<br>1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO<br>10 | PO<br>11 | PSO1 | PSO2 |
|-------------|---------|-----|-----|-----|-----|-----|-----|-----|-----|----------|----------|------|------|
| C503.1      | 3       | 2   | -   | -   | 2   | -   | -   | -   | -   | -        | 2        | 2    | -    |
| C503.2      | 3       | 3   | 2   | 2   | 3   | -   | -   | 2   | -   | -        | 2        | 3    | 2    |
| C503.3      | 3       | 3   | 3   | 2   | 3   | -   | -   | 2   | -   | -        | 2        | 3    | 2    |
| C503.4      | 3       | 2   | 2   | 2   | 3   | -   | -   | -   | -   | -        | 2        | 3    | 2    |
| C503.5      | 3       | 3   | 2   | 3   | 3   | 2   | 2   | 2   | 2   | -        | 2        | 3    | 2    |

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Course Name                                                                                                                                                                   | Category               | Hours/Week                |   |   | C    |   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|---|------|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                               |                        | L                         | T | P |      |   |
| 24CS504                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | SECURITY AND PRIVACY IN CLOUD                                                                                                                                                 | PC                     | 3                         | 0 | 0 | 3    |   |
| Regulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Nature of the Course                                                                                                                                                          | Semester               | Data Book/Codes/Standards |   |   |      |   |
| 2024                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Theory                                                                                                                                                                        | V                      | -                         |   |   |      |   |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                               | Co-requisite Course(s) |                           |   |   |      |   |
| Cloud Computing, Computer Networks                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                               | Nil                    |                           |   |   |      |   |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                               |                        |                           |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | To Understand the architecture and security challenges of cloud computing.                                                                                                    |                        |                           |   |   |      |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Understand cryptographic mechanisms used in cloud security.                                                                                                                   |                        |                           |   |   |      |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Apply secure cloud design principles and data protection techniques.                                                                                                          |                        |                           |   |   |      |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Apply identity management and access control mechanisms in cloud environments.                                                                                                |                        |                           |   |   |      |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Apply monitoring, auditing, and compliance practices for secure cloud systems.                                                                                                |                        |                           |   |   |      |   |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                               |                        |                           |   |   |      |   |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                               |                        |                           |   |   |      |   |
| C504.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Explain cloud security concepts and cryptographic mechanisms                                                                                                                  |                        |                           |   |   | [U]  |   |
| C504.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Describe cloud security architecture and protection mechanisms                                                                                                                |                        |                           |   |   | [U]  |   |
| C504.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Apply identity management and access control techniques in cloud                                                                                                              |                        |                           |   |   | [AP] |   |
| C504.4                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Apply cloud security models and design patterns for secure deployment                                                                                                         |                        |                           |   |   | [AP] |   |
| C504.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Apply monitoring, auditing and management mechanisms in cloud security                                                                                                        |                        |                           |   |   | [AP] |   |
| Course Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                               |                        | Hrs                       |   |   |      |   |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | FUNDAMENTALS OF CLOUD SECURITY                                                                                                                                                |                        |                           |   |   | CO1  | 9 |
| Overview of cloud security- Security Services - Confidentiality, Integrity, Authentication, Nonrepudiation, Access Control - Fundamentals of Cryptography – Symmetric Cryptography – Public Key Cryptography – Hash Functions – Authentication Mechanisms – Digital Signatures – Role of Cryptography in Cloud Security.                                                                                                                                                   |                                                                                                                                                                               |                        |                           |   |   |      |   |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | CLOUD SECURITY DESIGN AND ARCHITECTURE                                                                                                                                        |                        |                           |   |   | CO2  | 9 |
| Security design principles for Cloud Computing - Comprehensive data protection - End-to-end access control - Common attack vectors and threats - Network and Storage - Secure Isolation Strategies - Virtualization strategies - Inter-tenant network segmentation strategies - Data Protection strategies: Data retention, deletion and archiving procedures for tenant data, Encryption, Data Redaction, Tokenization, Obfuscation, PKI and Key.                         |                                                                                                                                                                               |                        |                           |   |   |      |   |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | IDENTITY MANAGEMENT AND ACCESS CONTROL                                                                                                                                        |                        |                           |   |   | CO3  | 9 |
| Identity and Access Management in Cloud – Access Control Models – Role-Based Access Control (RBAC) – Attribute-Based Access Control (ABAC) – Authentication Mechanisms – Multi-Factor Authentication – Single Sign-On (SSO) – Identity Federation – OAuth and SAML – Identity Providers and Service Consumers – Storage Access Control – Network Access Control – Operating System Hardening – Secure Boot and Measured Boot – Intrusion Detection and Prevention Systems. |                                                                                                                                                                               |                        |                           |   |   |      |   |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | CLOUD SECURITY MODELS AND DESIGN PATTERNS                                                                                                                                     |                        |                           |   |   | CO4  | 9 |
| Introduction to Security Design Patterns – Cloud Security Reference Architecture – Cloud Resource Access Control – Secure Cloud Interfaces – Cloud Bursting – Geo-tagging – Secure On-Premise Internet Access – Secure External Cloud – Secure API Gateways – Microservices Security – Container Security – DevSecOps in Cloud – Zero Trust Security Model.                                                                                                                |                                                                                                                                                                               |                        |                           |   |   |      |   |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | MONITORING, AUDITING AND MANAGEMENT                                                                                                                                           |                        |                           |   |   | CO5  | 9 |
| Introduction to Security Design Patterns – Cloud Security Reference Architecture – Cloud Resource Access Control – Secure Cloud Interfaces – Cloud Bursting – Geo-tagging – Secure On-Premise Internet Access – Secure External Cloud – Secure API Gateways – Microservices Security – Container Security – DevSecOps in Cloud – Zero Trust Security Model.                                                                                                                |                                                                                                                                                                               |                        |                           |   |   |      |   |
| Total Theory Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                               |                        |                           |   |   | 45   |   |
| Textbooks:                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                               |                        |                           |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Tim Mather, Subra Kumaraswamy, Shahed Latif,Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance,1st EditionO'Reilly Media2009,ISBN: 978-0596802769. |                        |                           |   |   |      |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Ronald L. Krutz, Russell Dean Vines, Cloud Security: A Comprehensive Guide to Secure Cloud                                                                                    |                        |                           |   |   |      |   |

|                         |                                                                                                                                                                                                           |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         | Computing, 1st Edition, Wiley Publishing, 2010, ISBN: 978-0470589878.                                                                                                                                     |
| 3                       | Vic (J.R.) Winkler, Securing the Cloud: Cloud Computer Security Techniques and Tactics, 1st Edition, Elsevier / Syngress, 2011, ISBN: 978-1597495929.                                                     |
| <b>Reference Books:</b> |                                                                                                                                                                                                           |
| 1                       | Thomas Erl, Cloud Computing: Concepts, Technology and Architecture, 1st Edition, Prentice Hall / Pearson Education, 2013, ISBN: 978-0133387520.                                                           |
| 2                       | Rajkumar Buyya, James Broberg, Andrzej Goscinski, Cloud Computing: Principles and Paradigms, 1st Edition, Wiley, 2011, ISBN: 978-0470887998.                                                              |
| <b>Web References:</b>  |                                                                                                                                                                                                           |
| 1                       | National Institute of Standards and Technology, NIST SP 800-145: The NIST Definition of Cloud Computing, NIST Publications, 2011, Available at: <a href="https://www.nist.gov">https://www.nist.gov</a> . |

| Assessment based on Continuous and End Semester Examination |                       |                   |                         |            |            |                                |
|-------------------------------------------------------------|-----------------------|-------------------|-------------------------|------------|------------|--------------------------------|
| BLOOM'S<br>TAXONOMY<br>LEVEL                                | CONTINUOUS ASSESSMENT |                   |                         | ASSIGNMENT | ATTENDANCE | END<br>SEMESTER<br>EXAMINATION |
|                                                             | CIA1<br>(6 Marks)     | CIA2<br>(6 Marks) | Model Exam<br>(8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)                     |
| Remember                                                    |                       |                   |                         | 10         | 10         | 60                             |
| Understand                                                  | 80                    | 20                | 20                      |            |            |                                |
| Apply                                                       | 20                    | 80                | 80                      |            |            |                                |
| Analyze                                                     |                       |                   |                         |            |            |                                |
| Evaluate                                                    |                       |                   |                         |            |            |                                |
| Create                                                      |                       |                   |                         |            |            |                                |
| <b>Total<br/>(100 Marks)</b>                                | <b>6</b>              | <b>6</b>          | <b>8</b>                | <b>10</b>  | <b>10</b>  | <b>60</b>                      |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO<br>10 | PO<br>11 | PS01 | PS02 |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------|----------|------|------|
| C504.1      | 3   | 2   | 1   | -   | 2   | -   | -   | -   | -   | 2        | 3        | 2    | 2    |
| C504.2      | 2   | 3   | 1   | 2   | 2   | -   | -   | -   | -   | 2        | 3        | 2    | 3    |
| C504.3      | 2   | 3   | 2   | 2   | 3   | -   | -   | -   | -   | 2        | 3        | 2    | 3    |
| C504.4      | 2   | 2   | 2   | 3   | 3   | -   | -   | -   | -   | 2        | 3        | 1    | 3    |
| C504.5      | 3   | 2   | 2   | 2   | 3   | -   | -   | -   | -   | 3        | 3        | 2    | 3    |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                       | Course Name                                                                                                                    | Category               | Hours/Week                |   |             | C     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|-------------|-------|
|                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                |                        | L                         | T | P           |       |
| 24CS505                                                                                                                                                                                                                                                                                                                           | STORAGE TECHNOLOGY                                                                                                             | PE                     | 3                         | 0 | 0           | 3     |
| Regulation                                                                                                                                                                                                                                                                                                                        | Nature of the Course                                                                                                           | Semester               | Data Book/Codes/Standards |   |             |       |
| 2024                                                                                                                                                                                                                                                                                                                              | THEORY                                                                                                                         | 5                      | -                         |   |             |       |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                           |                                                                                                                                | Co-requisite Course(s) |                           |   |             |       |
| Database Design and Management                                                                                                                                                                                                                                                                                                    |                                                                                                                                | Big Data Analytics     |                           |   |             |       |
| Course Objectives                                                                                                                                                                                                                                                                                                                 |                                                                                                                                |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                                                                                 | To understand the physical and logical components of storage.                                                                  |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                                                                                 | To implement RAID and the intelligent storage systems                                                                          |                        |                           |   |             |       |
| 3                                                                                                                                                                                                                                                                                                                                 | To set up SAN, NAS, and virtualized storage environments.                                                                      |                        |                           |   |             |       |
| 4                                                                                                                                                                                                                                                                                                                                 | To demonstrate disaster recovery and backup strategies.                                                                        |                        |                           |   |             |       |
| 5                                                                                                                                                                                                                                                                                                                                 | To examine security measures with the implementation of storage security mechanisms                                            |                        |                           |   |             |       |
| Course Outcomes                                                                                                                                                                                                                                                                                                                   |                                                                                                                                |                        |                           |   |             |       |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                           |                                                                                                                                |                        |                           |   |             |       |
| C505.1                                                                                                                                                                                                                                                                                                                            | Understand the information storage devices, computing platforms and data center environments                                   |                        |                           |   |             | [U]   |
| C505.2                                                                                                                                                                                                                                                                                                                            | Implementation of intelligent storage systems and RAID                                                                         |                        |                           |   |             | [AP]  |
| C505.3                                                                                                                                                                                                                                                                                                                            | Examine Storage Networking Technologies and Virtualization                                                                     |                        |                           |   |             | [AN]  |
| C505.4                                                                                                                                                                                                                                                                                                                            | Demonstrate virtualized storage environments                                                                                   |                        |                           |   |             | [AP]  |
| C505.5                                                                                                                                                                                                                                                                                                                            | Examine security measures with the implementation of storage security mechanisms                                               |                        |                           |   |             | [AN]  |
| Course Contents                                                                                                                                                                                                                                                                                                                   |                                                                                                                                |                        |                           |   |             |       |
| Unit – 1                                                                                                                                                                                                                                                                                                                          | Introduction to Information Storage                                                                                            |                        |                           |   | C01         | 9 Hrs |
| Digital data types (structured/unstructured), data center components, Information Lifecycle Management (ILM)- Evolution of Computing Platforms: Third Platform Technologies: Cloud computing, Big Data analytics, Social networking, and Mobile computing - Data Center Environment: Core elements, software-defined data center. |                                                                                                                                |                        |                           |   |             |       |
| Unit – 2                                                                                                                                                                                                                                                                                                                          | Intelligent Storage Systems and RAID                                                                                           |                        |                           |   | C02         | 9 Hrs |
| Intelligent Storage Systems: Components, architecture, and performance-RAID: RAID implementations, RAID array components, and RAID performance-Storage Types: File-based, Object-based, and Unified storage.                                                                                                                      |                                                                                                                                |                        |                           |   |             |       |
| Unit – 3                                                                                                                                                                                                                                                                                                                          | Storage Networking Technologies and Virtualization                                                                             |                        |                           |   | C03         | 9 Hrs |
| Storage Networking: Fibre Channel SAN (FC SAN) components, topologies, and architecture-Networking Protocols: iSCSI, FCIP, and FCoE (Fibre Channel over Ethernet)-Storage Virtualization: Block-level and file-level virtualization, software-defined storage.                                                                    |                                                                                                                                |                        |                           |   |             |       |
| Unit – 4                                                                                                                                                                                                                                                                                                                          | Backup, Replication, and Disaster Recovery                                                                                     |                        |                           |   | C04         | 9 Hrs |
| Backup and Recovery: Information availability, business continuity, backup methods, and recovery techniques-Replication Technologies: Local and remote replication, storage-based, compute-based, and network-based replication-Disaster Recovery: Disaster recovery as a service (DRaaS).                                        |                                                                                                                                |                        |                           |   |             |       |
| Unit – 5                                                                                                                                                                                                                                                                                                                          | Securing Storage Infrastructure                                                                                                |                        |                           |   | C05         | 9 Hrs |
| Storage Security: Security framework, threats, and risk management-Security Measures: Security in FC SAN, iSCSI, and NAS environments-Management: Monitoring and managing storage infrastructure.                                                                                                                                 |                                                                                                                                |                        |                           |   |             |       |
|                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                |                        |                           |   | Total Hours | 45    |
| Textbooks:                                                                                                                                                                                                                                                                                                                        |                                                                                                                                |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                                                                                 | Susanta Dutta"Computer storage fundamentals ", 2nd Edition, BPB Publications, 2025.                                            |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                                                                                 | Jiwu Shu “Data Storage Architectures and Technologies”, Springer publications,2024.                                            |                        |                           |   |             |       |
| 3                                                                                                                                                                                                                                                                                                                                 | Azam Seyedi, “Computer Memory and Data Storage”, Intech Open publications ,2024.                                               |                        |                           |   |             |       |
| Reference Books:                                                                                                                                                                                                                                                                                                                  |                                                                                                                                |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                                                                                 | Sachi Choudhary, “Fundamentals of Storage Technologies”, Technical Publications, 2023.                                         |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                                                                                 | Robert Spalding, “Storage Networks: The Complete Reference”, Tata McGraw-Hill Education,2023.                                  |                        |                           |   |             |       |
| 3                                                                                                                                                                                                                                                                                                                                 | Vaishali Khairnar, “Storage Network Management and Retrieval”, Technical Publications,2019.                                    |                        |                           |   |             |       |
| 4                                                                                                                                                                                                                                                                                                                                 | S. P. S. Saini, “Computer Storage Fundamentals: Storage System, Storage Networking, and Host Connectivity”, 2nd Edition, 2020. |                        |                           |   |             |       |

| Web References: |                                                                                                                                                           |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1               | <a href="https://spark.apache.org/docs/latest/streaming-programming-guide.html">https://spark.apache.org/docs/latest/streaming-programming-guide.html</a> |
| 2               | <a href="https://spark.apache.org/docs/latest/streaming-kafka-integration.html">https://spark.apache.org/docs/latest/streaming-kafka-integration.html</a> |

| Assessment based on Continuous and End Semester Examination |                       |                |                      |            |            |                          |
|-------------------------------------------------------------|-----------------------|----------------|----------------------|------------|------------|--------------------------|
| BLOOM'S TAXONOMY LEVEL                                      | CONTINUOUS ASSESSMENT |                |                      | ASSIGNMENT | ATTENDANCE | END SEMESTER EXAMINATION |
|                                                             | CIA1 (6 Marks)        | CIA2 (6 Marks) | Model Exam (8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)               |
| Remember                                                    |                       |                |                      | 10         | 10         | 60                       |
| Understand                                                  | 60                    | 20             | 20                   |            |            |                          |
| Apply                                                       | 40                    | 60             | 40                   |            |            |                          |
| Analyze                                                     |                       | 20             | 40                   |            |            |                          |
| Evaluate                                                    |                       |                |                      |            |            |                          |
| Create                                                      |                       |                |                      |            |            |                          |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>       | <b>8</b>             | <b>10</b>  | <b>10</b>  | <b>60</b>                |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO 1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PS01 | PS02 |
|-------------|------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|------|------|
| C505.1      | 3    | 3   | 2   | 2   | 2   | 2   | -   | -   | -   | 2     | 2     | 2    | 2    |
| C505.2      | 3    | 3   | 2   | 2   | 2   | 3   | -   | -   | -   | 3     | 2     | 3    | 3    |
| C505.3      | 3    | 3   | 2   | 3   | 2   | 2   | -   | -   | -   | 2     | 2     | 3    | 3    |
| C505.4      | 3    | 2   | 3   | 2   | 2   | 2   | -   | -   | -   | 3     | 2     | 3    | 3    |
| C505.5      | 3    | 3   | 3   | 3   | 2   | 2   | -   | -   | -   | 2     | 3     | 3    | 3    |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                               | Course Name                                                                                                                                         | Category               | Hours/Week                |   |     | C     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|-----|-------|
|                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                     |                        | L                         | T | P   |       |
| 24CS506                                                                                                                                                                                                                                                                                                                                                                   | STREAM PROCESSING                                                                                                                                   | PE                     | 3                         | 0 | 0   | 3     |
| Regulation                                                                                                                                                                                                                                                                                                                                                                | Nature of the Course                                                                                                                                | Semester               | Data Book/Codes/Standards |   |     |       |
| 2024                                                                                                                                                                                                                                                                                                                                                                      | THEORY                                                                                                                                              | 5                      | -                         |   |     |       |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                     | Co-requisite Course(s) |                           |   |     |       |
| Database Design and Management                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                     | Big Data Analytics     |                           |   |     |       |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                     |                        |                           |   |     |       |
| 1                                                                                                                                                                                                                                                                                                                                                                         | To introduce data processing paradigms and modern data systems for real-time concepts                                                               |                        |                           |   |     |       |
| 2                                                                                                                                                                                                                                                                                                                                                                         | To select appropriate structures for business-oriented real-time data services                                                                      |                        |                           |   |     |       |
| 3                                                                                                                                                                                                                                                                                                                                                                         | To understand and identify the architectures for storage systems in distributed systems and stream processing                                       |                        |                           |   |     |       |
| 4                                                                                                                                                                                                                                                                                                                                                                         | To design and implement real-time applications using Apache Spark or Kafka                                                                          |                        |                           |   |     |       |
| 5                                                                                                                                                                                                                                                                                                                                                                         | To implement Spark structured streaming and design fault tolerance in streaming systems                                                             |                        |                           |   |     |       |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                     |                        |                           |   |     |       |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                     |                        |                           |   |     |       |
| C506.1                                                                                                                                                                                                                                                                                                                                                                    | Summarize data processing paradigms and modern data systems                                                                                         |                        |                           |   |     | [U]   |
| C506.2                                                                                                                                                                                                                                                                                                                                                                    | Describe data management strategies and NoSQL data models                                                                                           |                        |                           |   |     | [AP]  |
| C506.3                                                                                                                                                                                                                                                                                                                                                                    | identify the architectures for storage systems in distributed systems and stream processing                                                         |                        |                           |   |     | [AP]  |
| C506.4                                                                                                                                                                                                                                                                                                                                                                    | Make use of Kafka in event processing systems and design use cases for event driven systems                                                         |                        |                           |   |     | [AP]  |
| C506.5                                                                                                                                                                                                                                                                                                                                                                    | Execute real time analytics in streaming applications using Apache Spark                                                                            |                        |                           |   |     | [AP]  |
| Course Contents                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                     |                        |                           |   |     |       |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                                  | Data Systems & Processing Models                                                                                                                    |                        |                           |   | C01 | 9 Hrs |
| Overview of modern data systems and data processing paradigms: batch processing vs stream processing- Characteristics and applications of batch processing -Characteristics and applications of real-time stream processing - differences between batch and stream processing- Use cases and industry applications.                                                       |                                                                                                                                                     |                        |                           |   |     |       |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                                  | Data Management Strategies and Data Models                                                                                                          |                        |                           |   | C02 | 9 Hrs |
| Data management in large-scale distributed systems-Data storage strategies and scalability considerations- Overview of NoSQL databases-Types of NoSQL databases: Key-Value Stores-Document Databases-Column-Oriented Databases-Graph Databases Introduction to Graph Data Models-Comparison of relational and NoSQL data models Applications of graph-based data systems. |                                                                                                                                                     |                        |                           |   |     |       |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                                  | Stream Processing Technologies                                                                                                                      |                        |                           |   | C03 | 9 Hrs |
| Introduction to real-time data processing frameworks`-Stream processing architecture and work flow Lambda Architecture – Batch layer, Speed layer, Serving layer Kappa Architecture – Concept and benefits - Distributed storage systems in stream processing- Data ingestion and data flow management-Stream processing pipelines.                                       |                                                                                                                                                     |                        |                           |   |     |       |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                                  | Event Processing with Kafka                                                                                                                         |                        |                           |   | C04 | 9 Hrs |
| Introduction to Apache Kafka- Kafka architecture and ecosystem-Components of Kafka-Kafka data flow and message handling -Kafka Producer API - Kafka Consumer API -Kafka use cases in event-driven systems.                                                                                                                                                                |                                                                                                                                                     |                        |                           |   |     |       |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                                  | Spark Streaming                                                                                                                                     |                        |                           |   | C05 | 9 Hrs |
| Introduction to Apache Spark and streaming analytics- Overview of Spark Structured Streaming-Micro-batch processing model-Window-based stream processing-Watermarking for late data handling-Fault tolerance in streaming systems-Checkpointing and recovery mechanisms-Real-time analytics applications.                                                                 |                                                                                                                                                     |                        |                           |   |     |       |
| Total Hours                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                     |                        |                           |   | 45  |       |
| Textbooks:                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                     |                        |                           |   |     |       |
| 1                                                                                                                                                                                                                                                                                                                                                                         | Joe Reis, Matt Housley, Reuven Lax,” Fundamentals of Data Engineering: Plan and Build Robust Data Systems”O’Reilly Media, 2022.                     |                        |                           |   |     |       |
| 2                                                                                                                                                                                                                                                                                                                                                                         | Fabian Hueske, Vasiliki Kalavri, “Fundamentals of Stream Processing: Application Design, Systems, and Analytics”, O’Reilly Media, 2019              |                        |                           |   |     |       |
| 3                                                                                                                                                                                                                                                                                                                                                                         | Martin Kleppmann, “Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems”. O’Reilly Media, 2017. |                        |                           |   |     |       |

