



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



DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE CURRICULUM & SYLLABUS REGULATION 2024



5th & 6th Semester

BATCH : 2024 - 28, 2025 - 29

CREDITS : 170

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INSTITUTE VISION AND MISSION

VISION

Strive to promote Excellence in Engineering Education and Research by developing our students as Real-Time Problem solvers thereby contributing to the Societal needs

MISSION

- Promote excellence in Core and allied studies through Technology enabled Teaching and active learning practices
- Develop multi-talented and committed human resources by providing research and development environment to innovate and find solutions for Real-Time Problems.
- Create socially responsible engineers with team-spirit / entrepreneurs with necessary leadership skills thus contributing towards a better world.

CORE VALUES

- Our motto is to serve the society through producing responsible citizens by imparting integrity and ethics
- We strongly believe in inclusivity and consider every stake holder as responsible to set benchmark in each of our activities
- Our faculty members exhibit excellent team-spirit and achieve excellence in each of our curricular, co-curricular and extra-curricular activities.
- We see every student of our Institution as a problem solver and our start-up studios help them to become entrepreneurs and provide solutions for the societal needs
- We promote the sense of social responsibilities in students by providing ample opportunities to participate in various social activities
- We create an eco-system where every faculty member and student accepts responsibility for personal and professional growth and development.

DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

VISION

- To empower students as global leaders in innovative and transformative fields of Artificial Intelligence and Data Science, fostering groundbreaking discoveries that impact society and address real-world challenges.

MISSION

- To impart high quality education with strong fundamentals by continuously evolving teaching and learning methodologies by using cutting-edge technology.
- To provide a knowledge Centre of Artificial Intelligence and Data Science with a never-ending desire to learn through the growth, maintenance, innovation of computing, and continuous improvement of Data Science.
- To equip students with interdisciplinary skill sets to meet the new advancement in high performance computing provides dynamic and promising careers in emerging technologies and research endeavours.

PROGRAM EDUCATIONAL OBJECTIVES

1	The graduates will possess exceptional engineering knowledge to overcome the challenges in developing solutions in the field of Artificial Intelligence and Data Science
2	The graduates will be technically skilled to adapt to the innovations taking place in the ever growing area of automation through artificial Intelligence
3	To graduates will demonstrate professional capabilities and motivation for sustaining life long career.

PROGRAM OUTCOMES (POs)

PO	Graduate Attribute
1	Engineering Knowledge: 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	Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.
3	Design/Development of Solutions: 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.
4	Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

5	Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.
6	The Engineer and The World: 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.
7	Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.
8	Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
9	Communication: 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	Project Management and Finance: 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	Life-Long Learning: 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.

PROGRAM SPECIFIC OUTCOMES (PSOs)

- Evolve AI based efficient domain specific processes for effective decision making in several domains such as business and governance domains.
- Create, Select and Apply the theoretical knowledge of AI and Data Analytics along with practical industrial tools and techniques to manage and solve societal problems
- Develop data analytics and data visualization skills, skills pertaining to knowledge acquisition, knowledge representation and knowledge engineering, and hence be capable of coordinating complex projects.

SCHEME OF CREDIT DISTRIBUTION

S. No.	Stream	Credits/Semester								Total Credits
		I	II	III	IV	V	VI	VII	VIII	
1	Humanities (HSM)	3	3	0	0	0	3	2	0	11
2	Basic Sciences(BS)	8	8	4	4	0	0	0	0	24
3	Engineering Sciences(ES)	8	10	0	9	3	0	4	0	34
4	Program Core(PC)	0	0	19	14	12	11	4	0	60
5	Professional Electives(PE)	0	0	0	0	3	3	9	0	15
6	Open Electives(OE)	0	0	0	0	3	6	3	0	12
7	Project Work(PW)	0	0	0	0	0	0	0	12	12
8	Industry Practices (IP)	0	0	0	0	0	2	0	0	2
9	Mandatory Course (MC)	0	0	0	0	0	0	0	0	-
Total		19	21	23	27	21	25	22	12	170