| Reference Books: |                                                                                                                                                                      |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                | Fabian Hueske, Vasiliki Kalavri, "Stream Processing with Apache Flink: Fundamentals, Implementation, and Operation of Streaming Applications", O'Reilly Media, 2019. |
| 2                | Mayank Pandey, "Kafka Streams: Real-Time Stream Processing", Packet Publishing, 2019.                                                                                |
| 3                | Ben Stopford, "Designing Event-Driven Systems: Concepts and Patterns for Streaming Services with Apache Kafka", O'Reilly Media, 2018.                                |
| Web References:  |                                                                                                                                                                      |
| 1                | <a href="https://flink.apache.org/">https://flink.apache.org/</a>                                                                                                    |
| 2                | <a href="https://docs.databricks.com/">https://docs.databricks.com/</a>                                                                                              |

| Assessment based on Continuous and End Semester Examination |                       |                |                      |            |            |                          |
|-------------------------------------------------------------|-----------------------|----------------|----------------------|------------|------------|--------------------------|
| BLOOM'S TAXONOMY LEVEL                                      | CONTINUOUS ASSESSMENT |                |                      | ASSIGNMENT | ATTENDANCE | END SEMESTER EXAMINATION |
|                                                             | CIA1 (6 Marks)        | CIA2 (6 Marks) | Model Exam (8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)               |
| Remember                                                    |                       |                |                      | 10         | 10         | 60                       |
| Understand                                                  | 60                    | 40             | 40                   |            |            |                          |
| Apply                                                       | 40                    | 60             | 60                   |            |            |                          |
| Analyze                                                     |                       |                |                      |            |            |                          |
| Evaluate                                                    |                       |                |                      |            |            |                          |
| Create                                                      |                       |                |                      |            |            |                          |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>       | <b>8</b>             | <b>10</b>  | <b>10</b>  | <b>60</b>                |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO 1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PSO1 | PSO2 |
|-------------|------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|------|------|
| C506.1      | 3    | 3   | 2   | 3   | 1   | -   | -   | -   | 2   | 3     | 3     | 2    | 3    |
| C506.2      | 2    | 2   | 2   | 3   | 3   | -   | -   | -   | 2   | 2     | 3     | 3    | 3    |
| C506.3      | 3    | 2   | 2   | 3   | 3   | -   | -   | -   | 2   | 2     | 3     | 3    | 2    |
| C506.4      | 2    | 3   | 3   | 3   | 3   | -   | -   | -   | 2   | 2     | 2     | 3    | 2    |
| C506.5      | 3    | 3   | 3   | 2   | 2   | -   | -   | -   | 2   | 3     | 3     | 3    | 3    |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                                        | Course Name                                                                                                                       | Category               | Hours/Week                |   |   | C   |   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|---|-----|---|
|                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                   |                        | L                         | T | P |     |   |
| 24AD508                                                                                                                                                                                                                                                                                                                                                                            | AUGMENTED REALITY/ VIRTUAL REALITY                                                                                                | PE                     | 3                         | 0 | 0 | 3   |   |
| Regulation                                                                                                                                                                                                                                                                                                                                                                         | Nature of the Course                                                                                                              | Semester               | Data Book/Codes/Standards |   |   |     |   |
| 2024                                                                                                                                                                                                                                                                                                                                                                               | Theory                                                                                                                            | -                      | -                         |   |   |     |   |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                   | Co-requisite Course(s) |                           |   |   |     |   |
|                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                   |                        |                           |   |   |     |   |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                   |                        |                           |   |   |     |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                  | Explain fundamentals of Virtual Reality Systems                                                                                   |                        |                           |   |   |     |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                  | Summarize the Fundamentals of VR and hardware and software of the Virtual Reality                                                 |                        |                           |   |   |     |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                  | To learn about the graphical processing units and their architectures                                                             |                        |                           |   |   |     |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                  | To gain knowledge about AR/VR application development.                                                                            |                        |                           |   |   |     |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                  | Understand the usage of Augmented Reality                                                                                         |                        |                           |   |   |     |   |
| Course Outcomes Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                                            |                                                                                                                                   |                        |                           |   |   |     |   |
| C508.1                                                                                                                                                                                                                                                                                                                                                                             | Understand the basic concepts of Virtual Reality Fundamentals                                                                     |                        |                           |   |   | U   |   |
| C508.2                                                                                                                                                                                                                                                                                                                                                                             | Differentiate the O/P devices of VR                                                                                               |                        |                           |   |   | U   |   |
| C508.3                                                                                                                                                                                                                                                                                                                                                                             | Discuss various modeling techniques of VR                                                                                         |                        |                           |   |   | AP  |   |
| C508.4                                                                                                                                                                                                                                                                                                                                                                             | Predict various Applications of VR                                                                                                |                        |                           |   |   | AP  |   |
| C508.5                                                                                                                                                                                                                                                                                                                                                                             | Illustrate working principles of AR                                                                                               |                        |                           |   |   | AP  |   |
| Course Contents                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                   |                        |                           |   |   |     |   |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                                           | INTRODUCTION                                                                                                                      |                        |                           |   |   | C01 | 9 |
| Introduction: The three I’s of virtual reality, commercial VR technology and the five classic components of a VR system. Input Devices: Three-dimensional position trackers, navigation and manipulation.                                                                                                                                                                          |                                                                                                                                   |                        |                           |   |   |     |   |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                                           | OUTPUT DEVICES                                                                                                                    |                        |                           |   |   | C02 | 9 |
| Gesture Interfaces - The Pinch Glove, The 5DT Data Glove, The Didji glove, The Cyber Glove -Gesture Interfaces – Types of Gesture Input Devices Output Devices – Graphics Display – Human Visual System – Personal Graphics Displays – Large – Volume Displays – Sound Displays – Human Auditory System.                                                                           |                                                                                                                                   |                        |                           |   |   |     |   |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                                           | MODELING AND VR PROGRAMMING                                                                                                       |                        |                           |   |   | C03 | 9 |
| Modeling: Geometric modelling- Kinematics Modeling-Physical Modeling-behavior modelling-model management .VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D                                                                                                                                                           |                                                                                                                                   |                        |                           |   |   |     |   |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                                           | APPLICATIONS                                                                                                                      |                        |                           |   |   | C04 | 9 |
| Human Factors in VR – Methodology and Terminology – VR Health and Safety Issues – VR and Society-Medical Applications of VR – Education, Arts and Entertainment – Military VR Applications – Emerging Applications of VR – VR Applications in Manufacturing – Applications of VR in Robotics – Information Visualization – VR in Business – VR in Entertainment – VR in Education. |                                                                                                                                   |                        |                           |   |   |     |   |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                                           | AUGMENTED REALITY                                                                                                                 |                        |                           |   |   | C05 | 9 |
| Introduction to Augmented Reality-Augmented Reality Concepts- Working principles of Augmented Reality. Visualization techniques for augmented reality. Computer vision for AR-Interaction-Modelling and Annotation-Navigation-Wearable devices                                                                                                                                     |                                                                                                                                   |                        |                           |   |   |     |   |
| Total Hours                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                   |                        |                           |   |   | 45  |   |
| Textbooks:                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                   |                        |                           |   |   |     |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                  | Samuel Greengard, Steven Jay Cohen, “Virtual Reality”, Gilden Media, First Edition, 2019                                          |                        |                           |   |   |     |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                  | Charles Palmer, John Williamson, “Virtual Reality Blueprints: Create compelling VR experiences for mobile”, Packt Publisher, 2018 |                        |                           |   |   |     |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                  | Dieter Schmalstieg, Tobias Hollerer, “Augmented Reality: Principles & Practice”, Addison Wesley, 2016                             |                        |                           |   |   |     |   |
| Reference Books:                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                   |                        |                           |   |   |     |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                  | John Vince, “Introduction to Virtual Reality”, Springer-Verlag, 2004.                                                             |                        |                           |   |   |     |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                  | William R. Sherman, Alan B. Craig: Understanding Virtual Reality – Interface, Application, Design”, Morgan Kaufmann, 2003         |                        |                           |   |   |     |   |

|   |                                                                                                             |
|---|-------------------------------------------------------------------------------------------------------------|
| 3 | Gregory C. Burdea & Philippe Coiffet, "Virtual Reality Technology", Second Edition, John Wiley & Sons, 2006 |
| 4 | Allan Fowler-AR Game Development, 1st Edition, A press Publications, 2018, ISBN 978- 1484236178             |

**Web References:**

|   |                                                                                                                                   |
|---|-----------------------------------------------------------------------------------------------------------------------------------|
| 1 | <a href="https://techoid.com/input-devices-vr">https://techoid.com/input-devices-vr</a>                                           |
| 2 | <a href="https://www.techtarget.com/whatis/definition/virtual-real">https://www.techtarget.com/whatis/definition/virtual-real</a> |

| Assessment based on Continuous and End Semester Examination |                       |                |                      |            |            |                          |
|-------------------------------------------------------------|-----------------------|----------------|----------------------|------------|------------|--------------------------|
| BLOOM'S TAXONOMY LEVEL                                      | CONTINUOUS ASSESSMENT |                |                      | ASSIGNMENT | ATTENDANCE | END SEMESTER EXAMINATION |
|                                                             | CIA1 (6 Marks)        | CIA2 (6 Marks) | Model Exam (8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)               |
| Remember                                                    |                       |                |                      | 10         | 10         | 60                       |
| Understand                                                  | 100%                  | 20%            | 40%                  |            |            |                          |
| Apply                                                       |                       | 80%            | 60%                  |            |            |                          |
| Analyze                                                     |                       |                |                      |            |            |                          |
| Evaluate                                                    |                       |                |                      |            |            |                          |
| Create                                                      |                       |                |                      |            |            |                          |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>       | <b>8</b>             | <b>10</b>  | <b>10</b>  | <b>60</b>                |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO 1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PSO1 | PSO2 |
|-------------|------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|------|------|
| C508.1      | 3    | 2   | 2   | -   | -   | -   | -   | -   | -   | -     | 1     | 2    | 2    |
| C508.2      | 3    | 2   | 2   | 2   | -   | -   | -   | -   | -   | -     | 2     | 3    | 2    |
| C508.3      | 3    | 3   | 2   | 2   | -   | -   | -   | -   | -   | -     | 1     | 3    | 2    |
| C508.4      | 3    | 3   | 3   | 2   | -   | -   | -   | -   | -   | -     | 2     | 3    | 2    |
| C508.5      | 3    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -     | 3     | 3    | 3    |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                   | Course Name                                                                                                                                                                   | Category               | Hours/Week                |   |             | C     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|-------------|-------|
|                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                               |                        | L                         | T | P           |       |
| 24AD509                                                                                                                                                                                                                                                                                                                                                                                                                       | ROBOTIC PROCESS AUTOMATION                                                                                                                                                    | PC                     | 3                         | 0 | 0           | 3     |
| Regulation                                                                                                                                                                                                                                                                                                                                                                                                                    | Nature of the Course                                                                                                                                                          | Semester               | Data Book/Codes/Standards |   |             |       |
| 2024                                                                                                                                                                                                                                                                                                                                                                                                                          | THEORY                                                                                                                                                                        | VI                     | --                        |   |             |       |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                               | Co-requisite Course(s) |                           |   |             |       |
| Programming for Problem Solving                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                               | --                     |                           |   |             |       |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                               |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                             | To understand the basic concepts of Robotic Process Automation.                                                                                                               |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                             | To expose to the key RPA design and development strategies and methodologies.                                                                                                 |                        |                           |   |             |       |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                             | To learn the fundamental RPA logic and structure. 163                                                                                                                         |                        |                           |   |             |       |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                             | To explore the Exception Handling, Debugging and Logging operations in RPA.                                                                                                   |                        |                           |   |             |       |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                             | To learn to deploy and Maintain the software bot.                                                                                                                             |                        |                           |   |             |       |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                               |                        |                           |   |             |       |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                               |                        |                           |   |             |       |
| C509.1                                                                                                                                                                                                                                                                                                                                                                                                                        | Summarize the key distinctions between RPA and existing automation techniques and platforms.                                                                                  |                        |                           |   |             | [U]   |
| C509.2                                                                                                                                                                                                                                                                                                                                                                                                                        | Use UiPath to design control flows and work flows for the target process                                                                                                      |                        |                           |   |             | [AP]  |
| C509.3                                                                                                                                                                                                                                                                                                                                                                                                                        | Experiment recording, web scraping and process mining by automation                                                                                                           |                        |                           |   |             | [AP]  |
| C509.4                                                                                                                                                                                                                                                                                                                                                                                                                        | Use UiPath Studio to detect, and handle exceptions in automation processes                                                                                                    |                        |                           |   |             | [AP]  |
| C509.5                                                                                                                                                                                                                                                                                                                                                                                                                        | Analyze and use Orchestrator for creation, monitoring, scheduling, and controlling of automated bots and processes.                                                           |                        |                           |   |             | [AN]  |
| Course Contents                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                               |                        |                           |   |             |       |
| UNIT I                                                                                                                                                                                                                                                                                                                                                                                                                        | INTRODUCTION TO ROBOTIC PROCESS AUTOMATION                                                                                                                                    |                        |                           |   | C01         | 9 Hrs |
| Emergence of Robotic Process Automation (RPA), Evolution of RPA, RPA Architecture(bot,studio,orchester), Differentiating RPA from Automation - Benefits of RPA - Application areas of RPA, Components of RPA, RPA Platforms, About Uipath. Robotic Process Automation Tools – Templates, User Interface – Managing Variables and types- arguments and panels, Domains in Activities - importing new namespace, Workflow Files |                                                                                                                                                                               |                        |                           |   |             |       |
| UNIT II                                                                                                                                                                                                                                                                                                                                                                                                                       | AUTOMATION PROCESS ACTIVITIES                                                                                                                                                 |                        |                           |   | C02         | 9 Hrs |
| Sequence, Flowchart & Control Flow: Sequencing the Workflow, Activities, Flowchart, Control Flow for Decision making. Data Manipulation: Variables, Collection, Arguments, Data Table, Clipboard management, File operations Controls: Finding the control, waiting for a control, Act on a control, UiExplorer, Handling Events                                                                                              |                                                                                                                                                                               |                        |                           |   |             |       |
| UNIT III                                                                                                                                                                                                                                                                                                                                                                                                                      | APP INTEGRATION, RECORDING AND SCRAPING                                                                                                                                       |                        |                           |   | C03         | 9 Hrs |
| App Integration, Recording, Scraping, Selector, Workflow Activities. Recording mouse and keyboard actions to perform operation, Scraping data from website and writing to CSV. Process Mining and Case study: real-time applications.                                                                                                                                                                                         |                                                                                                                                                                               |                        |                           |   |             |       |
| UNIT IV                                                                                                                                                                                                                                                                                                                                                                                                                       | EXCEPTION HANDLING AND CODE MANAGEMENT                                                                                                                                        |                        |                           |   | C04         | 9 Hrs |
| Exception handling, Common exceptions, Logging- Debugging techniques, Collecting crash dumps, Error reporting. Code management and maintenance: Project organization, Nesting workflows, Reusability, Templates, Commenting techniques, State Machine.                                                                                                                                                                        |                                                                                                                                                                               |                        |                           |   |             |       |
| UNIT V                                                                                                                                                                                                                                                                                                                                                                                                                        | DEPLOYMENT AND MAINTENANCE                                                                                                                                                    |                        |                           |   | C05         | 9 Hrs |
| Publishing using publish utility, Orchestration Server, Control bots, Orchestration Server to deploy bots, License management, Publishing and managing updates, Security issues in RPA. RPA Vendors - Open Source RPA, Future of RPA. Case studies and real-time business applications.                                                                                                                                       |                                                                                                                                                                               |                        |                           |   |             |       |
|                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                               |                        |                           |   | Total Hours | 45    |
| Textbooks:                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                               |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                             | Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath by Alok Mani Tripathi, Packt Publishing, 2018. |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                             | Tom Taulli , “The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems”, Apress publications, 2020.                                                       |                        |                           |   |             |       |

| Reference Books: |                                                                                                                                                                                                                                                      |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                | Frank Casale (Author), Rebecca Dilla (Author), Heidi Jaynes (Author), Lauren Livingston (Author), Introduction to Robotic Process Automation: a Primer, Institute of Robotic Process Automation, Amazon Asia-Pacific Holdings Private Limited, 2018. |
| 2                | Richard Murdoch, Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant, Amazon Asia-Pacific Holdings Private Limited, 2018                                                             |
| Web References:  |                                                                                                                                                                                                                                                      |
| 1                | <a href="https://onlinecourses.nptel.ac.in/noc21_me76/preview">https://onlinecourses.nptel.ac.in/noc21_me76/preview</a>                                                                                                                              |
| 2                | <a href="https://onlinecourses.nptel.ac.in/noc21_me32/preview">https://onlinecourses.nptel.ac.in/noc21_me32/preview</a>                                                                                                                              |