SCHEME OF COURSE DISTRIBUTION

Stream	No. of Courses								Total No. of courses
	I	II	III	IV	V	VI	VII	VIII	
Humanities (HS)	1	1	0	0	0	1	1	0	4
Basic Sciences(BS)	2	2	1	1	0	0	0	0	6
Engineering Sciences(ES)	3	4	0	3	1	0	1	0	12
Program Core(PC)	0	0	7	5	4	3	1	0	20
Program Electives(PE)	0	0	0	0	1	1	3	0	5
Open Electives(OE)	0	0	0	0	1	2	1	0	4
Project Work(PW)	0	0	0	0	0	0	0	1	1
Industry Practices (IP)	0	0	0	0	0	1	0	0	1
Mandatory Course (MC)	1	1	1	1	0	0	0	0	4
Total	7	8	9	10	7	8	7	1	57

CURRICULUM

SEMESTER I							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credits	Ext/Int	Category
THEORY							
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	ES
THEORY CUM PRACTICAL							
3	24AC213	Chemistry for Computing Sciences	3/0/2	5	4	40/60	BS
4	24HS114	Technical English	2/0/2	4	3	40/60	HS
5	24EG315	Engineering Graphics	1/0/4	5	3	40/60	ES
PRACTICAL							
6	24CS316	Programming in C Laboratory	0/0/4	4	2	40/60	ES
MANDATORY COURSE							
7	24MC901	Mandatory Course I Induction program	3 Weeks Program		0	0	MC
Total			12/1/12	25	19	600	

SEMESTER II							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credits	Ext/Int	Category
THEORY							
1	24MA221	Differential Equations and Complex Functions	3/1/0	4	4	60/40	BS
2	24EE312	Basic Electrical and Electronics Engineering	3/0/0	3	3	60/40	ES
3	24CS423	Object Oriented Programming and Java	3/0/0	3	3	60/40	ES
THEORY CUM PRACTICAL							
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
PRACTICAL							
6	24EP315	Engineering Practices Laboratory	0/0/4	4	2	40/60	ES
7	24CS427	Object Oriented Programming and Java Laboratory	0/0/4	4	2	40/60	ES
MANDATORY COURSE							
8	24MC902	Mandatory Course II Heritage of Tamils	2/0/0	2	0	0	MC
Total			16/1/12	29	21	700	

SEMESTER III							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credits	Ext/Int	Category
THEORY							
1	24MA231	Discrete Mathematics	3/1/0	4	4	60/40	BS
2	24AD432	Artificial Intelligence I	3/0/0	3	3	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
THEORY CUM PRACTICAL							
5	24AD435	Data Exploration and Visualization	3/0/2	5	4	40/60	PC
PRACTICAL							
6	24AD436	Artificial Intelligence I Laboratory	0/0/4	4	2	40/60	PC
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
MANDATORY COURSE							
9	24MC903	Mandatory Course III Environmental Science and Sustainability	2/0/0	2	0	0	MC
Total			17/1/14	32	23	800	

SEMESTER IV							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credits	Ext/Int	Category
THEORY							
1	24MA242	Probability and Statistics	3/1/0	4	4	60/40	BS
2	24AM442	Machine Learning	3/0/0	3	3	60/40	PC
3	24AD443	Fundamentals of Data Science and Analytics	3/0/0	3	3	60/40	PC
4	24CC344	Database Design and Management	3/0/0	3	3	60/40	ES
THEORY CUM PRACTICAL							
5	24CS456	Computer Networks	3/0/2	5	4	40/60	PC
6	24EC336	Digital Principles and Computer Organization	3/0/2	5	4	40/60	ES
PRACTICAL							
7	24AM447	Machine Learning Laboratory	0/0/4	4	2	40/60	PC
8	24AD448	Data Science and Analytics Laboratory	0/0/4	4	2	40/60	PC
9	24CC349	Database Design and Management Laboratory	0/0/4	4	2	40/60	ES
MANDATORY COURSE							
10	24MC904	Mandatory Course IV Introduction to Women and Gender Studies	2/0/0	2	0	0	MC
Total			20/1/16	37	27	900	