| Assessment based on Continuous and End Semester Examination |                       |                |                      |            |            |                          |
|-------------------------------------------------------------|-----------------------|----------------|----------------------|------------|------------|--------------------------|
| BLOOM'S TAXONOMY LEVEL                                      | CONTINUOUS ASSESSMENT |                |                      | ASSIGNMENT | ATTENDANCE | END SEMESTER EXAMINATION |
|                                                             | CIA1 (6 Marks)        | CIA2 (6 Marks) | Model Exam (8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)               |
| Remember                                                    |                       |                |                      | 10         | 10         | 60                       |
| Understand                                                  | 80%                   |                | 20%                  |            |            |                          |
| Apply                                                       | 20%                   | 100%           | 60%                  |            |            |                          |
| Analyze                                                     |                       |                | 20%                  |            |            |                          |
| Evaluate                                                    |                       |                |                      |            |            |                          |
| Create                                                      |                       |                |                      |            |            |                          |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>       | <b>8</b>             | <b>10</b>  | <b>10</b>  | <b>60</b>                |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 | PSO 3 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| C509.1      | 3    | 2    | 2    | 1    | -    | -    | -    | -    | -    | -     | 3     | 3     | 3     | 2     |
| C509.2      | 1    | 1    | 2    | 2    | -    | -    | -    | -    | -    | -     | 3     | 3     | 2     | 2     |
| C509.3      | 2    | 3    | 3    | 1    | -    | -    | -    | -    | -    | -     | 1     | 2     | 3     | 2     |
| C509.4      | 1    | 2    | 1    | 3    | -    | -    | -    | -    | -    | -     | 3     | 3     | 2     | 2     |
| C509.5      | 3    | 3    | 1    | 1    | -    | -    | -    | -    | -    | -     | 1     | 2     | 2     | 2     |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                        | Course Name                                                                                                                        | Category                                  | Hours/Week                |   |     | C     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|---------------------------|---|-----|-------|
|                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                    |                                           | L                         | T | P   |       |
| 24AM505                                                                                                                                                                                                                                                                                                                                                                                                            | Neural Networks and Deep Learning                                                                                                  | OE                                        | 3                         | 0 | 0   | 3     |
| Regulation                                                                                                                                                                                                                                                                                                                                                                                                         | Nature of the Course                                                                                                               | Semester                                  | Data Book/Codes/Standards |   |     |       |
| R24                                                                                                                                                                                                                                                                                                                                                                                                                | Theory                                                                                                                             | VI                                        | -                         |   |     |       |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                    | Co-requisite Course(s)                    |                           |   |     |       |
| Machine Learning                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                    | Artificial Intelligence, Machine Learning |                           |   |     |       |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                    |                                           |                           |   |     |       |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                  | To understand the basics in deep neural networks                                                                                   |                                           |                           |   |     |       |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                  | To understand the basics of associative memory and unsupervised learning networks                                                  |                                           |                           |   |     |       |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                  | To apply CNN architectures of deep neural networks                                                                                 |                                           |                           |   |     |       |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                  | To analyze the key computations underlying deep learning, then use them to build and train deep neural networks for various tasks. |                                           |                           |   |     |       |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                  | To apply autoencoders and generative models for suitable applications.                                                             |                                           |                           |   |     |       |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                    |                                           |                           |   |     |       |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                    |                                           |                           |   |     |       |
| C505.1                                                                                                                                                                                                                                                                                                                                                                                                             | Understand the Convolution Neural Network for image processing.                                                                    |                                           |                           |   |     | [U]   |
| C505.2                                                                                                                                                                                                                                                                                                                                                                                                             | Develop the basics of associative memory and unsupervised learning networks.                                                       |                                           |                           |   |     | [AP]  |
| C505.3                                                                                                                                                                                                                                                                                                                                                                                                             | Apply CNN and its variants for suitable applications.                                                                              |                                           |                           |   |     | [AP]  |
| C505.4                                                                                                                                                                                                                                                                                                                                                                                                             | Apply the key computations underlying deep learning and use them to build and train deep neural networks for various tasks.        |                                           |                           |   |     | [AP]  |
| C505.5                                                                                                                                                                                                                                                                                                                                                                                                             | Apply autoencoders and generative models for suitable applications.                                                                |                                           |                           |   |     | [AP]  |
| Course Contents                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                    |                                           |                           |   |     |       |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                                                                           | INTRODUCTION                                                                                                                       |                                           |                           |   | CO1 | 9 Hrs |
| Neural Networks-Application Scope of Neural Networks-Artificial Neural Network: An Introduction to Evolution of Neural Networks-Basic Models of Artificial Neural Network- Important Terminologies of ANNs-Supervised Learning Network.                                                                                                                                                                            |                                                                                                                                    |                                           |                           |   |     |       |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                                                                           | ASSOCIATIVE MEMORY AND UNSUPERVISED LEARNING NETWORKS                                                                              |                                           |                           |   | CO2 | 9 Hrs |
| Training Algorithms for Pattern Association-Autoassociative Memory Network-Heteroassociative Memory Network-Bidirectional Associative Memory (BAM)-Hopfield Networks-Iterative Autoassociative Memory Networks-Temporal Associative Memory Network-Fixed Weight Competitive Nets-Kohonen Self-Organizing Feature Maps-Learning Vector Quantization-Counter propagation Networks-Adaptive Resonance Theory Network  |                                                                                                                                    |                                           |                           |   |     |       |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                                                                           | THIRD-GENERATION NEURAL NETWORKS                                                                                                   |                                           |                           |   | CO3 | 9 Hrs |
| Spiking Neural Networks-Convolutional Neural Networks-Deep Learning Neural Networks-Extreme Learning Machine Model-Convolutional Neural Networks: The Convolution Operation – Motivation – Pooling – Variants of the basic Convolution Function – Structured Outputs – Data Types – Efficient Convolution Algorithms – Neuroscientific Basis – Applications: Computer Vision, Image Generation, Image Compression. |                                                                                                                                    |                                           |                           |   |     |       |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                                                                           | DEEP FEEDFORWARD NETWORKS                                                                                                          |                                           |                           |   | CO4 | 9 Hrs |
| History of Deep Learning- A Probabilistic Theory of Deep Learning- Gradient Learning – Chain Rule and Backpropagation - Regularization: Dataset Augmentation – Noise Robustness -Early Stopping, Bagging and Dropout - batch normalization- VC Dimension and Neural Nets.                                                                                                                                          |                                                                                                                                    |                                           |                           |   |     |       |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                                                                           | RECURRENT NEURAL NETWORKS                                                                                                          |                                           |                           |   | CO5 | 9 Hrs |
| Recurrent Neural Networks: Introduction – Recursive Neural Networks – Bidirectional RNNs – Deep Recurrent Networks – Applications: Image Generation, Image Compression, Natural Language Processing. Complete Auto encoder, Regularized Autoencoder, Stochastic Encoders and Decoders, Contractive Encoders.                                                                                                       |                                                                                                                                    |                                           |                           |   |     |       |
| Total Hours                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                    |                                           |                           |   |     | 45    |
| Textbooks:                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                    |                                           |                           |   |     |       |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                  | Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016.                                                  |                                           |                           |   |     |       |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                  | Francois Chollet, “Deep Learning with Python”, Second Edition, Manning Publications,2021                                           |                                           |                           |   |     |       |

|                         |                                                                                                                                                                                                                               |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3                       | Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020                                                                                                                                                 |
| <b>Reference Books:</b> |                                                                                                                                                                                                                               |
| 1                       | Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn and TensorFlow", Oreilly, 2018                                                                                                                                   |
| 2                       | Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017                                                                                                                                 |
| 3                       | Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer, International Publishing, 1st Edition, 2018.                                                                                                    |
| 4                       |                                                                                                                                                                                                                               |
| <b>Web References:</b>  |                                                                                                                                                                                                                               |
| 1                       | <a href="https://static.latexstudio.net/article/2018/0912/neuralnetworksanddeeplearning.pdf">https://static.latexstudio.net/article/2018/0912/neuralnetworksanddeeplearning.pdf</a>                                           |
| 2                       | <a href="https://jingyuexing.github.io/Ebook/Machine%20Learning/Neural%20Networks%20and%20Deep%20Learning-eng.pdf">https://jingyuexing.github.io/Ebook/Machine Learning/Neural%20Networks%20and%20Deep%20Learning-eng.pdf</a> |

| Assessment based on Continuous and End Semester Examination |                       |                |                      |            |            |                          |
|-------------------------------------------------------------|-----------------------|----------------|----------------------|------------|------------|--------------------------|
| BLOOM'S TAXONOMY LEVEL                                      | CONTINUOUS ASSESSMENT |                |                      | ASSIGNMENT | ATTENDANCE | END SEMESTER EXAMINATION |
|                                                             | CIA1 (6 Marks)        | CIA2 (6 Marks) | Model Exam (8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)               |
| Remember                                                    |                       |                |                      | 10         | 10         | 60                       |
| Understand                                                  | 80                    | 20             | 20                   |            |            |                          |
| Apply                                                       | 20                    | 80             | 80                   |            |            |                          |
| Analyze                                                     |                       |                |                      |            |            |                          |
| Evaluate                                                    |                       |                |                      |            |            |                          |
| Create                                                      |                       |                |                      |            |            |                          |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>       | <b>8</b>             | <b>10</b>  | <b>10</b>  | <b>60</b>                |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/ POs | PO 1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PS01 | PS02 |
|----------|------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|------|------|
| C505.1   | 3    | 2   | 1   | -   | 1   | -   | -   | -   | -   | -     | -     | 2    | 1    |
| C505.2   | 2    | 3   | 2   | 2   | 3   | -   | -   | -   | -   | -     | -     | 3    | 2    |
| C505.3   | 2    | 2   | 3   | 2   | 3   | -   | -   | -   | 1   | -     | 1     | 3    | 3    |
| C505.4   | 2    | 3   | 2   | 3   | 2   | -   | -   | -   | -   | -     | 1     | 2    | 2    |
| C505.5   | 2    | 2   | 3   | 2   | 3   | -   | -   | -   | 1   | 1     | 1     | 3    | 3    |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                           | Course Name                                                                                                                                                                | Category                          | Hours/Week                       |   |            |           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|----------------------------------|---|------------|-----------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                            |                                   | L                                | T | P          | c         |
| 25AM501                                                                                                                                                                                                                                                                                                                                                                                                                               | Cryptocurrency and Blockchain Technology                                                                                                                                   | PE                                | 3                                | 0 | 0          | 3         |
| <b>Regulation</b>                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Nature of the Course</b>                                                                                                                                                | <b>Semester</b>                   | <b>Data Book/Codes/Standards</b> |   |            |           |
| 2024                                                                                                                                                                                                                                                                                                                                                                                                                                  | Theory                                                                                                                                                                     |                                   | Nil                              |   |            |           |
| <b>Pre-requisite Course(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                            | <b>Co-requisite Course(s)</b>     |                                  |   |            |           |
| Computer Networks,<br>Data Structures and Algorithms, Distributed Systems                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                            | Cryptography and Network Security |                                  |   |            |           |
| <b>Course Objectives</b>                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                            |                                   |                                  |   |            |           |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                     | To understand the basics of Blockchain                                                                                                                                     |                                   |                                  |   |            |           |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                     | To learn Different protocols and consensus algorithms in Blockchain                                                                                                        |                                   |                                  |   |            |           |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                     | To learn the Blockchain implementation frameworks                                                                                                                          |                                   |                                  |   |            |           |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                     | To provide knowledge of cryptographic techniques used for securing blockchain systems.                                                                                     |                                   |                                  |   |            |           |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                     | To provide an understanding of blockchain applications in emerging technologies.                                                                                           |                                   |                                  |   |            |           |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                            |                                   |                                  |   |            |           |
| <b>Upon completion of the course, students will be able to</b>                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                            |                                   |                                  |   |            |           |
| C501.1                                                                                                                                                                                                                                                                                                                                                                                                                                | Understand the concepts of Bitcoin, mining, wallets, and token ecosystems                                                                                                  |                                   |                                  |   |            | [U]       |
| C501.2                                                                                                                                                                                                                                                                                                                                                                                                                                | Describe the working principles of Bitcoin and cryptocurrencies including transaction processing, mining, scripting, wallets, and security mechanisms.                     |                                   |                                  |   |            | [U]       |
| C501.3                                                                                                                                                                                                                                                                                                                                                                                                                                | Understand blockchain consensus mechanisms such as Proof of Work (PoW), Proof of Stake (PoS), and Proof of Burn (PoB) in the cryptocurrency ecosystem.                     |                                   |                                  |   |            | [U]       |
| C501.4                                                                                                                                                                                                                                                                                                                                                                                                                                | Apply cryptographic techniques such as public-private keys, digital signatures, hash functions, and Elliptic Curve Cryptography to enhance security in blockchain systems. |                                   |                                  |   |            | [AP]      |
| C501.5                                                                                                                                                                                                                                                                                                                                                                                                                                | Apply blockchain concepts to emerging applications including NFTs, Central Bank Digital Currencies (CBDCs), and Internet of Things (IoT) based systems.                    |                                   |                                  |   |            | [AP]      |
| <b>Course Contents</b>                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                            |                                   |                                  |   |            |           |
| <b>Unit – 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>INTRODUCTION TO CRYPTOCURRENCIES</b>                                                                                                                                    |                                   |                                  |   | <b>CO1</b> | <b>9</b>  |
| Definition and characteristics-Digital currency vs. traditional currency-Decentralization and distributed ledger technology-Origins of cryptocurrencies- Historical challenges and successes-Components of a blockchain-Overview of Bitcoin-Mining and the creation of new coins-Wallets and transactions on the Bitcoin network-alternative cryptocurrencies (Altcoins)-Token creation and use cases-Initial Coin Offerings (ICOs) . |                                                                                                                                                                            |                                   |                                  |   |            |           |
| <b>Unit – 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>BITCOIN AND CRYPTOCURRENCY</b>                                                                                                                                          |                                   |                                  |   | <b>CO2</b> | <b>9</b>  |
| A basic crypto currency, Creation of coins, Payments and double spending, FORTH – the precursor for Bitcoin scripting, Bitcoin Scripts , Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay-Bitcoin Wallets and Key Management-Bitcoin Consensus Mechanism-Bitcoin Security and Attacks.                                                                                            |                                                                                                                                                                            |                                   |                                  |   |            |           |
| <b>Unit – 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>BITCOIN CONSENSUS</b>                                                                                                                                                   |                                   |                                  |   | <b>CO3</b> | <b>9</b>  |
| Bitcoin Consensus, Proof of Work (PoW)- Hashcash PoW , Bitcoin PoW, Attacks on PoW ,monopoly problem- Proof of Stake- Proof of Burn - Proof of Elapsed Time - Bitcoin Miner, Mining Difficulty, Mining Pool-Permissioned model and use cases- Litecoin-Namecoin-Peercoin-Cryptocurrency ecosystem                                                                                                                                     |                                                                                                                                                                            |                                   |                                  |   |            |           |
| <b>Unit – 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>BLOCH CHAIN SECURITY</b>                                                                                                                                                |                                   |                                  |   | <b>CO4</b> | <b>9</b>  |
| Cryptographic Security in Blockchain:Public and private keys, digital signatures, cryptographic hash functions and their properties, key management and secure practices, use of hash functions in Blockchain security, Diffie–Hellman key exchange, Elliptic Curve Cryptography (ECC), and quantum-resistant cryptographic algorithms.                                                                                               |                                                                                                                                                                            |                                   |                                  |   |            |           |
| <b>Unit – 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>EMERGING TRENDS AND FUTURE DEVELOPMENTS</b>                                                                                                                             |                                   |                                  |   | <b>CO5</b> | <b>9</b>  |
| Introduction to NFTs-ERC-721 and other token standards-Applications beyond digital art and collectibles-Overview of CBDCs-The role of governments and central banks in digital currencies-Impact on the traditional financial system- Internet of Things (IoT) and blockchain applications-Future trends in the integration of emerging technologies with blockchain.                                                                 |                                                                                                                                                                            |                                   |                                  |   |            |           |
| <b>Total Hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                            |                                   |                                  |   |            | <b>45</b> |
| <b>Textbooks:</b>                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                            |                                   |                                  |   |            |           |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                     | Arvind Narayanan et al., Bitcoin and Cryptocurrency Technologies, Princeton University Press, 2016.                                                                        |                                   |                                  |   |            |           |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                     | Andreas M. Antonopoulos, Mastering Bitcoin, O'Reilly Media, 2nd Edition, 2017.                                                                                             |                                   |                                  |   |            |           |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                            |                                   |                                  |   |            |           |

|                        |                                                                                                                                                    |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                      | Imran Bashir, Mastering Blockchain, Packt Publishing, 3rd Edition, 2020.                                                                           |
| 2                      | Daniel Drescher, Blockchain Basics, Apress, 2017.                                                                                                  |
| 3                      | Don Tapscott and Alex Tapscott, Blockchain Revolution, Penguin, 2016.                                                                              |
| <b>Web References:</b> |                                                                                                                                                    |
| 1                      | Bitcoin and Cryptocurrency Technologies – <a href="https://bitcoinbook.cs.princeton.edu">https://bitcoinbook.cs.princeton.edu</a>                  |
| 2                      | Ethereum Foundation Documentation – <a href="https://ethereum.org/en/developers/docs/">https://ethereum.org/en/developers/docs/</a>                |
| 3                      | Mastering Bitcoin by Andreas M. Antonopoulos – <a href="https://github.com/bitcoinbook/bitcoinbook">https://github.com/bitcoinbook/bitcoinbook</a> |

| Assessment based on Continuous and End Semester Examination |                       |                |                      |            |            |                          |
|-------------------------------------------------------------|-----------------------|----------------|----------------------|------------|------------|--------------------------|
| BLOOM'S TAXONOMY LEVEL                                      | CONTINUOUS ASSESSMENT |                |                      | ASSIGNMENT | ATTENDANCE | END SEMESTER EXAMINATION |
|                                                             | CIA1 (6 Marks)        | CIA2 (6 Marks) | Model Exam (8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)               |
| Remember                                                    |                       |                |                      | 10         | 10         | 60                       |
| Understand                                                  | 100%                  | 60%            | 60%                  |            |            |                          |
| Apply                                                       |                       | 40%            | 40%                  |            |            |                          |
| Analyze                                                     |                       |                |                      |            |            |                          |
| Evaluate                                                    |                       |                |                      |            |            |                          |
| Create                                                      |                       |                |                      |            |            |                          |
| Total (100 Marks)                                           | 6                     | 6              | 8                    | 10         | 10         | 60                       |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| C501.1      | 3   | 2   |     |     | 1   |     |     |     |     |      | 1    | 2    | 1    |
| C501.2      | 3   | 2   |     |     | 3   |     |     |     |     |      | 1    | 2    | 2    |
| C501.3      | 2   | 3   | 1   |     | 2   |     |     |     |     |      | 1    | 3    | 2    |
| C501.4      | 2   | 3   | 3   | 1   | 3   |     |     |     |     |      | 1    | 2    | 3    |
| C501.5      | 1   | 2   | 3   | 2   | 2   |     |     |     |     |      | 1    | 3    | 3    |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                                          | Course Name                                                                                                                                            | Category               | Hours/Week                |   |     | C      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|-----|--------|
|                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                        |                        | L                         | T | P   |        |
| 24AM502                                                                                                                                                                                                                                                                                                                                                                              | VIDEO CREATION AND EDITING                                                                                                                             | PE                     | 3                         | 0 | 0   | 3      |
| Regulation                                                                                                                                                                                                                                                                                                                                                                           | Nature of the Course                                                                                                                                   | Semester               | Data Book/Codes/Standards |   |     |        |
| R24                                                                                                                                                                                                                                                                                                                                                                                  | Theory                                                                                                                                                 |                        |                           |   |     |        |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                        | Co-requisite Course(s) |                           |   |     |        |
| -                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                        | -                      |                           |   |     |        |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                        |                        |                           |   |     |        |
| 1                                                                                                                                                                                                                                                                                                                                                                                    | To understand the fundamentals and evolution of digital video and editing                                                                              |                        |                           |   |     |        |
| 2                                                                                                                                                                                                                                                                                                                                                                                    | To develop storytelling skills using modern editing techniques                                                                                         |                        |                           |   |     |        |
| 3                                                                                                                                                                                                                                                                                                                                                                                    | To capture, edit, and produce professional-quality video and audio                                                                                     |                        |                           |   |     |        |
| 4                                                                                                                                                                                                                                                                                                                                                                                    | To work with industry-standard non-linear editing (NLE) tools                                                                                          |                        |                           |   |     |        |
| 5                                                                                                                                                                                                                                                                                                                                                                                    | To apply emerging technologies in video production and post-production                                                                                 |                        |                           |   |     |        |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                        |                        |                           |   |     |        |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                        |                        |                           |   |     |        |
| C502.1                                                                                                                                                                                                                                                                                                                                                                               | Apply the fundamentals and ethical principles of digital video editing in creating video content.                                                      |                        |                           |   |     | [AP]   |
| C502.2                                                                                                                                                                                                                                                                                                                                                                               | Apply storytelling techniques to create engaging video narratives                                                                                      |                        |                           |   |     | [AP]   |
| C502.3                                                                                                                                                                                                                                                                                                                                                                               | Apply digital tools and editing techniques to capture and produce audio-visual content.                                                                |                        |                           |   |     | [AP]   |
| C502.4                                                                                                                                                                                                                                                                                                                                                                               | Apply non-linear editing workflows using industry-standard software                                                                                    |                        |                           |   |     | [AP]   |
| C502.5                                                                                                                                                                                                                                                                                                                                                                               | Analyze and apply emerging technologies in video creation and post-production                                                                          |                        |                           |   |     | [AN]   |
| Course Contents                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                        |                        |                           |   |     |        |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                                             | FUNDAMENTALS OF DIGITAL VIDEO AND EDITING                                                                                                              |                        |                           |   | CO1 | 9 Hrs  |
| Evolution of filmmaking – Transition from linear to non-linear editing – Digital video concepts – Frame rates, aspect ratios, codecs, containers – Economy of expression – Ethics of editing – Risks associated with altering reality through editing – Introduction to contemporary video workflows – Overview of digital cinema and online video platforms.                        |                                                                                                                                                        |                        |                           |   |     |        |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                                             | STORYTELLING AND EDITING TECHNIQUES                                                                                                                    |                        |                           |   | CO2 | 9 Hrs  |
| Principles of visual storytelling – Narrative structures for digital media – Editing styles: jump cuts, match cuts, L-cuts, J-cuts, cutaways, dissolves, split edits – Rhythm and pacing – Continuity editing – Storytelling for short-form, social media, and web videos – Managing resolutions (HD, 4K, 8K) – Media management and proxy workflows.                                |                                                                                                                                                        |                        |                           |   |     |        |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                                             | AUDIO AND VIDEO ACQUISITION & POST-PRODUCTION                                                                                                          |                        |                           |   | CO3 | 9 Hrs  |
| Capturing digital and analog video – Camera basics – Mobile filmmaking techniques – Importing audio and video – Syncing audio – Basic sound design – Voice-over recording – Exporting and rendering formats – Delivery for broadcast, web, and streaming platforms – Archiving and backup strategies.                                                                                |                                                                                                                                                        |                        |                           |   |     |        |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                                             | NON-LINEAR EDITING TOOLS AND WORKFLOWS                                                                                                                 |                        |                           |   | CO4 | 9 Hrs  |
| Working with clips, timelines, and sequences – Basic and advanced editing techniques – Transitions and effects – Color correction and basic color grading – Working with audio tracks – Titles and captions – Media organization and preferences – Introduction to modern NLE tools:Final Cut Pro-Adobe Premiere Pro - DaVinci Resolve                                               |                                                                                                                                                        |                        |                           |   |     |        |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                                             | ADVANCED POST-PRODUCTION AND EMERGING TECHNOLOGIES                                                                                                     |                        |                           |   | CO5 | 9 Hrs  |
| Motion graphics and visual effects basics – Introduction to compositing – AI-assisted editing tools (auto cuts, noise reduction, upscaling) – Multicam editing – Sound mixing and mastering – Exporting for OTT platforms – Basics of VR/360° video – Introduction to live streaming workflows – Ethics and copyright issues in digital video – Career pathways in video production. |                                                                                                                                                        |                        |                           |   |     |        |
| Total Theory Hours                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                        |                        |                           |   |     | 45 Hrs |
| Textbooks:                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                        |                        |                           |   |     |        |
| 1                                                                                                                                                                                                                                                                                                                                                                                    | Keith Underdahl, “Digital Video for Dummies”, Third Edition, Dummy Series, 2001.                                                                       |                        |                           |   |     |        |
| 2                                                                                                                                                                                                                                                                                                                                                                                    | Robert M. Goodman and Partick McGarth, “Editing Digital Video: The Complete Creative and Technical Guide”, Digital Video and Audio, McGraw – Hill 2003 |                        |                           |   |     |        |

**Reference Books:**

|   |                                                                                          |
|---|------------------------------------------------------------------------------------------|
| 1 | Wallace Jackson, Digital Video Editing Fundamentals, Apress.                             |
| 2 | Walter Murch, In the Blink of an Eye: A Perspective on Film Editing, Silman-James Press. |
| 3 | Stu Maschwitz, The DV Rebel's Guide, Peachpit Press.                                     |

**Web References:**

|   |                                                                                                                                                                                           |
|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <a href="https://digitalnz.org/make-it-digital/creating-digital-content/creating-digital-video">https://digitalnz.org/make-it-digital/creating-digital-content/creating-digital-video</a> |
| 2 | <a href="https://www.agitraining.com/">https://www.agitraining.com/</a>                                                                                                                   |

| Assessment based on Continuous and End Semester Examination |                       |                      |                               |            |            |                             |
|-------------------------------------------------------------|-----------------------|----------------------|-------------------------------|------------|------------|-----------------------------|
| BLOOM'S<br>TAXONOMY<br>LEVEL                                | CONTINUOUS ASSESSMENT |                      |                               | ASSIGNMENT | ATTENDANCE | END SEMESTER<br>EXAMINATION |
|                                                             | CIA1<br>(6<br>Marks)  | CIA2<br>(6<br>Marks) | Model<br>Exam<br>(8<br>Marks) | (10 Marks) | (10 Marks) | (60 Marks)                  |
| Remember                                                    |                       |                      |                               |            |            |                             |
| Understand                                                  | 20                    |                      | 20                            |            |            |                             |
| Apply                                                       | 80                    | 100                  | 80                            |            |            |                             |
| Analyze                                                     |                       |                      |                               |            |            |                             |
| Evaluate                                                    |                       |                      |                               |            |            |                             |
| Create                                                      |                       |                      |                               |            |            |                             |
| <b>Total<br/>(100 Marks)</b>                                | <b>6</b>              | <b>6</b>             | <b>8</b>                      | <b>10</b>  | <b>10</b>  | <b>60</b>                   |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 marks.
- Experiment wise laboratory completion 10 marks and Model lab exam will be conducted for 100 marks and the same will be converted to 10 marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|-------|-------|
| C502.1      | 2   | 2   | -   | -   | 1   | -   | -   | 2   | -   | -    | -    | 1     | -     |
| C502.2      | 2   | 2   | 3   | -   | 2   | -   | -   | -   | 2   | 3    | -    | 2     | 1     |
| C502.3      | 2   | 2   | 3   | 1   | 3   | -   | -   | -   | 2   | 3    | -    | 3     | 2     |
| C502.4      | 2   | 2   | 3   | 1   | 3   | -   | -   | -   | 2   | 2    | -    | 3     | 2     |
| C502.5      | 2   | 3   | 2   | 2   | 2   | -   | 1   | 1   | -   | 1    | -    | 2     | 3     |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                          | Course Name                                                                                                                                                                                                       | Category               | Hours/Week                |   |     | C    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|-----|------|
|                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                   |                        | L                         | T | P   |      |
| 24AM503                                                                                                                                                                                                                                                                                                                              | DIGITAL MARKETING                                                                                                                                                                                                 | PC                     | 3                         | 0 | 0   | 3    |
| Regulation                                                                                                                                                                                                                                                                                                                           | Nature of the Course                                                                                                                                                                                              | Semester               | Data Book/Codes/Standards |   |     |      |
| 2024                                                                                                                                                                                                                                                                                                                                 | Theory                                                                                                                                                                                                            | V                      | -                         |   |     |      |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                   | Co-requisite Course(s) |                           |   |     |      |
| Nil                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                   | Nil                    |                           |   |     |      |
| Course Objectives                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                   |                        |                           |   |     |      |
| 1                                                                                                                                                                                                                                                                                                                                    | To Understand the fundamentals and importance of digital marketing in modern business.                                                                                                                            |                        |                           |   |     |      |
| 2                                                                                                                                                                                                                                                                                                                                    | To Learn the concepts of search engine optimization (SEO) and search engine marketing (SEM).                                                                                                                      |                        |                           |   |     |      |
| 3                                                                                                                                                                                                                                                                                                                                    | To Apply social media and content marketing strategies.                                                                                                                                                           |                        |                           |   |     |      |
| 4                                                                                                                                                                                                                                                                                                                                    | To Apply email marketing and online advertising techniques                                                                                                                                                        |                        |                           |   |     |      |
| 5                                                                                                                                                                                                                                                                                                                                    | To Analyze digital marketing performance using analytics tools.                                                                                                                                                   |                        |                           |   |     |      |
| Course Outcomes                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                   |                        |                           |   |     |      |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                   |                        |                           |   |     |      |
| C504.1                                                                                                                                                                                                                                                                                                                               | Understand digital marketing concepts and tools.                                                                                                                                                                  |                        |                           |   |     | [U]  |
| C504.2                                                                                                                                                                                                                                                                                                                               | Implement SEO and search engine marketing strategies.                                                                                                                                                             |                        |                           |   |     | [AP] |
| C504.3                                                                                                                                                                                                                                                                                                                               | Develop social media marketing campaigns.                                                                                                                                                                         |                        |                           |   |     | [AP] |
| C504.4                                                                                                                                                                                                                                                                                                                               | Apply email marketing and online advertising techniques.                                                                                                                                                          |                        |                           |   |     | [AP] |
| C504.5                                                                                                                                                                                                                                                                                                                               | Analyze digital marketing performance using analytics tools.                                                                                                                                                      |                        |                           |   |     | [AN] |
| Course Contents                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                   |                        | Hrs                       |   |     |      |
| Unit – 1                                                                                                                                                                                                                                                                                                                             | FUNDAMENTALS OF DIGITAL MARKETING                                                                                                                                                                                 |                        |                           |   | CO1 | 9    |
| Introduction to Marketing and Digital Marketing,Traditional Marketing vs Digital Marketing, Digital Marketing Ecosystem,Online Consumer Behaviour,Digital Marketing Channels:Search Engines,Social Media,Email,Mobile Marketing.Website planning and development,Content marketing fundamentals,Digital marketing strategy framework |                                                                                                                                                                                                                   |                        |                           |   |     |      |
| Unit – 2                                                                                                                                                                                                                                                                                                                             | SEARCH ENGINE OPTIMIZATION (SEO) & SEARCH MARKETING                                                                                                                                                               |                        |                           |   | CO2 | 9    |
| Search engines and their working,Keyword research techniques,On-page SEO:Meta tags,Title tags,Internal linking.Off-page SEO:Backlinks,Directory submissions,Social bookmarking.Technical SEO,Search Engine Marketing (SEM),Pay-Per-Click (PPC) advertising,Google Ads basics                                                         |                                                                                                                                                                                                                   |                        |                           |   |     |      |
| Unit – 3                                                                                                                                                                                                                                                                                                                             | SOCIAL MEDIA & CONTENT MARKETING                                                                                                                                                                                  |                        |                           |   | CO3 | 9    |
| Social media platforms overview:Facebook,Instagram, LinkedIn,YouTube,Twitter.Social media marketing strategy,Content creation and storytelling,Blogging and microblogging, Influencer marketing,Online reputation management,Social media advertising                                                                                |                                                                                                                                                                                                                   |                        |                           |   |     |      |
| Unit – 4                                                                                                                                                                                                                                                                                                                             | EMAIL MARKETING & ONLINE ADVERTISING                                                                                                                                                                              |                        |                           |   | CO4 | 9    |
| Email marketing fundamentals, Email campaign design, Email automation, Customer segmentation, Lead generation strategies, Display advertising, Affiliate marketing, Mobile marketing, Retargeting and remarketing                                                                                                                    |                                                                                                                                                                                                                   |                        |                           |   |     |      |
| Unit – 5                                                                                                                                                                                                                                                                                                                             | DIGITAL MARKETING ANALYTICS & EMERGING TRENDS                                                                                                                                                                     |                        |                           |   | CO5 | 9    |
| Web analytics fundamentals, Google Analytics overview, Conversion rate optimization (CRO), Marketing performance metrics:CTR, CPC, ROI.Conversion rate, Data-driven marketing decisions, Marketing automation tools, Artificial Intelligence in marketing, Future trends in digital marketing                                        |                                                                                                                                                                                                                   |                        |                           |   |     |      |
| Total Theory Hours                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                   |                        |                           |   | 45  |      |
| Textbooks:                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                   |                        |                           |   |     |      |
| 1                                                                                                                                                                                                                                                                                                                                    | Dave Chaffey and Fiona Ellis-Chadwick, Digital Marketing: Strategy, Implementation and Practice, 8th Edition, Pearson Education, 2022, ISBN: 978-1292400969.                                                      |                        |                           |   |     |      |
| 2                                                                                                                                                                                                                                                                                                                                    | Seema Gupta, Digital Marketing, 2nd Edition, McGraw Hill Education, 2023, ISBN: 978-9355324245.                                                                                                                   |                        |                           |   |     |      |
| 3                                                                                                                                                                                                                                                                                                                                    | Ian Dodson, The Art of Digital Marketing: The Definitive Guide to Creating Strategic, Targeted, and Measurable Online Campaigns, 1st Edition, John Wiley & Sons (Wiley Publications), 2016, ISBN: 978-1119265702. |                        |                           |   |     |      |
| Reference Books:                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                   |                        |                           |   |     |      |
| 1                                                                                                                                                                                                                                                                                                                                    | Philip Kotler, Hermawan Kartajaya and Iwan Setiawan, Marketing 4.0: Moving from Traditional to Digital,                                                                                                           |                        |                           |   |     |      |

|                        |                                                                                                                                                                                                          |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                        | 1st Edition, John Wiley & Sons (Wiley), 2017, ISBN: 978-1119341208.                                                                                                                                      |
| 2                      | Ryan Deiss and Russ Henneberry, Digital Marketing for Dummies, 2nd Edition, Wiley, 2020, ISBN: 978-1119660484.                                                                                           |
| 3                      | Joe Pulizzi, Epic Content Marketing: How to Tell a Different Story, Break Through the Clutter, and Win More Customers by Marketing Less, 2nd Edition, McGraw Hill Education, 2014, ISBN: 978-0071819893. |
| <b>Web References:</b> |                                                                                                                                                                                                          |
| 1                      | <a href="https://nptel.ac.in/courses/110105920">https://nptel.ac.in/courses/110105920</a>                                                                                                                |
| 2                      | <a href="https://swayam.gov.in/search_courses?searchText=digital%20marketing">https://swayam.gov.in/search_courses?searchText=digital%20marketing</a>                                                    |
| 3                      | <a href="https://skillshop.exceedlms.com/student/catalog/list?category_ids=7879-google-digital-garage">https://skillshop.exceedlms.com/student/catalog/list?category_ids=7879-google-digital-garage</a>  |

| Assessment based on Continuous and End Semester Examination |                       |                      |                            |            |            |                             |
|-------------------------------------------------------------|-----------------------|----------------------|----------------------------|------------|------------|-----------------------------|
| BLOOM'S<br>TAXONOMY<br>LEVEL                                | CONTINUOUS ASSESSMENT |                      |                            | ASSIGNMENT | ATTENDANCE | END SEMESTER<br>EXAMINATION |
|                                                             | CIA1<br>(6<br>Marks)  | CIA2<br>(6<br>Marks) | Model<br>Exam<br>(8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)                  |
| Remember                                                    |                       |                      |                            | 10         | 10         | 60                          |
| Understand                                                  | 80                    | 20                   | 20                         |            |            |                             |
| Apply                                                       | 20                    | 80                   | 80                         |            |            |                             |
| Analyze                                                     |                       |                      |                            |            |            |                             |
| Evaluate                                                    |                       |                      |                            |            |            |                             |
| Create                                                      |                       |                      |                            |            |            |                             |
| <b>Total<br/>(100 Marks)</b>                                | <b>6</b>              | <b>6</b>             | <b>8</b>                   | <b>10</b>  | <b>10</b>  | <b>60</b>                   |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO<br>10 | PO<br>11 | PS01 | PS02 |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------|----------|------|------|
| C504.1      | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -        | -        | 1    | 2    |
| C504.2      | 3   | 3   | 2   | -   | 2   | -   | -   | -   | -   | -        | 3        | 2    | 2    |
| C504.3      | 2   | 3   | 3   | -   | 2   | -   | -   | -   | 2   | 2        | 3        | 1    | 2    |
| C504.4      | 2   | 2   | 3   | -   | 2   | -   | -   | -   | 2   | 2        | -        | 1    | 2    |
| C504.5      | 3   | 3   | 2   | 2   | 3   | -   | -   | -   | -   | 2        | 3        | 2    | 3    |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Course Name                                                                                                           | Category               | Hours/Week                |   |   | C    |       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|---|------|-------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                       |                        | L                         | T | P |      |       |
| 24CC511                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | OPTICAL COMMUNICATION AND NETWORKS                                                                                    | PE                     | 3                         | 0 | 0 | 3    |       |
| Regulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Nature of the Course                                                                                                  | Semester               | Data Book/Codes/Standards |   |   |      |       |
| 2024                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | THEORY                                                                                                                | -                      | --                        |   |   |      |       |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                       | Co-requisite Course(s) |                           |   |   |      |       |
| --                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                       | --                     |                           |   |   |      |       |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                       |                        |                           |   |   |      |       |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | To Study About the Various Optical Fiber Modes, Configuration Of Optical Fibers                                       |                        |                           |   |   |      |       |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | To Study Transmission Characteristics Of Optical Fibers.                                                              |                        |                           |   |   |      |       |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | To Learn About the Various Optical Sources, Detectors and Transmission Techniques.                                    |                        |                           |   |   |      |       |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | To Explore Various Idea About Optical Fiber Measurements and Various Coupling Techniques.                             |                        |                           |   |   |      |       |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | To Enrich the Knowledge About Optical Communication Systems and Networks.                                             |                        |                           |   |   |      |       |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                       |                        |                           |   |   |      |       |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                       |                        |                           |   |   |      |       |
| CC511.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Realize Basic Elements in Optical Fibers, Different Modes and Configurations.                                         |                        |                           |   |   | [U]  |       |
| CC511.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Apply dispersion and polarization techniques to evaluate transmission characteristics in optical fiber communication. |                        |                           |   |   | [AP] |       |
| CC511.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Apply optical sources and detectors in optical communication systems.                                                 |                        |                           |   |   | [AP] |       |
| CC511.4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Construct Fiber Optic Receiver Systems, Measurements and Techniques.                                                  |                        |                           |   |   | [AP] |       |
| CC511.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Apply optical communication systems and networks in communication applications.                                       |                        |                           |   |   | [AP] |       |
| Course Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                       |                        |                           |   |   |      |       |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | INTRODUCTION TO OPTICAL FIBER COMMUNICATION                                                                           |                        |                           |   |   | CO1  | 9 Hrs |
| Introduction - The General Systems - Advantages of Optical Fiber Communication- Ray Theory Transmission: Total Internal Reflection, Acceptance Angle, Numerical Aperture, Skew Rays - Electromagnetic Mode Theory for Optical Propagation: Modes in a Planar Guide, Phase and group velocity - Cylindrical Fiber: Step index fibers, Graded index fibers - Single mode fibers: Cutoff wavelength.                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                       |                        |                           |   |   |      |       |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | TRANSMISSION CHARACTERISTICS OF OPTICAL FIBERS                                                                        |                        |                           |   |   | CO2  | 9 Hrs |
| Attenuation - Material absorption losses in silica glass fibers: Intrinsic absorption, Extrinsic absorption - Linear scattering losses: Rayleigh Scattering, Mie Scattering -Nonlinear scattering losses: Stimulated Brillouin Scattering, Stimulated Raman Scattering – Fiber Bend Loss – Dispersion- Chromatic dispersion: Material dispersion, Waveguide dispersion- Intermodal dispersion: Multimode step index fiber, Multimode graded index fiber.                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                       |                        |                           |   |   |      |       |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | OPTICAL SOURCES AND OPTICAL DETECTORS                                                                                 |                        |                           |   |   | CO3  | 9 Hrs |
| The laser: Introduction - Basic concepts: Absorption and emission of radiation, Population inversion, Optical feedback and laser oscillation, Threshold condition for laser oscillation- Optical emission from semiconductors: The PN junction, Spontaneous emission, Carrier recombination, Stimulated emission and lasing, Hetero junctions- LED: Introduction- Power and Efficiency - LED structures: Planar LED, Dome LED, Surface emitter LED, Edge emitter LED- LED Characteristics. Optical Detectors: Introduction, Optical Detection Principles, Quantum Efficiency, Responsivity, P-N Photodiode, P-I-N Photo Diode and Avalanche Photodiode.                                                                                                                                                                                     |                                                                                                                       |                        |                           |   |   |      |       |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | OPTICAL FIBER MEASUREMENTS                                                                                            |                        |                           |   |   | CO4  | 9 Hrs |
| Introduction- Total Fiber Attenuation Measurement, Fiber Dispersion Measurements in Time Domain and Frequency Domain, Fiber Cut off Wavelength Measurements, Numerical Aperture Measurements. Fiber Diameter Measurements, Reflectance and Optical Return Loss, Field Measurements                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                       |                        |                           |   |   |      |       |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | OPTICAL NETWORKS                                                                                                      |                        |                           |   |   | CO5  | 9 Hrs |
| Introduction- Optical Network Concepts: Optical Networking Terminology, Optical Network Node And Switching Elements, Wavelength Division Multiplexed Networks, Public Telecommunications Network Overview- Optical Network Transmission Modes, Layers And Protocols: Synchronous Networks, Asynchronous Transfer Mode, Open System Interconnection Reference Model, Optical Transport Network, Internet Protocol- Wavelength Routing Networks: Routing And Wavelength Assignment- Optical Switching Networks: Optical Circuit Switched Networks, Optical Packet Switched Networks, Multiprotocol Label Switching, Optical Burst Switching Networks- Optical Network Deployment : Long Haul Networks, Metropolitan area networks, Access networks, Local Area Networks- Optical Ethernet: Network protection. restoration and survivability. |                                                                                                                       |                        |                           |   |   |      |       |

|                         |                                                                                                                                                                                                     | Total Hours | 45 |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----|
| <b>Textbooks:</b>       |                                                                                                                                                                                                     |             |    |
| 1                       | John M.Senior, “Optical Fiber Communication”, Pearson Education, Fouth Edition.2010.                                                                                                                |             |    |
| 2                       | Gred Keiser,"Optical Fiber Communication", McGraw Hill Education (India) Private Limited. Fifth Edition, Reprint 2013.                                                                              |             |    |
| 3                       | Govind P. Agrawal, “Fiber-Optic Communication Systems”, Third Edition, John Wiley & Sons, 2004.                                                                                                     |             |    |
| <b>Reference Books:</b> |                                                                                                                                                                                                     |             |    |
| 1                       | J.Gower, “Optical Communication System”, Prentice Hall Of India, 2001                                                                                                                               |             |    |
| 2                       | Rajiv Ramaswami, “Optical Networks “, Second Edition, Elsevier , 2004.                                                                                                                              |             |    |
| 3                       | P Chakrabarti, "Optical Fiber Communication", McGraw Hill Education (India)Private Limited, 2016                                                                                                    |             |    |
| 4                       | A. Selvarajan, S. Kar, and T. Srinivas, Optical Fiber Communication: Principles and Systems, Tata McGraw-Hill, 2003.                                                                                |             |    |
| <b>Web References:</b>  |                                                                                                                                                                                                     |             |    |
| 1                       | “Fiber Optic Communication Technology,” by Prof. Deepa Venkitesh, IIT Madras. Available at: <a href="https://nptel.ac.in/courses/108106167">https://nptel.ac.in/courses/108106167</a> .             |             |    |
| 2                       | NPTEL, “Fiber Optics,” by Prof. Vipul Rastogi, IIT Roorkee. Available at: <a href="https://onlinecourses.nptel.ac.in/noc20_ph07/preview">https://onlinecourses.nptel.ac.in/noc20_ph07/preview</a> . |             |    |

| Assessment based on Continuous and End Semester Examination |                       |                |                      |            |            |                          |
|-------------------------------------------------------------|-----------------------|----------------|----------------------|------------|------------|--------------------------|
| BLOOM'S TAXONOMY LEVEL                                      | CONTINUOUS ASSESSMENT |                |                      | ASSIGNMENT | ATTENDANCE | END SEMESTER EXAMINATION |
|                                                             | CIA1 (6 Marks)        | CIA2 (6 Marks) | Model Exam (8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)               |
| Remember                                                    |                       |                |                      | 10         | 10         | 60                       |
| Understand                                                  | 60                    |                | 20                   |            |            |                          |
| Apply                                                       | 40                    | 100            | 80                   |            |            |                          |
| Analyze                                                     |                       |                |                      |            |            |                          |
| Evaluate                                                    |                       |                |                      |            |            |                          |
| Create                                                      |                       |                |                      |            |            |                          |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>       | <b>8</b>             | <b>10</b>  | <b>10</b>  | <b>60</b>                |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/ POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 | PSO 3 |
|----------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CC511.1  | 3    | 3    | 2    | 3    | 3    | -    | -    | -    | -    | -     | 1     | 2     | 1     | 2     |
| CC511.2  | 3    | 3    | 2    | 1    | 3    | -    | -    | -    | -    | -     | 1     | 2     | 2     | 2     |
| CC511.3  | 3    | 3    | 3    | 3    | 2    | -    | -    | -    | -    | -     | 1     | 2     | 2     | 2     |
| CC511.4  | 3    | 3    | 3    | 3    | 2    | -    | -    | -    | -    | -     | 1     | 2     | 1     | 2     |
| CC511.5  | 3    | 3    | 2    | 3    | 3    | -    | -    | -    | -    | -     | 1     | 2     | 2     | 2     |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                     | Course Name                                                                                                     | Category               | Hours/Week                |   |   | C    |       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|---|------|-------|
|                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                 |                        | L                         | T | P |      |       |
| 24CC512                                                                                                                                                                                                                                                                                                                                         | ADVANCED WIRELESS COMMUNICATION TECHNIQUES                                                                      | PE                     | 3                         | 0 | 0 | 3    |       |
| Regulation                                                                                                                                                                                                                                                                                                                                      | Nature of the Course                                                                                            | Semester               | Data Book/Codes/Standards |   |   |      |       |
| 2024                                                                                                                                                                                                                                                                                                                                            | THEORY                                                                                                          | -                      | --                        |   |   |      |       |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                         |                                                                                                                 | Co-requisite Course(s) |                           |   |   |      |       |
| Wireless Communication                                                                                                                                                                                                                                                                                                                          |                                                                                                                 | --                     |                           |   |   |      |       |
| Course Objectives                                                                                                                                                                                                                                                                                                                               |                                                                                                                 |                        |                           |   |   |      |       |
| 1                                                                                                                                                                                                                                                                                                                                               | To provide knowledge about the emerging concepts of cooperative communication.                                  |                        |                           |   |   |      |       |
| 2                                                                                                                                                                                                                                                                                                                                               | To introduce the fundamental concepts of green wireless communication.                                          |                        |                           |   |   |      |       |
| 3                                                                                                                                                                                                                                                                                                                                               | To enable students with power-saving strategies and energy-efficient signal, system, and network design.        |                        |                           |   |   |      |       |
| 4                                                                                                                                                                                                                                                                                                                                               | To expose students to energy-saving techniques used in existing wireless communication components.              |                        |                           |   |   |      |       |
| 5                                                                                                                                                                                                                                                                                                                                               | To develop an understanding of protocols and networks used in future green wireless communication technologies. |                        |                           |   |   |      |       |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                 |                                                                                                                 |                        |                           |   |   |      |       |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                         |                                                                                                                 |                        |                           |   |   |      |       |
| CC512.1                                                                                                                                                                                                                                                                                                                                         | Describe the necessity and design aspects of cooperative communication.                                         |                        |                           |   |   | [U]  |       |
| CC512.2                                                                                                                                                                                                                                                                                                                                         | The student would be able to appreciate the necessity and the design aspects of green wireless communication.   |                        |                           |   |   | [U]  |       |
| CC512.3                                                                                                                                                                                                                                                                                                                                         | Implement power-saving strategies and energy-efficient signal, system, and network design techniques.           |                        |                           |   |   | [AP] |       |
| CC512.4                                                                                                                                                                                                                                                                                                                                         | Demonstrate the feasibility of mathematical models using simulation tools.                                      |                        |                           |   |   | [AP] |       |
| CC512.5                                                                                                                                                                                                                                                                                                                                         | Apply protocols and networks used in future green wireless communication technologies.                          |                        |                           |   |   | [AP] |       |
| Course Contents                                                                                                                                                                                                                                                                                                                                 |                                                                                                                 |                        |                           |   |   |      |       |
| Unit – 1                                                                                                                                                                                                                                                                                                                                        | COOPERATIVE COMMUNICATIONS AND GREEN CONCEPTS                                                                   |                        |                           |   |   | C01  | 9 Hrs |
| Network architectures and research issues in cooperative cellular wireless networks; Cooperative communications in OFDM and MIMO cellular relay networks: issues and approaches; Fundamental trade-offs on the design of green radio networks, green modulation and coding schemes.                                                             |                                                                                                                 |                        |                           |   |   |      |       |
| Unit – 2                                                                                                                                                                                                                                                                                                                                        | COOPERATIVE TECHNIQUES                                                                                          |                        |                           |   |   | C02  | 9 Hrs |
| Cooperative techniques for energy efficiency, Cooperative base station techniques for cellular wireless networks; Turbo base stations; Antenna architectures for cooperation; Cooperative communications in 3GPP LTE-Advanced, Partial information relaying and coordinated multi-point transmission in LTE-Advanced.                           |                                                                                                                 |                        |                           |   |   |      |       |
| Unit – 3                                                                                                                                                                                                                                                                                                                                        | RELAY-BASED COOPERATIVE CELLULAR NETWORKS                                                                       |                        |                           |   |   | C03  | 9 Hrs |
| Distributed space-time block codes; Collaborative relaying in downlink cellular systems; Radio resource optimization; Adaptive resource allocation; Cross-layer scheduling design for cooperative wireless two-way relay networks; Network coding in relay-based networks.                                                                      |                                                                                                                 |                        |                           |   |   |      |       |
| Unit – 4                                                                                                                                                                                                                                                                                                                                        | GREEN RADIO NETWORKS                                                                                            |                        |                           |   |   | C04  | 9 Hrs |
| Base Station Power-Management Techniques- Opportunistic spectrum and load management, Energy-saving techniques in cellular wireless base stations, Power-management for base stations in smart grid environment, Cooperative multi cell processing techniques for energy-efficient cellular wireless communications.                            |                                                                                                                 |                        |                           |   |   |      |       |
| Unit – 5                                                                                                                                                                                                                                                                                                                                        | ACCESS TECHNIQUES FOR GREEN RADIO NETWORKS                                                                      |                        |                           |   |   | C05  | 9 Hrs |
| Cross-layer design of adaptive packet scheduling for green radio networks; Energy-efficient relaying for cooperative cellular wireless networks; Energy performance in TDD-CDMA multihop cellular networks; Resource allocation for green communication in relay-based cellular networks; Green Radio Test-Beds and Standardization Activities. |                                                                                                                 |                        |                           |   |   |      |       |
| Total Hours                                                                                                                                                                                                                                                                                                                                     |                                                                                                                 |                        |                           |   |   | 45   |       |
| Textbooks:                                                                                                                                                                                                                                                                                                                                      |                                                                                                                 |                        |                           |   |   |      |       |
| 1                                                                                                                                                                                                                                                                                                                                               | Ekram Hossain, Dong In Kim, Vijay K. Bhargava . “Cooperative Cellular Wireless                                  |                        |                           |   |   |      |       |

|                         |                                                                                                                                                                                                             |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         | Networks", Cambridge University Press, 2011.                                                                                                                                                                |
| 2                       | Ekram Hossain, Vijay K. Bhargava(Editor), Gerhard P. Fettweis (Editor), "Green Radio Communication Networks", Cambridge University Press, 2012.                                                             |
| 3                       | F. Richard Yu, Yu, Zhang and Victor C. M. Leung "Green Communications and Networking", CRC press, 2012.                                                                                                     |
| <b>Reference Books:</b> |                                                                                                                                                                                                             |
| 1                       | Ramjee Prasad and Shingo Ohmori, Dina Simunic, "Towards Green ICT", River Publishers, 2010.                                                                                                                 |
| 2                       | Jinsong Wu, Sundeep Rangan and Honggang Zhang, "Green Communications: Theoretical Fundamentals, Algorithms and Applications", CRC Press, 2012.                                                              |
| 3                       | Green Communications: Theoretical Fundamentals, Algorithms and Applications, edited by Jinsong Wu, Sundeep Rangan and Honggang Zhang, CRC Press, 2012.                                                      |
| 4                       | Towards Green ICT, by Ramjee Prasad, Shingo Ohmori and Dina Simunic, River Publishers, 2010.                                                                                                                |
| <b>Web References:</b>  |                                                                                                                                                                                                             |
| 1                       | NPTEL, "Fundamentals of Wireless Communication," by Prof. Vivek Ashok Bohara, IIT Delhi. Available at: <a href="https://onlinecourses.nptel.ac.in">https://onlinecourses.nptel.ac.in</a> , (Accessed 2026). |
| 2                       | NPTEL, "Enabling Technologies for 6G Communication Networks," by Prof. Vivek Ashok Bohara. Available at: <a href="https://nptel.ac.in">https://nptel.ac.in</a> .                                            |

| Assessment based on Continuous and End Semester Examination |                       |                |                      |            |            |                          |
|-------------------------------------------------------------|-----------------------|----------------|----------------------|------------|------------|--------------------------|
| BLOOM'S TAXONOMY LEVEL                                      | CONTINUOUS ASSESSMENT |                |                      | ASSIGNMENT | ATTENDANCE | END SEMESTER EXAMINATION |
|                                                             | CIA1 (6 Marks)        | CIA2 (6 Marks) | Model Exam (8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)               |
| Remember                                                    |                       |                |                      | 10         | 10         | 60                       |
| Understand                                                  | 100                   | 20             | 40                   |            |            |                          |
| Apply                                                       |                       | 80             | 60                   |            |            |                          |
| Analyze                                                     |                       |                |                      |            |            |                          |
| Evaluate                                                    |                       |                |                      |            |            |                          |
| Create                                                      |                       |                |                      |            |            |                          |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>       | <b>8</b>             | <b>10</b>  | <b>10</b>  | <b>60</b>                |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/ POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 | PSO 3 |
|----------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CC512.1  | 3    | 3    | 3    | 2    | 1    | -    | -    | -    | -    | -     | 1     | 3     | 3     | 3     |
| CC512.2  | 3    | 3    | 3    | 2    | 2    | -    | -    | -    | -    | -     | 1     | 3     | 2     | 3     |
| CC512.3  | 3    | 2    | 2    | 1    | 2    | -    | -    | -    | -    | -     | 1     | 2     | 1     | 1     |
| CC512.4  | 3    | 3    | 3    | 3    | 2    | -    | -    | -    | -    | -     | 1     | 3     | 1     | 2     |
| CC512.5  | 3    | 3    | 3    | 2    | 1    | -    | -    | -    | -    | -     | 1     | 2     | 3     | 1     |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Course Name                                                                                                                                         | Category               | Hours/Week                |   |   | C    |   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|---|------|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                     |                        | L                         | T | P |      |   |
| 24CC513                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | WIRELESS BROAD BAND NETWORKS                                                                                                                        | PE                     | 3                         | 0 | 0 | 3    |   |
| Regulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Nature of the Course                                                                                                                                | Semester               | Data Book/Codes/Standards |   |   |      |   |
| 2024                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | THEORY                                                                                                                                              | -                      | -                         |   |   |      |   |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                     | Co-requisite Course(s) |                           |   |   |      |   |
| -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                     | -                      |                           |   |   |      |   |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                     |                        |                           |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | To understand the basics of WiMAX and MIMO                                                                                                          |                        |                           |   |   |      |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | To study the various network layer and transport layer protocols for wireless networks                                                              |                        |                           |   |   |      |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | To study the architecture and mitigation techniques in 3G standards and 4G technologies .                                                           |                        |                           |   |   |      |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | To learn about the layer level functionalities in interconnecting networks.                                                                         |                        |                           |   |   |      |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | To study the emerging techniques in 5G network.                                                                                                     |                        |                           |   |   |      |   |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                     |                        |                           |   |   |      |   |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                     |                        |                           |   |   |      |   |
| CC513.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Understand the fundamentals of broadband wireless communication techniques.                                                                         |                        |                           |   |   | [U]  |   |
| CC513.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Implement mobile networking protocols in wireless networks.                                                                                         |                        |                           |   |   | [AP] |   |
| CC513.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Apply and manage 3G and 4G (LTE-A) network architectures including channel allocation, packet data transport and mobility management procedures     |                        |                           |   |   | [AP] |   |
| CC513.4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Apply the interconnecting network functionalities by layer level functions.                                                                         |                        |                           |   |   | [AP] |   |
| CC513.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Apply the current generation (5G) network architecture.                                                                                             |                        |                           |   |   | [AP] |   |
| Course Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                     |                        |                           |   |   |      |   |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | INTRODUCTION                                                                                                                                        |                        |                           |   |   | C01  | 9 |
| Evolution of Broadband Wireless; Fixed Broadband Wireless and Mobile Broadband Wireless; WiMAX, 3G & Wi-Fi Systems; Spectrum Options for Broadband Wireless; Technical Challenges for Broadband Wireless -Wireless Radio Channel: Path loss and Shadowing; Spectrum Scarcity, Quality of Service, Mobility, Portability, Security, Supporting IP in Wireless. Orthogonal Frequency Division Multiplexing, Multicarrier Modulation –OFDM; Introduction to Multiple Antenna Techniques                                                                                                                  |                                                                                                                                                     |                        |                           |   |   |      |   |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | WIRELESS PROTOCOLS                                                                                                                                  |                        |                           |   |   | C02  | 9 |
| Mobile network layer- Fundamentals of Mobile IP, data forwarding procedures in mobile IP, IPv4, IPv6, IP mobility management, IP addressing - DHCP, Mobile transport layer-Traditional TCP, congestion control, slow start, fast recovery/fast retransmission, classical TCP improvements, Indirect TCP, snooping TCP, Mobile TCP.                                                                                                                                                                                                                                                                    |                                                                                                                                                     |                        |                           |   |   |      |   |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 3G & 4G EVOLUTION                                                                                                                                   |                        |                           |   |   | C03  | 9 |
| 3G:IMT-2000 - W-CDMA, CDMA 2000 - radio & network components, network structure, packet-data transport process flow, Channel Allocation, core network, interference-mitigation techniques, UMTS-services, air interface, network architecture of 3GPP, UTRAN – architecture, High Speed Packet Data.4G:Introduction to LTE-A – network architectures – EPC, E- UTRAN architecture - mobility and resource management, services, channel - logical and transport channel mapping, downlink/uplink data transfer, MAC control element, PDU packet formats, scheduling services, random access procedure |                                                                                                                                                     |                        |                           |   |   |      |   |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | LAYER-LEVEL FUNCTIONS                                                                                                                               |                        |                           |   |   | C04  | 9 |
| Characteristics of wireless channels - downlink physical layer, uplink physical layer, MAC scheme - frame structure, resource structure, mapping, synchronization, reference signals and channel estimation, SC-FDMA, interference cancellation – COMP, Carrier aggregation, Services - multimedia broadcast/multicast, location-based services                                                                                                                                                                                                                                                       |                                                                                                                                                     |                        |                           |   |   |      |   |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 5G EVOLUTION                                                                                                                                        |                        |                           |   |   | C05  | 9 |
| 5G Roadmap - Pillars of 5G - 5G Architecture, The 5G internet - IoT and context awareness - Networking reconfiguration and virtualization support - Mobility QoS control - emerging approach for resource over provisioning, Small cells for 5G mobile networks- capacity limits and achievable gains with densification - Mobile data demand, Demand Vs Capacity, Small cell challenges, conclusion and future directions.                                                                                                                                                                           |                                                                                                                                                     |                        |                           |   |   |      |   |
| TOTAL HOURS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                     |                        |                           |   |   | 45   |   |
| Textbooks:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                     |                        |                           |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Kaveh Pahlavan, “Principles of wireless networks”, Prentice-Hall of India, 2008                                                                     |                        |                           |   |   |      |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Jeffrey G. Andrews, Arunabha Ghosh and Rias Muhamed, “Fundamentals of WiMAX: Understanding Broadband Wireless Networking”, Pearson Education, 2007. |                        |                           |   |   |      |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Yan Zhang and Hsiao-Hwa Chen, “Mobile WiMAX : toward broadband wireless metropolitan area                                                           |                        |                           |   |   |      |   |

|                         |                                                                                                                                                          |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         | networks",Auerbach Publications, 2007                                                                                                                    |
| <b>Reference Books:</b> |                                                                                                                                                          |
| 1                       | Vijay K.Garg, "Wireless Network Evolution - 2G & 3G". Prentice Hall, 2008                                                                                |
| 2                       | Clint Smith,P.E, Dannel Collins, "3G Wireless Networks" Tata McGraw- Hill, 2nd Edition, 2011.                                                            |
| 3                       | Sassan Ahmadi, "LTE-Advanced – A practical systems approach to understanding the 3GPP LTE Releases 10 and 11 radio access technologies", Elsevier, 2014. |
| 4                       | Jonathan Rodriguez, "Fundamentals of 5G Mobile networks", John Wiley, 2015.                                                                              |
| <b>Web References:</b>  |                                                                                                                                                          |
| 1                       | <a href="https://nptel.ac.in/courses/117101050">https://nptel.ac.in/courses/117101050</a>                                                                |
| 2                       | <a href="https://www.coursera.org/courses?query=wireless">https://www.coursera.org/courses?query=wireless</a>                                            |

| Assessment based on Continuous and End Semester Examination |                       |                   |                            |            |            |                                |
|-------------------------------------------------------------|-----------------------|-------------------|----------------------------|------------|------------|--------------------------------|
| BLOOM'S<br>TAXONOMY<br>LEVEL                                | CONTINUOUS ASSESSMENT |                   |                            | ASSIGNMENT | ATTENDANCE | END<br>SEMESTER<br>EXAMINATION |
|                                                             | CIA1<br>(6 Marks)     | CIA2<br>(6 Marks) | Model<br>Exam<br>(8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)                     |
| Remember                                                    |                       |                   |                            | 10         | 10         | 60                             |
| Understand                                                  | 80                    |                   | 20                         |            |            |                                |
| Apply                                                       | 20                    | 100               | 80                         |            |            |                                |
| Analyze                                                     |                       |                   |                            |            |            |                                |
| Evaluate                                                    |                       |                   |                            |            |            |                                |
| Create                                                      |                       |                   |                            |            |            |                                |
| <b>Total<br/>(100 Marks)</b>                                | <b>6</b>              | <b>6</b>          | <b>8</b>                   | <b>10</b>  | <b>10</b>  | <b>60</b>                      |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO<br>10 | PO<br>11 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|-------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|
| CC513.1     | 3       | 2       | 2       | 3       | 3       | -       | -       | -       | -       | -        | 3        | 3        | 1        | 1        |
| CC513.2     | 3       | 3       | 2       | 1       | 3       | -       | -       | -       | -       | -        | 2        | 3        | 2        | 2        |
| CC513.3     | 3       | 3       | 3       | 3       | 2       | -       | -       | -       | -       | -        | 1        | 3        | 2        | 2        |
| CC513.4     | 2       | 3       | 3       | 3       | 2       | -       | -       | -       | -       | -        | 2        | 2        | 1        | 2        |
| CC513.5     | 2       | 1       | 3       | 3       | 2       | -       | -       | -       | -       | -        | 3        | 2        | 2        | 1        |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                   | Course Name                                                                                                                          | Category               | Hours/Week                |   |   | C    |   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|---|------|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                      |                        | L                         | T | P |      |   |
| 24CC514                                                                                                                                                                                                                                                                                                                                                                                                                                       | TELECOMMUNICATION SWITCHING AND NETWORKS                                                                                             | PE                     | 3                         | 0 | 0 | 3    |   |
| Regulation                                                                                                                                                                                                                                                                                                                                                                                                                                    | Nature of the Course                                                                                                                 | Semester               | Data Book/Codes/Standards |   |   |      |   |
| 2024                                                                                                                                                                                                                                                                                                                                                                                                                                          | THEORY                                                                                                                               | -                      | -                         |   |   |      |   |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                      | Co-requisite Course(s) |                           |   |   |      |   |
| -                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                      | -                      |                           |   |   |      |   |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                      |                        |                           |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                             | To have knowledge about telecommunication and digital hierarchy, SONET/SDH.                                                          |                        |                           |   |   |      |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                             | To introduce the concepts of different types of switching.                                                                           |                        |                           |   |   |      |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                             | To introduce the need for network synchronization and study synchronization issues.                                                  |                        |                           |   |   |      |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                             | To introduce ISDN, DSL / ADSL, and fiber optic systems in subscriber loop.                                                           |                        |                           |   |   |      |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                             | To introduce a mathematical model for the analysis of telecommunication traffic.                                                     |                        |                           |   |   |      |   |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                      |                        |                           |   |   |      |   |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                      |                        |                           |   |   |      |   |
| CC514.1                                                                                                                                                                                                                                                                                                                                                                                                                                       | Understand basic and advanced techniques of telecommunications networks .                                                            |                        |                           |   |   | [U]  |   |
| CC514.2                                                                                                                                                                                                                                                                                                                                                                                                                                       | Implement the different types of digital switching in telecommunication networks.                                                    |                        |                           |   |   | [AP] |   |
| CC514.3                                                                                                                                                                                                                                                                                                                                                                                                                                       | Determine network synchronization and timing control in communication networks using various techniques.                             |                        |                           |   |   | [AP] |   |
| CC514.4                                                                                                                                                                                                                                                                                                                                                                                                                                       | Employ digital subscriber access technologies including ISDN services, digital loop carrier systems and fiber-based access networks. |                        |                           |   |   | [AP] |   |
| CC514.5                                                                                                                                                                                                                                                                                                                                                                                                                                       | Interpret telecommunication traffic parameters .                                                                                     |                        |                           |   |   | [AP] |   |
| Course Contents                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                      |                        |                           |   |   |      |   |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                                                                                                      | INTRODUCTION                                                                                                                         |                        |                           |   |   | C01  | 9 |
| Evolution of telecommunications, simple telephone communication, manual switching system, strowger switching system, crossbar switching; Electronic Space Division Switching: Stored program control, centralized SPC, distributed SPC. SONET/SDH: SONET Multiplexing Overview-182 SONET Frame Formats- SONET Operations- Administration and Maintenance-Payload Framing and Frequency Justification-SONET Optical Standards- SONET Networks. |                                                                                                                                      |                        |                           |   |   |      |   |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                                                                                                      | DIGITAL SWITCHING                                                                                                                    |                        |                           |   |   | C02  | 9 |
| Switching Functions-Space Division Switching- Time Division Switching- two-dimensional Switching-STC Switching, TST Switching- No.4 ESS Toll Switch- Digital Cross-Connect Systems-Digital Switching in an Analog Environment-Elements of SSN07 signaling.                                                                                                                                                                                    |                                                                                                                                      |                        |                           |   |   |      |   |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                                                                                                      | NETWORK SYNCHRONIZATION CONTROL AND MANAGEMENT                                                                                       |                        |                           |   |   | C03  | 9 |
| Timing: Timing Recovery: Phase-Locked Loop-Clock Instability-Jitter Measurements-Systematic Jitter-Timing Inaccuracies: Slips, Asynchronous Multiplexing-Network Synchronization-U.S.Network Synchronization-Network Control-Network Management.                                                                                                                                                                                              |                                                                                                                                      |                        |                           |   |   |      |   |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                                                                                                      | DIGITAL SUBSCRIBER ACCESS                                                                                                            |                        |                           |   |   | C04  | 9 |
| ISDN services-Network and Protocol architecture-High-Data-Rate Digital Subscriber Loops: Asymmetric Digital Subscriber Line-VDSL. Digital Loop Carrier Systems: Universal Digital Loop Carrier Systems-Integrated Digital Loop Carrier Systems-Next-Generation Digital Loop Carrier-Fiber in the Loop-Hybrid Fiber Coax Systems-Voice band Modems: PCM Modems-Digital Satellite Services.                                                     |                                                                                                                                      |                        |                           |   |   |      |   |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                                                                                                      | TRAFFIC ANALYSIS                                                                                                                     |                        |                           |   |   | C05  | 9 |
| Traffic Characterization: Arrival Distributions-Holding Time Distributions-Loss Systems-Network Blocking Probabilities: End-to-End Blocking Probabilities-Overflow Traffic-Exponential service Times-Constant Service Times-Finite Queues-Tandem Queues.                                                                                                                                                                                      |                                                                                                                                      |                        |                           |   |   |      |   |
| TOTAL HOURS                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                      |                        |                           |   |   | 45   |   |
| Textbooks:                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                      |                        |                           |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                             | Bellamy John, “Digital Telephony”, John Wily & Sons, Inc. 3rd Edition. 2000                                                          |                        |                           |   |   |      |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                             | J. E. Flood, “Telecommunications Switching, Traffic and Networks”, Pearson Education.                                                |                        |                           |   |   |      |   |
| Reference Books:                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                      |                        |                           |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                             | Viswanathan. T., “Telecommunication Switching System and Networks”, Prentice Hall of IndiaLtd., 1994.                                |                        |                           |   |   |      |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                             | Telecommunication switching, Traffic and Networks - J E Flood, Pearson Education, 2002.                                              |                        |                           |   |   |      |   |

|                        |                                                                                                                                 |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| 3                      | Wayne Tomasi Advanced electronic communications systems -, PHI, 2014.                                                           |
| <b>Web References:</b> |                                                                                                                                 |
| 1                      | <a href="https://onlinecourses.nptel.ac.in/noc25_ee12/preview">https://onlinecourses.nptel.ac.in/noc25_ee12/preview</a>         |
| 2                      | <a href="https://www.coursera.org/courses?query=telecommunication">https://www.coursera.org/courses?query=telecommunication</a> |

| <b>Assessment based on Continuous and End Semester Examination</b> |                              |                       |                             |                   |                   |                                 |
|--------------------------------------------------------------------|------------------------------|-----------------------|-----------------------------|-------------------|-------------------|---------------------------------|
| <b>BLOOM'S TAXONOMY LEVEL</b>                                      | <b>CONTINUOUS ASSESSMENT</b> |                       |                             | <b>ASSIGNMENT</b> | <b>ATTENDANCE</b> | <b>END SEMESTER EXAMINATION</b> |
|                                                                    | <b>CIA1 (6 Marks)</b>        | <b>CIA2 (6 Marks)</b> | <b>Model Exam (8 Marks)</b> | <b>(10 Marks)</b> | <b>(10 Marks)</b> | <b>(60 Marks)</b>               |
| Remember                                                           |                              |                       |                             | <b>10</b>         | <b>10</b>         | <b>60</b>                       |
| Understand                                                         | 80                           |                       | 20                          |                   |                   |                                 |
| Apply                                                              | 20                           | 100                   | 80                          |                   |                   |                                 |
| Analyze                                                            |                              |                       |                             |                   |                   |                                 |
| Evaluate                                                           |                              |                       |                             |                   |                   |                                 |
| Create                                                             |                              |                       |                             |                   |                   |                                 |
| <b>Total (100 Marks)</b>                                           | <b>6</b>                     | <b>6</b>              | <b>8</b>                    | <b>10</b>         | <b>10</b>         | <b>60</b>                       |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| <b>COs/ POs</b> | <b>PO 1</b> | <b>PO 2</b> | <b>PO 3</b> | <b>PO 4</b> | <b>PO 5</b> | <b>PO 6</b> | <b>PO 7</b> | <b>PO 8</b> | <b>PO 9</b> | <b>PO 10</b> | <b>PO 11</b> | <b>PSO 1</b> | <b>PSO 2</b> | <b>PSO 3</b> |
|-----------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|--------------|--------------|--------------|
| CC514.1         | 3           | 3           | 3           | 1           | -           | -           | -           | -           | -           | -            | 2            | 2            | 2            | 2            |
| CC514.2         | 3           | 3           | 3           | 1           | -           | -           | -           | -           | -           | -            | 1            | 2            | 2            | 1            |
| CC514.3         | 3           | 3           | 3           | 1           | -           | -           | -           | -           | -           | -            | 1            | 2            | 2            | 2            |
| CC514.4         | 3           | 3           | 3           | 1           | -           | -           | -           | -           | -           | -            | 2            | 2            | 2            | 1            |
| CC514.5         | 3           | 3           | 3           | 1           | -           | -           | -           | -           | -           | -            | 2            | 2            | 2            | 1            |

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

| Course Code                                                                                                                                                                                                                                                                 | Course Name                                                                                                                    | Category               | Hours/Week                |   |             | C     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|-------------|-------|
|                                                                                                                                                                                                                                                                             |                                                                                                                                |                        | L                         | T | P           |       |
| 24CC515                                                                                                                                                                                                                                                                     | VEHICULAR NETWORKS                                                                                                             | PE                     | 3                         | 0 | 0           | 3     |
| Regulation                                                                                                                                                                                                                                                                  | Nature of the Course                                                                                                           | Semester               | Data Book/Codes/Standards |   |             |       |
| 2024                                                                                                                                                                                                                                                                        | THEORY                                                                                                                         | -                      | -                         |   |             |       |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                     |                                                                                                                                | Co-requisite Course(s) |                           |   |             |       |
| MOBILE COMMUNICATION                                                                                                                                                                                                                                                        |                                                                                                                                | NIL                    |                           |   |             |       |
| Course Objectives                                                                                                                                                                                                                                                           |                                                                                                                                |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                           | To understand the fundamentals of vehicular networks and Intelligent Transportation Systems.                                   |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                           | To study vehicular communication types and the architecture of Vehicular Ad hoc Networks.                                      |                        |                           |   |             |       |
| 3                                                                                                                                                                                                                                                                           | To learn vehicular communication technologies and standards such as DSRC, IEEE 802.11p, and Cellular V2X.                      |                        |                           |   |             |       |
| 4                                                                                                                                                                                                                                                                           | To analyze routing protocols and security challenges in vehicular networks.                                                    |                        |                           |   |             |       |
| 5                                                                                                                                                                                                                                                                           | To explore applications and emerging trends in vehicular networking for intelligent transportation and smart mobility systems. |                        |                           |   |             |       |
| Course Outcomes                                                                                                                                                                                                                                                             |                                                                                                                                |                        |                           |   |             |       |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                     |                                                                                                                                |                        |                           |   |             |       |
| CC515.1                                                                                                                                                                                                                                                                     | Understand the fundamental concepts of vehicular networks and Intelligent Transportation Systems (ITS).                        |                        |                           |   |             | [U]   |
| CC515.2                                                                                                                                                                                                                                                                     | Describe vehicular communication types and the architecture of Vehicular Ad hoc Networks (VANETs).                             |                        |                           |   |             | [U]   |
| CC515.3                                                                                                                                                                                                                                                                     | Explain vehicular communication technologies and standards such as IEEE 802.11p used in vehicular networks.                    |                        |                           |   |             | [U]   |
| CC515.4                                                                                                                                                                                                                                                                     | Determine appropriate routing protocols and security mechanisms to address challenges in vehicular networks.                   |                        |                           |   |             | [AP]  |
| CC515.5                                                                                                                                                                                                                                                                     | Develop vehicular networking solutions for intelligent transportation and smart mobility applications.                         |                        |                           |   |             | [AP]  |
| Course Contents                                                                                                                                                                                                                                                             |                                                                                                                                |                        |                           |   |             |       |
| Unit – 1                                                                                                                                                                                                                                                                    | INTRODUCTION TO VEHICULAR NETWORKS AND ITS                                                                                     |                        |                           |   | CO1         | 9 Hrs |
| Overview of vehicular networks – Applications of vehicular communication – Vehicular Ad hoc Networks (VANETs) – Intelligent Transportation Systems (ITS) – Components and basic architecture of ITS – DSRC and ITS-G5 overview.                                             |                                                                                                                                |                        |                           |   |             |       |
| Unit – 2                                                                                                                                                                                                                                                                    | COMMUNICATION TYPES AND ARCHITECTURE                                                                                           |                        |                           |   | CO2         | 9 Hrs |
| Vehicular communication types: V2V, V2I, V2X, V2P – Basic VANET architecture – On-Board Units (OBU) – Road Side Units (RSU) – Communication links – Role of vehicular networks in traffic safety and cooperative driving.                                                   |                                                                                                                                |                        |                           |   |             |       |
| Unit – 3                                                                                                                                                                                                                                                                    | COMMUNICATION TECHNOLOGIES AND STANDARDS                                                                                       |                        |                           |   | CO3         | 9 Hrs |
| Dedicated Short Range Communication (DSRC) – IEEE 802.11p – Cellular V2X (C-V2X): LTE-V2X and 5G V2X – Comparison of DSRC and C-V2X – Vehicular network protocol stack and architecture.                                                                                    |                                                                                                                                |                        |                           |   |             |       |
| Unit – 4                                                                                                                                                                                                                                                                    | ROUTING PROTOCOLS AND SECURITY                                                                                                 |                        |                           |   | CO4         | 9 Hrs |
| Routing challenges in VANETs – Position-based, broadcast and geocast routing – Routing protocols: AODV, DSR and GPSR – Security issues in vehicular networks – Attacks such as eavesdropping, Sybil and DoS – Authentication and Vehicular Public Key Infrastructure (PKI). |                                                                                                                                |                        |                           |   |             |       |
| Unit – 5                                                                                                                                                                                                                                                                    | APPLICATIONS AND FUTURE TRENDS                                                                                                 |                        |                           |   | CO5         | 9 Hrs |
| Applications of vehicular networks: traffic safety, collision avoidance, infotainment and platooning – Intelligent transportation services – Integration with autonomous vehicles and smart cities – Emerging trends in vehicular networking.                               |                                                                                                                                |                        |                           |   |             |       |
|                                                                                                                                                                                                                                                                             |                                                                                                                                |                        |                           |   | Total Hours | 45    |
| Textbooks:                                                                                                                                                                                                                                                                  |                                                                                                                                |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                           | Sonali P. Botkar, <i>VANET: Challenges and Opportunities</i> , CRC Press, 2021.                                                |                        |                           |   |             |       |
| 2                                                                                                                                                                                                                                                                           | Liang Xiao, Xiaodong Lin, Xuemin Shen, <i>Learning-Based VANET Communication and Security Techniques</i> , Springer, 2019.     |                        |                           |   |             |       |
| Reference Books:                                                                                                                                                                                                                                                            |                                                                                                                                |                        |                           |   |             |       |
| 1                                                                                                                                                                                                                                                                           | Hannes Hartenstein, Kenneth Laberteaux, <i>VANET: Vehicular Applications and Inter-Networking Technologies</i> , Wiley, 2009.  |                        |                           |   |             |       |

|                        |                                                                                                                                       |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| 2                      | Ljubo Vlacic, Michel Parent, Fumio Harashima, Intelligent Vehicle Technologies: Theory and Applications, Butterworth-Heinemann, 2015. |
| 3                      | Yilin Zhao, Vehicle Location and Navigation Systems, Artech House, 1997.                                                              |
| 4                      | C. Campolo, A. Molinaro, Vehicular Ad Hoc Networks: Standards, Solutions and Research, Springer, 2015.                                |
| <b>Web References:</b> |                                                                                                                                       |
| 1                      | <a href="https://onlinecourses.nptel.ac.in/noc25_cs74/preview">https://onlinecourses.nptel.ac.in/noc25_cs74/preview</a>               |

| <b>Assessment based on Continuous and End Semester Examination</b> |                              |                       |                             |                              |                              |                                            |
|--------------------------------------------------------------------|------------------------------|-----------------------|-----------------------------|------------------------------|------------------------------|--------------------------------------------|
| <b>BLOOM'S TAXONOMY LEVEL</b>                                      | <b>CONTINUOUS ASSESSMENT</b> |                       |                             | <b>ASSIGNMENT (10 Marks)</b> | <b>ATTENDANCE (10 Marks)</b> | <b>END SEMESTER EXAMINATION (60 Marks)</b> |
|                                                                    | <b>CIA1 (6 Marks)</b>        | <b>CIA2 (6 Marks)</b> | <b>Model Exam (8 Marks)</b> |                              |                              |                                            |
| Remember                                                           | -                            | -                     | -                           | <b>10</b>                    | <b>10</b>                    | <b>60</b>                                  |
| Understand                                                         | 100                          | 100                   | 60                          |                              |                              |                                            |
| Apply                                                              | -                            | -                     | 40                          |                              |                              |                                            |
| Analyze                                                            | -                            | -                     | -                           |                              |                              |                                            |
| Evaluate                                                           | -                            | -                     | -                           |                              |                              |                                            |
| Create                                                             | -                            | -                     | -                           | <b>10</b>                    | <b>10</b>                    | <b>60</b>                                  |
| <b>Total (100 Marks)</b>                                           | <b>6</b>                     | <b>6</b>              | <b>8</b>                    |                              |                              |                                            |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| <b>COs/ POs</b> | <b>PO 1</b> | <b>PO 2</b> | <b>PO 3</b> | <b>PO 4</b> | <b>PO 5</b> | <b>PO 6</b> | <b>PO 7</b> | <b>PO 8</b> | <b>PO 9</b> | <b>PO 10</b> | <b>PO 11</b> | <b>PSO 1</b> | <b>PSO 2</b> | <b>PSO 3</b> |
|-----------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|--------------|--------------|--------------|
| CC515.1         | 3           | 1           | 1           | 1           | 1           | -           | -           | -           | -           | -            | 1            | 2            | 1            | 1            |
| CC515.2         | 2           | 2           | 1           | 1           | 1           | -           | -           | -           | -           | -            | 1            | 2            | 2            | 1            |
| CC515.3         | 2           | 2           | 1           | 1           | 2           | -           | -           | -           | -           | -            | 1            | 2            | 2            | 1            |
| CC515.4         | 2           | 3           | 1           | 1           | 2           | -           | -           | -           | -           | -            | 1            | 2            | 3            | 2            |
| CC515.5         | 1           | 2           | 3           | 1           | 2           | -           | -           | -           | -           | -            | 1            | 2            | 3            | 3            |

1 - Low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                         | Course Name                                                                                                                                  | Category               | Hours/Week                |   |   | C    |   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|---|------|---|
|                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                              |                        | L                         | T | P |      |   |
| 24EC521                                                                                                                                                                                                                                                                                                                                                             | Software Defined Networks                                                                                                                    | PE                     | 3                         | 0 | 0 | 3    |   |
| Regulation                                                                                                                                                                                                                                                                                                                                                          | Nature of the Course                                                                                                                         | Semester               | Data Book/Codes/Standards |   |   |      |   |
| 2024                                                                                                                                                                                                                                                                                                                                                                | Theory                                                                                                                                       | ---                    | -                         |   |   |      |   |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                              | Co-requisite Course(s) |                           |   |   |      |   |
| Data Communication concepts                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                              | -                      |                           |   |   |      |   |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                              |                        |                           |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                                                                                   | To give a comprehensive exposure to the fundamental concepts and architecture of Software Defined Networking.                                |                        |                           |   |   |      |   |
| 2                                                                                                                                                                                                                                                                                                                                                                   | To learn various concepts of SDN data plane and OpenFlow protocol                                                                            |                        |                           |   |   |      |   |
| 3                                                                                                                                                                                                                                                                                                                                                                   | To impart knowledge on SDN control plane architecture and evaluate controller platforms                                                      |                        |                           |   |   |      |   |
| 4                                                                                                                                                                                                                                                                                                                                                                   | To explore methods ofSDN control plane architecture and evaluate controller platforms                                                        |                        |                           |   |   |      |   |
| 5                                                                                                                                                                                                                                                                                                                                                                   | To understand thenetwork virtualization technologies and SDN integration.                                                                    |                        |                           |   |   |      |   |
| Course Outcomes:                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                              |                        |                           |   |   |      |   |
| Upon completion of the course, students will be able to                                                                                                                                                                                                                                                                                                             |                                                                                                                                              |                        |                           |   |   |      |   |
| C521.1                                                                                                                                                                                                                                                                                                                                                              | Understand the fundamental concepts and architecture of Software Defined Networking.                                                         |                        |                           |   |   | [U]  |   |
| C521.2                                                                                                                                                                                                                                                                                                                                                              | Analyze the SDN data plane and OpenFlow protocol                                                                                             |                        |                           |   |   | [AN] |   |
| C521.3                                                                                                                                                                                                                                                                                                                                                              | Analyze the SDN control plane architecture and evaluate controller platforms                                                                 |                        |                           |   |   | [AN] |   |
| C521.4                                                                                                                                                                                                                                                                                                                                                              | Apply SDN concepts to implement network services                                                                                             |                        |                           |   |   | [AP] |   |
| C521.5                                                                                                                                                                                                                                                                                                                                                              | Understand the network virtualization technologies and SDN integration for modern data center and cloud networking environments              |                        |                           |   |   | [U]  |   |
| Course Contents                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                              |                        |                           |   |   |      |   |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                            | EVOLUTION OF NETWORKING AND SDN FUNDAMENTALS                                                                                                 |                        |                           |   |   | CO1  | 9 |
| Introduction to Traditional Networks – Control Plane, Data Plane and Management Plane – Flow Tables – Limitations of Traditional Networking – Need for Network Simplification – Software Defined Networking concept – SDN Architecture overview – Separation of Control and Data planes – Role of Open Networking Foundation (ONF) – Overview of OpenFlow protocol. |                                                                                                                                              |                        |                           |   |   |      |   |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                            | SDN DATA PLANE AND OPENFLOW                                                                                                                  |                        |                           |   |   | CO2  | 9 |
| SDN Data Plane Architecture – OpenFlow Logical Switch – Flow Tables and Pipeline Processing – Packet Matching and Actions – Group Tables and Meter Tables – OpenFlow Ports and Counters – Flow Entry Management – OpenFlow versions overview – Secure communication between controller and switches.                                                                |                                                                                                                                              |                        |                           |   |   |      |   |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                            | SDN CONTROL PLANE ARCHITECTURE                                                                                                               |                        |                           |   |   | CO3  | 9 |
| SDN Control Plane – Controller Architecture and Functions – Southbound Interfaces – Northbound Interfaces – Controller Platforms – REST APIs in SDN – Coordination among multiple controllers – Network automation and programmability.                                                                                                                             |                                                                                                                                              |                        |                           |   |   |      |   |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                            | SDN APPLICATIONS AND NETWORK MANAGEMENT                                                                                                      |                        |                           |   |   | CO4  | 9 |
| SDN Application Plane Architecture – Network Services Abstraction Layer – Traffic Engineering – Network Monitoring and Measurement – Security Applications in SDN – Data Center Networking – Mobility and Wireless Network support – Information-centric networking concepts.                                                                                       |                                                                                                                                              |                        |                           |   |   |      |   |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                            | NETWORK VIRTUALIZATION AND SDN ECOSYSTEM                                                                                                     |                        |                           |   |   | CO5  | 9 |
| Network Virtualization concepts – Virtual LANs and Virtual Private Networks – Network Function Virtualization (NFV) – NFV Architecture and Infrastructure – Virtualized Network Functions – NFV Management and Orchestration – Integration of SDN and NFV – SDN use cases in Data Centers and Wide Area Networks – Software Defined Infrastructure.                 |                                                                                                                                              |                        |                           |   |   |      |   |
| Total Hours                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                              |                        |                           |   |   | 45   |   |
| Textbooks:                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                              |                        |                           |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                                                                                   | Siamak Azodolmolky – Software Defined Networking with OpenFlow, Software Defined Networking with OpenFlow, Packt Publishing.. (Unit 2 and 3) |                        |                           |   |   |      |   |
| 2                                                                                                                                                                                                                                                                                                                                                                   | Thomas Nadeau & Ken Gray, Software Defined Networks, O'Reilly Media. (Unit 4 & 5)                                                            |                        |                           |   |   |      |   |
| 3                                                                                                                                                                                                                                                                                                                                                                   | Paul Goransson & Chuck Black – Software Defined Networks: A Comprehensive Approach . (Unit 1)                                                |                        |                           |   |   |      |   |
| Reference Books:                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                              |                        |                           |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                                                                                   | Feamster, Rexford, and Zegura, The Road to SDN: An Intellectual History of Programmable Networks, ACM Queue / SIGCOMM.                       |                        |                           |   |   |      |   |

|                                                             |                                                                                                                                                           |                   |                            |            |            |                                |
|-------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|----------------------------|------------|------------|--------------------------------|
| 2                                                           | Kreutz, Ramos, Verissimo, Rothenberg, Azodolmolky&Uhlrig, Software-Defined Networking: A Comprehensive Survey, IEEE Proceedings.                          |                   |                            |            |            |                                |
| Web References:                                             |                                                                                                                                                           |                   |                            |            |            |                                |
| 1                                                           | <a href="https://nptel.ac.in/courses/106/106/106106234/">https://nptel.ac.in/courses/106/106/106106234/</a>                                               |                   |                            |            |            |                                |
| 2                                                           | <a href="https://www.vmware.com/topics/glossary/content/network-virtualization">https://www.vmware.com/topics/glossary/content/network-virtualization</a> |                   |                            |            |            |                                |
| 3                                                           | <a href="https://sdn.stanford.edu/openflow-tutorial/">https://sdn.stanford.edu/openflow-tutorial/</a>                                                     |                   |                            |            |            |                                |
| Assessment based on Continuous and End Semester Examination |                                                                                                                                                           |                   |                            |            |            |                                |
| BLOOM'S<br>TAXONOMY<br>LEVEL                                | CONTINUOUS ASSESSMENT                                                                                                                                     |                   |                            | ASSIGNMENT | ATTENDANCE | END<br>SEMESTER<br>EXAMINATION |
|                                                             | CIA1<br>(6 Marks)                                                                                                                                         | CIA2<br>(6 Marks) | Model<br>Exam<br>(8 Marks) | (10 Marks) | (10 Marks) | (60 Marks)                     |
| Remember                                                    |                                                                                                                                                           |                   | 10%                        | (10 Marks) | (10 Marks) | (60 Marks)                     |
| Understand                                                  | 70%                                                                                                                                                       | 30%               | 40%                        |            |            |                                |
| Apply                                                       |                                                                                                                                                           |                   | 40%                        |            |            |                                |
| Analyze                                                     | 30%                                                                                                                                                       | 70%               | 10%                        |            |            |                                |
| Evaluate                                                    |                                                                                                                                                           |                   |                            |            |            |                                |
| Create                                                      |                                                                                                                                                           |                   |                            |            |            |                                |
| Total<br>(100 Marks)                                        | 6                                                                                                                                                         | 6                 | 8                          | 10         | 10         | 60                             |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PS01 | PS02 | PS03 |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| C521.1      | 3   | 3   | -   | 2   | 2   | -   | -   | -   | -   | -    | -    | 2    | 1    | -    |
| C521.2      | 3   | 3   | 3   | 2   | 2   | -   | -   | -   | -   | -    | -    | 2    | 2    | -    |
| C521.3      | 3   | 3   | 3   | 2   | 2   | -   | -   | -   | -   | -    | -    | 2    | 2    | 1    |
| C521.4      | 3   | 3   | 3   | 2   | 2   | -   | -   | -   | -   | -    | -    | 2    | 2    | 1    |
| C521.5      | 3   | 3   | 3   | 2   | 2   | -   | -   | -   | -   | -    | -    | 2    | 2    | 1    |

1 - low, 2 - medium, 3 - high, '-' - no correlation

**SYLLABI****OPEN ELECTIVES****(APPLICABLE FOR STUDENTS ADMITTED FROM 2024-2025)**

| Course Code                                                                                                                                                                                                                                                                                                                   | Course Name                                                                                                          | Category               | Hours/Week                |   |     | C    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|-----|------|
|                                                                                                                                                                                                                                                                                                                               |                                                                                                                      |                        | L                         | T | P   |      |
| 24OE611                                                                                                                                                                                                                                                                                                                       | DATABASE FUNDAMENTALS                                                                                                | OE                     | 3                         | 0 | 0   | 3    |
| Regulation                                                                                                                                                                                                                                                                                                                    | Nature of the Course                                                                                                 | Semester               | Data Book/Codes/Standards |   |     |      |
| 2024                                                                                                                                                                                                                                                                                                                          | THEORY                                                                                                               | -                      | -----                     |   |     |      |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                       |                                                                                                                      | Co-requisite Course(s) |                           |   |     |      |
| -                                                                                                                                                                                                                                                                                                                             |                                                                                                                      | -                      |                           |   |     |      |
| Course Objectives                                                                                                                                                                                                                                                                                                             |                                                                                                                      |                        |                           |   |     |      |
| 1                                                                                                                                                                                                                                                                                                                             | To learn the fundamentals of data models, relational algebra and SQL                                                 |                        |                           |   |     |      |
| 2                                                                                                                                                                                                                                                                                                                             | To represent a database system using ER diagrams and to learn normalization techniques                               |                        |                           |   |     |      |
| 3                                                                                                                                                                                                                                                                                                                             | To have an introductory knowledge about the Distributed databases, NOSQL and database security                       |                        |                           |   |     |      |
| Course Outcomes                                                                                                                                                                                                                                                                                                               |                                                                                                                      |                        |                           |   |     |      |
| Upon completion of the course, students shall have ability to                                                                                                                                                                                                                                                                 |                                                                                                                      |                        |                           |   |     |      |
| OE611.1                                                                                                                                                                                                                                                                                                                       | To understand basics of Databases                                                                                    |                        |                           |   |     | [U]  |
| OE611.2                                                                                                                                                                                                                                                                                                                       | To understand basics of Relational Databases                                                                         |                        |                           |   |     | [U]  |
| OE611.3                                                                                                                                                                                                                                                                                                                       | To design database using ER model and normalize the database                                                         |                        |                           |   |     | [AP] |
| OE611.4                                                                                                                                                                                                                                                                                                                       | To apply database concepts on distributed Databases                                                                  |                        |                           |   |     | [AP] |
| OE611.5                                                                                                                                                                                                                                                                                                                       | To apply database concepts on Database Security                                                                      |                        |                           |   |     | [AP] |
| Course Contents                                                                                                                                                                                                                                                                                                               |                                                                                                                      |                        |                           |   |     |      |
| Unit – 1                                                                                                                                                                                                                                                                                                                      | Introduction                                                                                                         |                        |                           |   | C01 | 8    |
| Introduction to Databases - Database Models- Components of a DBMS- Types of Databases - Purpose of Database System – Views of data – Data Models – Database System Architecture - Applications of Databases                                                                                                                   |                                                                                                                      |                        |                           |   |     |      |
| Unit – 2                                                                                                                                                                                                                                                                                                                      | Relational Databases                                                                                                 |                        |                           |   | C02 | 10   |
| Introduction to relational databases – Relational Model – Keys – Relational Algebra – SQL fundamentals – Advanced SQL features – Embedded SQL– Dynamic SQL                                                                                                                                                                    |                                                                                                                      |                        |                           |   |     |      |
| Unit – 3                                                                                                                                                                                                                                                                                                                      | Database Design                                                                                                      |                        |                           |   | C03 | 9    |
| Entity-Relationship model – E-R Diagrams – Enhanced-ER Model – ER-to-Relational Mapping – Functional Dependencies – Non-loss Decomposition – First, Second, Third Normal Forms, Dependency Preservation – Boyce/Codd Normal Form – Multi-valued Dependencies and Fourth Normal Form – Join Dependencies and Fifth Normal Form |                                                                                                                      |                        |                           |   |     |      |
| Unit – 4                                                                                                                                                                                                                                                                                                                      | Distributed Databases                                                                                                |                        |                           |   | C04 | 9    |
| Architecture, Data Storage, Transaction Processing, Query processing and optimization – NOSQL Databases: Introduction – CAP Theorem – Document Based systems – Key value Stores – Column Based Systems – Graph Databases                                                                                                      |                                                                                                                      |                        |                           |   |     |      |
| Unit – 5                                                                                                                                                                                                                                                                                                                      | Database Security                                                                                                    |                        |                           |   | C05 | 9    |
| Security issues – Access control based on privileges – Role Based access control – SQL Injection – Statistical Database security – Flow control – Encryption and Public Key infrastructures – Challenges                                                                                                                      |                                                                                                                      |                        |                           |   |     |      |
| Total Hours                                                                                                                                                                                                                                                                                                                   |                                                                                                                      |                        |                           |   |     | 45   |
| Textbooks:                                                                                                                                                                                                                                                                                                                    |                                                                                                                      |                        |                           |   |     |      |
| 1                                                                                                                                                                                                                                                                                                                             | Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”, Seventh Edition, McGraw Hill, 2020. |                        |                           |   |     |      |
| 2                                                                                                                                                                                                                                                                                                                             | Ramez Elmasri, Shamkant B. Navathe, “Fundamentals of Database Systems”, Seventh Edition, Pearson Education, 2017     |                        |                           |   |     |      |
| Reference Books:                                                                                                                                                                                                                                                                                                              |                                                                                                                      |                        |                           |   |     |      |
| 1                                                                                                                                                                                                                                                                                                                             | C.J.Date, A.Kannan, S.Swamynathan, “An Introduction to Database Systems”, Eighth Edition, Pearson Education, 2006.   |                        |                           |   |     |      |

|                        |                                                                                                                                                           |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2                      | Thomas Connolly, Carolyn Begg, "Database Systems: A Practical Approach to Design, Implementation and Management", Sixth Edition, Pearson Education, 2015. |
| 3                      | Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom, "Database Systems: The Complete Book", Second Edition, Pearson Education, 2009.                  |
| <b>Web References:</b> |                                                                                                                                                           |
| 1.                     | <a href="https://nptel.ac.in/courses/106104135">https://nptel.ac.in/courses/106104135</a>                                                                 |
| 2.                     | <a href="https://onlinecourses.nptel.ac.in/noc22_cs91/preview">https://onlinecourses.nptel.ac.in/noc22_cs91/preview</a>                                   |

| Assessment based on Continuous and End Semester Examination |                       |                   |                         |                          |                          |                                        |
|-------------------------------------------------------------|-----------------------|-------------------|-------------------------|--------------------------|--------------------------|----------------------------------------|
| Bloom's Level                                               | Continuous Assessment |                   |                         | Assignment<br>(10 Marks) | Attendance<br>(10 Marks) | End Semester Examination<br>(60 Marks) |
|                                                             | CIA1<br>(6 Marks)     | CIA2<br>(6 Marks) | Model Exam<br>(8 Marks) |                          |                          |                                        |
| Remember                                                    |                       |                   |                         | 10                       | 10                       | 60                                     |
| Understand                                                  | 100                   | 60                | 80                      |                          |                          |                                        |
| Apply                                                       |                       | 40                | 20                      |                          |                          |                                        |
| Analyze                                                     |                       |                   |                         |                          |                          |                                        |
| Evaluate                                                    |                       |                   |                         |                          |                          |                                        |
| Create                                                      |                       |                   |                         | 10                       | 10                       | 60                                     |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>          | <b>8</b>                |                          |                          |                                        |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 | PSO 3 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| OE611.1     | 3    | 2    | 1    | 1    | 1    | -    | -    | -    | -    | -     | 1     | 2     | 1     | 1     |
| OE611.2     | 3    | 2    | 1    | 1    | 2    | -    | -    | -    | -    | -     | 1     | 2     | 2     | 2     |
| OE611.3     | 3    | 2    | 3    | 1    | 2    | -    | -    | -    | -    | -     | 1     | 3     | 2     | 3     |
| OE611.4     | 3    | 3    | 2    | 2    | 3    | -    | -    | -    | -    | -     | 2     | 2     | 3     | 3     |
| OE611.5     | 2    | 2    | 2    | 1    | 2    | -    | -    | -    | -    | -     | 1     | 2     | 3     | 2     |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                          | Course Name                                                                                                                            | Category               | Hours/Week                |   |   | C    |    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|---|------|----|
|                                                                                                                                                                                                                                                                                                      |                                                                                                                                        |                        | L                         | T | P |      |    |
| 24OE612                                                                                                                                                                                                                                                                                              | BASICS OF IMAGE PROCESSING                                                                                                             | OE                     | 3                         | 0 | 0 | 3    |    |
| Regulation                                                                                                                                                                                                                                                                                           | Nature of the Course                                                                                                                   | Semester               | Data Book/Codes/Standards |   |   |      |    |
| 2024                                                                                                                                                                                                                                                                                                 | THEORY                                                                                                                                 | -                      | -----                     |   |   |      |    |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                              |                                                                                                                                        | Co-requisite Course(s) |                           |   |   |      |    |
| -                                                                                                                                                                                                                                                                                                    |                                                                                                                                        | -                      |                           |   |   |      |    |
| Course Objectives                                                                                                                                                                                                                                                                                    |                                                                                                                                        |                        |                           |   |   |      |    |
| 1                                                                                                                                                                                                                                                                                                    | To become familiar with digital image fundamentals.                                                                                    |                        |                           |   |   |      |    |
| 2                                                                                                                                                                                                                                                                                                    | To get exposed to simple image enhancement techniques in Spatial and Frequency domain.                                                 |                        |                           |   |   |      |    |
| 3                                                                                                                                                                                                                                                                                                    | To learn concepts of degradation function and restoration techniques.                                                                  |                        |                           |   |   |      |    |
| 4                                                                                                                                                                                                                                                                                                    | To study the image segmentation and representation techniques.                                                                         |                        |                           |   |   |      |    |
| 5                                                                                                                                                                                                                                                                                                    | To become familiar with image compression and recognition methods                                                                      |                        |                           |   |   |      |    |
| Course Outcomes                                                                                                                                                                                                                                                                                      |                                                                                                                                        |                        |                           |   |   |      |    |
| Upon completion of the course, students shall have ability to                                                                                                                                                                                                                                        |                                                                                                                                        |                        |                           |   |   |      |    |
| OE612.1                                                                                                                                                                                                                                                                                              | To understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms |                        |                           |   |   | [U]  |    |
| OE612.2                                                                                                                                                                                                                                                                                              | To understand on images using the techniques of smoothing, sharpening and enhancement                                                  |                        |                           |   |   | [U]  |    |
| OE612.3                                                                                                                                                                                                                                                                                              | To apply the restoration concepts and filtering techniques.                                                                            |                        |                           |   |   | [AP] |    |
| OE612.4                                                                                                                                                                                                                                                                                              | To learn the basics of segmentation methods                                                                                            |                        |                           |   |   | [AP] |    |
| OE612.5                                                                                                                                                                                                                                                                                              | To Comprehend compression and recognition concepts.                                                                                    |                        |                           |   |   | [AP] |    |
| Course Contents                                                                                                                                                                                                                                                                                      |                                                                                                                                        |                        |                           |   |   |      |    |
| Unit – 1                                                                                                                                                                                                                                                                                             | DIGITAL IMAGE FUNDAMENTALS                                                                                                             |                        |                           |   |   | CO1  | 10 |
| Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels - Color image fundamentals - RGB, HSI models, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT.  |                                                                                                                                        |                        |                           |   |   |      |    |
| Unit – 2                                                                                                                                                                                                                                                                                             | IMAGE ENHANCEMENT                                                                                                                      |                        |                           |   |   | CO2  | 8  |
| Gray level transformations – Histogram processing – Basics of Spatial Filtering, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters                                                                    |                                                                                                                                        |                        |                           |   |   |      |    |
| Unit – 3                                                                                                                                                                                                                                                                                             | IMAGE RESTORATION                                                                                                                      |                        |                           |   |   | CO3  | 9  |
| Image Restoration - degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters                                                                                                                       |                                                                                                                                        |                        |                           |   |   |      |    |
| Unit – 4                                                                                                                                                                                                                                                                                             | IMAGE SEGMENTATION                                                                                                                     |                        |                           |   |   | CO4  | 9  |
| Edge detection, Edge linking via Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Segmentation by morphological watersheds – basic concepts.                                             |                                                                                                                                        |                        |                           |   |   |      |    |
| Unit – 5                                                                                                                                                                                                                                                                                             | IMAGE COMPRESSION AND RECOGNITION                                                                                                      |                        |                           |   |   | CO5  | 9  |
| Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching. |                                                                                                                                        |                        |                           |   |   |      |    |
| Total Hours                                                                                                                                                                                                                                                                                          |                                                                                                                                        |                        |                           |   |   | 45   |    |
| Textbooks:                                                                                                                                                                                                                                                                                           |                                                                                                                                        |                        |                           |   |   |      |    |
| 1                                                                                                                                                                                                                                                                                                    | Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”, Seventh Edition, McGraw Hill, 2020.                   |                        |                           |   |   |      |    |
| 2                                                                                                                                                                                                                                                                                                    | Ramez Elmasri, Shamkant B. Navathe, “Fundamentals of Database Systems”, Seventh Edition, Pearson Education, 2017                       |                        |                           |   |   |      |    |
| Reference Books:                                                                                                                                                                                                                                                                                     |                                                                                                                                        |                        |                           |   |   |      |    |
| 1                                                                                                                                                                                                                                                                                                    | C.J.Date, A.Kannan, S.Swamynathan, “An Introduction to Database Systems”, Eighth Edition, Pearson Education, 2006.                     |                        |                           |   |   |      |    |
| 2                                                                                                                                                                                                                                                                                                    | Rafael C. Gonzalez, Richard E. Woods, “Digital Image Processing”, Fourth Edition, Pearson                                              |                        |                           |   |   |      |    |

|                        |                                                                                                                           |
|------------------------|---------------------------------------------------------------------------------------------------------------------------|
|                        | Education, 2018.                                                                                                          |
| 3                      | Anil K. Jain, "Fundamentals of Digital Image Processing", First Edition, Prentice Hall, 1989.                             |
| <b>Web References:</b> |                                                                                                                           |
| 1.                     | <a href="https://onlinecourses.nptel.ac.in/noc22_ee116/preview">https://onlinecourses.nptel.ac.in/noc22_ee116/preview</a> |
| 2.                     | <a href="https://onlinecourses.nptel.ac.in/noc26_ee31/preview">https://onlinecourses.nptel.ac.in/noc26_ee31/preview</a>   |

| Assessment based on Continuous and End Semester Examination |                       |                   |                         |                          |                          |                                        |
|-------------------------------------------------------------|-----------------------|-------------------|-------------------------|--------------------------|--------------------------|----------------------------------------|
| Bloom's Level                                               | Continuous Assessment |                   |                         | Assignment<br>(10 Marks) | Attendance<br>(10 Marks) | End Semester Examination<br>(60 Marks) |
|                                                             | CIA1<br>(6 Marks)     | CIA2<br>(6 Marks) | Model Exam<br>(8 Marks) |                          |                          |                                        |
| Remember                                                    |                       |                   |                         | 10                       | 10                       | 60                                     |
| Understand                                                  | 100                   | 60                | 80                      |                          |                          |                                        |
| Apply                                                       |                       | 40                | 20                      |                          |                          |                                        |
| Analyze                                                     |                       |                   |                         |                          |                          |                                        |
| Evaluate                                                    |                       |                   |                         |                          |                          |                                        |
| Create                                                      |                       |                   |                         | 10                       | 10                       | 60                                     |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>          | <b>8</b>                |                          |                          |                                        |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 | PSO 3 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| OE612       | 3    | 2    | 1    | 1    | 1    | —    | —    | —    | —    | —     | 1     | 2     | 1     | 1     |
| OE612       | 3    | 2    | 1    | 1    | 2    | —    | —    | —    | —    | —     | 1     | 2     | 2     | 2     |
| OE612       | 3    | 3    | 2    | 2    | 3    | —    | —    | —    | —    | —     | 2     | 2     | 3     | 3     |
| OE612       | 3    | 3    | 2    | 2    | 2    | —    | —    | —    | —    | —     | 2     | 2     | 3     | 3     |
| OE612       | 2    | 2    | 2    | 1    | 2    | —    | —    | —    | —    | —     | 2     | 2     | 3     | 2     |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                     | Course Name                                                                                                                                                   | Category               | Hours/Week                |   |   | C    |   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|---|------|---|
|                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                               |                        | L                         | T | P |      |   |
| 24OE613                                                                                                                                                                                                                                                                                                         | VEHICULAR ADHOC NETWORKS                                                                                                                                      | OE                     | 3                         | 0 | 0 | 3    |   |
| Regulation                                                                                                                                                                                                                                                                                                      | Nature of the Course                                                                                                                                          | Semester               | Data Book/Codes/Standards |   |   |      |   |
| 2024                                                                                                                                                                                                                                                                                                            | THEORY                                                                                                                                                        | -                      | -----                     |   |   |      |   |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                         |                                                                                                                                                               | Co-requisite Course(s) |                           |   |   |      |   |
| -                                                                                                                                                                                                                                                                                                               |                                                                                                                                                               | -                      |                           |   |   |      |   |
| Course Objectives                                                                                                                                                                                                                                                                                               |                                                                                                                                                               |                        |                           |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                               | To teach the students concepts of VANET.                                                                                                                      |                        |                           |   |   |      |   |
| 2                                                                                                                                                                                                                                                                                                               | To understand about Message forwarding and Challenges of vehicular systems                                                                                    |                        |                           |   |   |      |   |
| 3                                                                                                                                                                                                                                                                                                               | To understand implementation scope, applications and case studies of VANET.                                                                                   |                        |                           |   |   |      |   |
| Course Outcomes                                                                                                                                                                                                                                                                                                 |                                                                                                                                                               |                        |                           |   |   |      |   |
| Upon completion of the course, students shall have ability to                                                                                                                                                                                                                                                   |                                                                                                                                                               |                        |                           |   |   |      |   |
| OE613.1                                                                                                                                                                                                                                                                                                         | To understand VANET Basics                                                                                                                                    |                        |                           |   |   | [U]  |   |
| OE613.2                                                                                                                                                                                                                                                                                                         | To comprehend the message forwarding strategies.                                                                                                              |                        |                           |   |   | [U]  |   |
| OE613.3                                                                                                                                                                                                                                                                                                         | To understand the challenges in VANET                                                                                                                         |                        |                           |   |   | [U]  |   |
| OE613.4                                                                                                                                                                                                                                                                                                         | To apply VANET in different services and to understand through simulation                                                                                     |                        |                           |   |   | [AP] |   |
| OE613.5                                                                                                                                                                                                                                                                                                         | To apply VANET concepts in different applications                                                                                                             |                        |                           |   |   | [AP] |   |
| Course Contents                                                                                                                                                                                                                                                                                                 |                                                                                                                                                               |                        |                           |   |   |      |   |
| Unit – 1                                                                                                                                                                                                                                                                                                        | INTRODUCTION TO VANET                                                                                                                                         |                        |                           |   |   | CO1  | 9 |
| VANET Basics – Scenarios – Components of VANET -Need and Characteristics of VANET – Communication in VANET: Types, Introduction to DSRC : IEEE 1609.0, 1609.1,1609.2,1609.3,1609.4, IEEE 802.11P – Physical and MAC layer.                                                                                      |                                                                                                                                                               |                        |                           |   |   |      |   |
| Unit – 2                                                                                                                                                                                                                                                                                                        | MESSAGING FORWARDING STRATEGIES                                                                                                                               |                        |                           |   |   | CO2  | 9 |
| Types of messages in VANET, Message Forwarding Strategies, Message Packet Format, Need of Priority-Based Message Forwarding, Priority assigning mechanism,                                                                                                                                                      |                                                                                                                                                               |                        |                           |   |   |      |   |
| Unit – 3                                                                                                                                                                                                                                                                                                        | CHALLENGES IN VANET                                                                                                                                           |                        |                           |   |   | CO3  | 9 |
| Challenges: Volatility, Critical Time latency, Diverse networking standards, High Mobility of nodes, Network Security, Efficient Message forwarding, Mitigation Techniques to address VANET Security                                                                                                            |                                                                                                                                                               |                        |                           |   |   |      |   |
| Unit – 4                                                                                                                                                                                                                                                                                                        | SCOPE AND APPLICATION OF VANET                                                                                                                                |                        |                           |   |   | CO4  | 9 |
| Scope of VANET, Application of VANET, Traffic Management, User-Oriented Services, Convenience Services, Potential Projects, Tools and Simulation Platform of VANET, Conclusions – VANET and Intelligent Transportation System                                                                                   |                                                                                                                                                               |                        |                           |   |   |      |   |
| Unit – 5                                                                                                                                                                                                                                                                                                        | CASE STUDIES                                                                                                                                                  |                        |                           |   |   | CO5  | 9 |
| Learning-Based Rogue Edge Detection in VANETs with Ambient Radio Signals, Learning While Offloading: Task Offloading in Vehicular Edge Computing Network, Intelligent Network Access System for Vehicular Real-Time Service Provisioning, UAV Relay in VANETs Against Smart Jamming with Reinforcement Learning |                                                                                                                                                               |                        |                           |   |   |      |   |
| Total Hours                                                                                                                                                                                                                                                                                                     |                                                                                                                                                               |                        |                           |   |   | 45   |   |
| Textbooks:                                                                                                                                                                                                                                                                                                      |                                                                                                                                                               |                        |                           |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                               | Botkar, Sonali P., et al. VANET: challenges and opportunities. CRC Press, 2021.                                                                               |                        |                           |   |   |      |   |
| 2                                                                                                                                                                                                                                                                                                               | Xiao, Liang, et al. Learning-based VANET communication and security techniques. Springer International Publishing, 2019.                                      |                        |                           |   |   |      |   |
| 3                                                                                                                                                                                                                                                                                                               | Hartenstein, Hannes, and Kenneth Laberteaux, eds. VANET: vehicular applications and inter-networking technologies. John Wiley & Sons, 2009.                   |                        |                           |   |   |      |   |
| Reference Books:                                                                                                                                                                                                                                                                                                |                                                                                                                                                               |                        |                           |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                               | Intelligent Vehicle Technologies Theory and Applications– L Vlacic, M Parent,FHarashima - Butterworth Heinemann, 2015                                         |                        |                           |   |   |      |   |
| 2                                                                                                                                                                                                                                                                                                               | Scorer, A. "Vehicle Location and Navigation Systems. By Yilin Zhao. Artech House, 1997. ISBN: 0-89006-861-5." The Journal of Navigation 51.3 (1998): 445-447. |                        |                           |   |   |      |   |
| Web References:                                                                                                                                                                                                                                                                                                 |                                                                                                                                                               |                        |                           |   |   |      |   |
| 1.                                                                                                                                                                                                                                                                                                              | https://onlinecourses.nptel.ac.in/noc26_cs51/preview                                                                                                          |                        |                           |   |   |      |   |

|    |                                                                                           |
|----|-------------------------------------------------------------------------------------------|
| 2. | <a href="https://nptel.ac.in/courses/106105160">https://nptel.ac.in/courses/106105160</a> |
|----|-------------------------------------------------------------------------------------------|

| Assessment based on Continuous and End Semester Examination |                       |                   |                         |                          |                          |                                        |
|-------------------------------------------------------------|-----------------------|-------------------|-------------------------|--------------------------|--------------------------|----------------------------------------|
| Bloom's Level                                               | Continuous Assessment |                   |                         | Assignment<br>(10 Marks) | Attendance<br>(10 Marks) | End Semester Examination<br>(60 Marks) |
|                                                             | CIA1<br>(6 Marks)     | CIA2<br>(6 Marks) | Model Exam<br>(8 Marks) |                          |                          |                                        |
| Remember                                                    |                       |                   |                         | 10                       | 10                       | 60                                     |
| Understand                                                  | 100                   | 100               | 60                      |                          |                          |                                        |
| Apply                                                       |                       |                   | 40                      |                          |                          |                                        |
| Analyze                                                     |                       |                   |                         |                          |                          |                                        |
| Evaluate                                                    |                       |                   |                         |                          |                          |                                        |
| Create                                                      |                       |                   |                         | 10                       | 10                       | 60                                     |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>          | <b>8</b>                |                          |                          |                                        |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 | PSO 3 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| OE613.1     | 3    | 2    | 1    | 1    | 1    | -    | -    | -    | -    | -     | 1     | 2     | 1     | 1     |
| OE613.2     | 3    | 3    | 1    | 1    | 2    | -    | -    | -    | -    | -     | 1     | 2     | 2     | 2     |
| OE613.3     | 3    | 3    | 1    | 2    | 2    | -    | -    | -    | -    | -     | 2     | 2     | 2     | 2     |
| OE613.4     | 3    | 2    | 3    | 2    | 3    | -    | -    | -    | -    | -     | 2     | 2     | 3     | 3     |
| OE613.5     | 3    | 2    | 3    | 2    | 2    | -    | -    | -    | -    | -     | 2     | 3     | 3     | 3     |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Course Name                                                                                               | Category               | Hours/Week                |   |   | C    |   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|---|------|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                           |                        | L                         | T | P |      |   |
| 24OE614                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | WEB TECHNOLOGY FUNDAMENTALS                                                                               | OE                     | 3                         | 0 | 0 | 3    |   |
| Regulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Nature of the Course                                                                                      | Semester               | Data Book/Codes/Standards |   |   |      |   |
| 2024                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | THEORY                                                                                                    | -                      | -----                     |   |   |      |   |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                           | Co-requisite Course(s) |                           |   |   |      |   |
| -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                           | -                      |                           |   |   |      |   |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                           |                        |                           |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | To understand different Internet Technologies                                                             |                        |                           |   |   |      |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | To learn java-specific web services architecture                                                          |                        |                           |   |   |      |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | To Develop web applications using frameworks                                                              |                        |                           |   |   |      |   |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                           |                        |                           |   |   |      |   |
| Upon completion of the course, students shall have ability to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                           |                        |                           |   |   |      |   |
| OE614.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To understand responsive web pages using HTML5 and CSS3                                                   |                        |                           |   |   | [U]  |   |
| OE614.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To build dynamic client-side functionality with JavaScript and DOM manipulation                           |                        |                           |   |   | [AP] |   |
| OE614.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To implement server-side functionality using PHP, Java Servlets, and Node.js.                             |                        |                           |   |   | [AP] |   |
| OE614.4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To create and connect web applications to databases using JDBC and MySQL                                  |                        |                           |   |   | [AP] |   |
| OE614.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To understand and apply modern frameworks like Angular, React, and Django for full-stack web development. |                        |                           |   |   | [AP] |   |
| Course Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                           |                        |                           |   |   |      |   |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | FUNDAMENTALS OF WEB TECHNOLOGIES                                                                          |                        |                           |   |   | CO1  | 9 |
| Web Essentials: Understanding Clients, Servers, and Communication - Internet Fundamentals: World Wide Web – HTTP Request and Response Messages - HTML5: Introduction to HTML5 Tags, Tables, Lists, and Images - HTML5 Control Elements: Forms, Input Types, Drag and Drop, Audio, and Video - CSS3: Inline, Embedded, and External Stylesheets - Rule Cascading and Inheritance in CSS3 - CSS3 Transitions, Animations & Transformations -Bootstrap Framework: Using the Bootstrap Grid System, Responsive Design Principles, and Components |                                                                                                           |                        |                           |   |   |      |   |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | CLIENT-SIDE PROGRAMMING                                                                                   |                        |                           |   |   | CO2  | 9 |
| JavaScript : Variables, Functions, Loops, Conditional Statements - DOM Manipulation: Selecting Elements, Modifying Content and Attributes- Exception Handling: Try-Catch Blocks, Throwing Custom Errors - Form Validation: Using JavaScript to Validate User Input -DHTML with JavaScript: Creating Dynamic Web Pages - JSON: Parsing JSON.                                                                                                                                                                                                  |                                                                                                           |                        |                           |   |   |      |   |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | SERVER-SIDE PROGRAMMING                                                                                   |                        |                           |   |   | CO3  | 9 |
| Java Servlet Technology: Servlet Architecture and Lifecycle - Handling HTTP Requests and Sessions: Form GET/POST, Cookies, URL Rewriting - JDBC: Connecting to Databases, Performing CRUD Operations - Advanced Java Concepts: Introduction to JSP Architecture - Database Connectivity: MySQL, SQLite.                                                                                                                                                                                                                                      |                                                                                                           |                        |                           |   |   |      |   |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | PHP AND XML                                                                                               |                        |                           |   |   | CO4  | 9 |
| PHP Basics: Syntax, Variables, Operators, Data Types, Conditionals, Arrays, Functions, Form Handling, and Validation - XML Basics: Understanding XML Structure, DTD, and XML Schemas - XML Parsing: Using DOM and SAX Parsers in PHP.                                                                                                                                                                                                                                                                                                        |                                                                                                           |                        |                           |   |   |      |   |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | MODERN WEB APPLICATION FRAMEWORKS                                                                         |                        |                           |   |   | CO5  | 9 |
| Introduction to AngularJS and Angular 2+: MVC Architecture, Components, Directives - Angular Data Binding: Expressions, ngModel, ng-repeat - React Basics: Component-Based Architecture, JSX, Props, State - Node.js Basics: Event-driven, Non-blocking I/O, Server-Side JavaScript -Express Framework: Building RESTful APIs with Express and Node.js - Django Framework: MVC/MVT Architecture, Python in Web Apps.                                                                                                                         |                                                                                                           |                        |                           |   |   |      |   |
| Total Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                           |                        |                           |   |   | 45   |   |
| Textbooks:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                           |                        |                           |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Harvey, Harvey Deitel, and Abbey Deitel. "Internet and World Wide Web How To Program." (2011).            |                        |                           |   |   |      |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Jeffrey, C. "Jackson,""Web Technologies A Computer Science Perspective"." (2011).                         |                        |                           |   |   |      |   |

|                         |                                                                                                                                                         |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3                       | Uluca, Doguhan. Angular 6 for Enterprise-Ready Web Applications: Deliver production-ready and cloud-scale Angular web apps. Packt Publishing Ltd, 2018. |
| <b>Reference Books:</b> |                                                                                                                                                         |
| 1                       | Stephen Wynkoop and John Burke "Running a Perfect Website", QUE, 2nd Edition, 1999                                                                      |
| 2                       | Chris Bates, Web Programming – Building Intranet Applications, 3rd Edition, Wiley Publications, 2009.                                                   |
| 3                       | Gopalan N.P. and Akilandeswari J., "Web Technology", Prentice Hall of India, 2011                                                                       |
| <b>Web References:</b>  |                                                                                                                                                         |
| 1.                      | <a href="https://onlinecourses.swayam2.ac.in/e-learning/preview/nou24_cs09">https://onlinecourses.swayam2.ac.in/e-learning/preview/nou24_cs09</a>       |
| 2.                      | <a href="https://onlinecourses.swayam2.ac.in/e-learning/preview/nou23_cs03">https://onlinecourses.swayam2.ac.in/e-learning/preview/nou23_cs03</a>       |

| Assessment based on Continuous and End Semester Examination |                       |                   |                         |                          |                          |                                        |
|-------------------------------------------------------------|-----------------------|-------------------|-------------------------|--------------------------|--------------------------|----------------------------------------|
| Bloom's Level                                               | Continuous Assessment |                   |                         | Assignment<br>(10 Marks) | Attendance<br>(10 Marks) | End Semester Examination<br>(60 Marks) |
|                                                             | CIA1<br>(6 Marks)     | CIA2<br>(6 Marks) | Model Exam<br>(8 Marks) |                          |                          |                                        |
| Remember                                                    |                       |                   |                         | 10                       | 10                       | 60                                     |
| Understand                                                  | 80                    | 100               | 20                      |                          |                          |                                        |
| Apply                                                       | 20                    |                   | 80                      |                          |                          |                                        |
| Analyze                                                     |                       |                   |                         |                          |                          |                                        |
| Evaluate                                                    |                       |                   |                         |                          |                          |                                        |
| Create                                                      |                       |                   |                         |                          |                          |                                        |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>          | <b>8</b>                | <b>10</b>                | <b>10</b>                | <b>60</b>                              |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 | PSO 3 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| OE614.1     | 3    | 2    | 3    | 1    | 3    | -    | -    | -    | -    | -     | 1     | 2     | 2     | 3     |
| OE614.2     | 3    | 3    | 2    | 2    | 3    | -    | -    | -    | -    | -     | 1     | 2     | 3     | 3     |
| OE614.3     | 3    | 3    | 3    | 2    | 3    | -    | -    | -    | -    | -     | 2     | 3     | 3     | 3     |
| OE614.4     | 3    | 3    | 3    | 2    | 3    | -    | -    | -    | -    | -     | 2     | 3     | 3     | 3     |
| OE614.5     | 3    | 2    | 3    | 2    | 3    | -    | -    | -    | -    | -     | 3     | 3     | 3     | 3     |

1 - low, 2 - medium, 3 - high, '-' - no correlation

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Course Name                                                                                                                  | Category               | Hours/Week                |   |     | C    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---|-----|------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                              |                        | L                         | T | P   |      |
| 24OE615                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | APP DEVELOPMENT FUNDAMENTALS                                                                                                 | OE                     | 3                         | 0 | 0   | 3    |
| Regulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Nature of the Course                                                                                                         | Semester               | Data Book/Codes/Standards |   |     |      |
| 2024                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | THEORY                                                                                                                       | -                      | -----                     |   |     |      |
| Pre-requisite Course(s)                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                              | Co-requisite Course(s) |                           |   |     |      |
| -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                              | -                      |                           |   |     |      |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                              |                        |                           |   |     |      |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | To learn development of native applications with basic GUI Components                                                        |                        |                           |   |     |      |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | To develop cross-platform applications with event handling                                                                   |                        |                           |   |     |      |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | To develop applications with location and data storage capabilities                                                          |                        |                           |   |     |      |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | To develop web applications with database access                                                                             |                        |                           |   |     |      |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                              |                        |                           |   |     |      |
| Upon completion of the course, students shall have ability to                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                              |                        |                           |   |     |      |
| OE615.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | To understand various mobile app development model.                                                                          |                        |                           |   |     | [U]  |
| OE615.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | To design simple native and cross-platform mobile applications                                                               |                        |                           |   |     | [AP] |
| OE615.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | To apply frameworks such as React Native and Ionic effectively                                                               |                        |                           |   |     | [AP] |
| OE615.4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | To evaluate frameworks based on performance and development needs                                                            |                        |                           |   |     | [AP] |
| OE615.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | To understand app deployment, debugging, and maintenance fundamentals                                                        |                        |                           |   |     | [AP] |
| Course Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                              |                        |                           |   |     |      |
| Unit – 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | FUNDAMENTALS OF WEB AND MOBILE APPLICATION DEVELOPMENT                                                                       |                        |                           |   | CO1 | 9    |
| Introduction to mobile and web app ecosystems -Native apps – architecture and characteristics - Hybrid apps – architecture and use cases - Cross-platform apps – concept and use cases- Progressive Web Apps (PWA) – functionality and offline capabilities- Responsive Web Design – fluid layouts, media queries, flexible grids.                                                                                                                                                              |                                                                                                                              |                        |                           |   |     |      |
| Unit – 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | NATIVE APP DEVELOPMENT                                                                                                       |                        |                           |   | CO2 | 9    |
| Native Android development – Java and Kotlin basics - Native iOS development – Swift and Objective-C overview - Android Studio and Xcode – IDE walkthrough - Activity lifecycle, Views, and UI components - Permissions, local storage, and app manifest configuration -Introduction to Gradle build process - Play Store and App Store – submission basics and guidelines.                                                                                                                     |                                                                                                                              |                        |                           |   |     |      |
| Unit – 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | HYBRID APP DEVELOPMENT                                                                                                       |                        |                           |   | CO3 | 9    |
| Hybrid app structure – HTML, CSS, JavaScript with WebView - Apache Cordova – plugins and native access - Ionic framework – UI toolkit and component structure - Integration with device features – camera, GPS, storage - Debugging and testing hybrid apps on emulators and devices - Performance considerations and offline support-Enterprise applications – hybrid use cases.                                                                                                               |                                                                                                                              |                        |                           |   |     |      |
| Unit – 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | CROSS-PLATFORM APP DEVELOPMENT                                                                                               |                        |                           |   | CO4 | 9    |
| Cross-platform frameworks – need and comparison - React Native – components, JSX, props, state - Flutter – Dart basics, widgets, state management -Navigation and routing in mobile apps - Hot reload and debugging techniques -Platform-specific code in cross-platform apps - Integration with REST APIs and Firebase – Overview.                                                                                                                                                             |                                                                                                                              |                        |                           |   |     |      |
| Unit – 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | NON-FUNCTIONAL ASPECTS AND DEPLOYMENT STRATEGIES                                                                             |                        |                           |   | CO5 | 9    |
| Framework comparison – performance, flexibility, and scalability - App performance – rendering, responsiveness, startup time - Debugging and profiling tools – Android Debug Bridge, Flutter DevTools, React DevTools - Time-to-market and maintainability - UI/UX consistency – Material Design, Human Interface Guidelines - CI/CD pipelines – GitHub Actions, Fastlane - Version control, build automation, and testing workflows - Basics of analytics, crash reporting, and user feedback. |                                                                                                                              |                        |                           |   |     |      |
| Total Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                              |                        |                           |   |     | 45   |
| Textbooks:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                              |                        |                           |   |     |      |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Griffiths, Dawn, and David Griffiths. Head first android development: a brain-friendly guide. " O'Reilly Media, Inc.", 2017. |                        |                           |   |     |      |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Camden, Raymond K. Apache Cordova in action. Simon and Schuster, 2015.                                                       |                        |                           |   |     |      |

|                         |                                                                                                                                                                |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3                       | Abbott, Devin, et al. "Fullstack React Native." (2017).                                                                                                        |
| <b>Reference Books:</b> |                                                                                                                                                                |
| 1                       | Horton, John. Android programming for beginners. Packt Publishing Ltd, 2015.                                                                                   |
| 2                       | Lewis, Shaun, and Mike Dunn. Native mobile development: a cross-reference for iOS and Android. O'Reilly Media, 2019.                                           |
| 3                       | Lingras, Rucha, Matt Triff, and Rucha Lingras. Building Cross-Platform Mobile and Web Apps for Engineers and Scientists. Cengage Learning, Incorporated, 2016. |
| 4                       | Wargo, John M. Apache Cordova 4 Programming. Pearson Education, 2015.                                                                                          |
| 5                       | Ward, Dan. React Native Cookbook: Recipes for solving common React Native development problems. Packt Publishing Ltd, 2019.                                    |
| <b>Web References:</b>  |                                                                                                                                                                |
| 1.                      | <a href="https://onlinecourses.swayam2.ac.in/e-learning/preview/nou22_ge25">https://onlinecourses.swayam2.ac.in/e-learning/preview/nou22_ge25</a>              |
| 2.                      | <a href="https://onlinecourses.nptel.ac.in/noc20_cs52/preview">https://onlinecourses.nptel.ac.in/noc20_cs52/preview</a>                                        |

| Assessment based on Continuous and End Semester Examination |                       |                   |                         |                          |                          |                                        |
|-------------------------------------------------------------|-----------------------|-------------------|-------------------------|--------------------------|--------------------------|----------------------------------------|
| Bloom's Level                                               | Continuous Assessment |                   |                         | Assignment<br>(10 Marks) | Attendance<br>(10 Marks) | End Semester Examination<br>(60 Marks) |
|                                                             | CIA1<br>(6 Marks)     | CIA2<br>(6 Marks) | Model Exam<br>(8 Marks) |                          |                          |                                        |
| Remember                                                    |                       |                   |                         | 10                       | 10                       | 60                                     |
| Understand                                                  | 80                    | 100               | 20                      |                          |                          |                                        |
| Apply                                                       | 20                    |                   | 80                      |                          |                          |                                        |
| Analyze                                                     |                       |                   |                         |                          |                          |                                        |
| Evaluate                                                    |                       |                   |                         |                          |                          |                                        |
| Create                                                      |                       |                   |                         | 10                       | 10                       | 60                                     |
| <b>Total (100 Marks)</b>                                    | <b>6</b>              | <b>6</b>          | <b>8</b>                |                          |                          |                                        |

- CIA1, CIA 2 and Model Exam will be conducted for 50, 50 and 100 marks. It shall be subsequently converted to 6, 6 and 8 marks respectively.
- The Assignment marks will be computed based on Assignment I, Assignment II and Assignment III marks converted to 10 Marks.
- BTL mark split up may vary based on the nature of the subject.

| COs/<br>POs | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO<br>10 | PO<br>11 | PSO<br>1 | PSO<br>2 | PSO<br>3 |
|-------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|
| OE615.1     | 3       | 2       | 1       | 1       | 1       | -       | -       | -       | -       | -        | 1        | 2        | 1        | 1        |
| OE615.2     | 3       | 2       | 3       | 1       | 3       | -       | -       | -       | -       | -        | 1        | 2        | 2        | 3        |
| OE615.3     | 3       | 3       | 2       | 2       | 3       | -       | -       | -       | -       | -        | 2        | 2        | 3        | 3        |
| OE615.4     | 3       | 3       | 2       | 2       | 2       | -       | -       | -       | -       | -        | 2        | 3        | 3        | 2        |
| OE615.5     | 3       | 2       | 2       | 2       | 3       | -       | -       | -       | -       | -        | 3        | 3        | 3        | 3        |

1 - low, 2 - medium, 3 - high, '-' - no correlation