SEMESTER V							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credits	Ext/Int	Category
THEORY							
1	24AD451	Deep Learning	3/0/0	3	3	60/40	PC
2	24AD452	Network Security	3/0/0	3	3	60/40	PC
3	24CS442	Operating Systems	3/0/0	3	3	60/40	ES
4	24XX5XX	Professional Elective I	3/0/0	3	3	60/40	PE
5	24OE6XX	Open Elective I	3/0/0	3	3	60/40	OE
THEORY CUM PRACTICAL							
6	24CS356	Cloud Computing	3/0/2	5	4	40/60	PC
PRACTICAL							
7	24AD457	Deep Learning Laboratory	0/0/4	4	2	40/60	PC
Total			18/0/6	24	21	700	

SEMESTER VI							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credits	Ext/Int	Category
THEORY							
1	24AD461	Artificial Intelligence II	3/0/0	3	3	60/40	PC
2	24MB151	Principles of Management	3/0/0	3	3	60/40	HS
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
THEORY CUM PRACTICAL							
6	24AD466	Computer Vision	3/0/2	5	4	40/60	PC
7	24AD467	Big Data Analytics	3/0/2	5	4	40/60	PC
Internship							
8	24AD861	Internship	0/0/0	0	2	0/100	IP
Total			21/0/4	25	25	800	

SEMESTER VII							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credits	Ext/Int	Category
THEORY							
1.	24HS171	Human Values and Ethics	2/0/0	2	2	60/40	HS
2.	24XX5XX	Professional Elective III	3/0/0	3	3	60/40	PE
3.	24XX5XX	Professional Elective IV	3/0/0	3	3	60/40	PE

4.	24XX5XX	Professional Elective V	3/0/0	3	3	60/40	PE
5.	24OE6XX	Open Elective IV	3/0/0	3	3	60/40	OE
THEORY CUM PRACTICAL							
6.	24EC366	Embedded Systems and Internet of Things	3/0/2	5	4	40/60	ES
7.	24AD477	Quantum Computing	3/0/2	5	4	40/60	PC
Total			20/0/4	24	22	700	

SEMESTER VIII							
S No.	Course Code	Course	L/T/P	Contact hrs/week	Credits	Ext/Int	Category
PRACTICAL							
1.	24AD781	Project Work	0/0/24	24	12	40/60	PW
Total			0/0/24	24	12	100	

PROFESSIONAL ELECTIVE COURSES

Vertical I	Vertical II	Vertical III	Vertical IV	Vertical V
ANALYTICS ENGINEERING	FULL STACK DEVELOPMENT	CLOUD COMPUTING AND DATA CENTER TECHNOLOGIES	EMERGING TECHNOLOGIES	LANGUAGE MODELLING
Exploratory Data Analysis	Web Technology	Data Warehousing	Augmented Reality/Virtual Reality	Linguistics Engineering
Image and Video Analytics	App Development	Cloud Services Management	Robotic Process Automation	Soft Computing
Healthcare Analytics	Software Testing and Automation	Virtualization	Cyber Security	Cognitive Science
Text and Speech Analysis	Web Application Security	Security and Privacy in Cloud	Cryptocurrency and Blockchain Technology	Ethical Hacking
Business Analytics	Principles of programming Languages	Storage Technology	Video Creation and Editing	Optimization Techniques
Ethics and Artificial Intelligence	Advanced Databases	Stream Processing	Digital Marketing	Recommender Systems

MANDATORY COURSES (Non-Credit)

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits
1.	24MC901	Induction program	3 Weeks Program	2	0
2.	24MC902	Heritage of Tamils	2/0/0	2	0
3.	24MC903	Environmental Sciences and Sustainability	2/0/0	2	0
4.	24MC904	Introduction to Women and Gender Studies	2/0/0	2	0

OPEN ELECTIVE COURSES (15 Credits)

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits
1.	24OE601	Text Analytics	3/0/0	3	3
2.	24OE602	Introduction to Artificial Intelligence	3/0/0	3	3
3.	24OE603	Health Informatics	3/0/0	3	3
4.	24OE604	Management Analytics	3/0/0	3	3
5.	24OE605	Data Science Essentials	3/0/0	3	3

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.	24AC213	Chemistry for Computing sciences	3/0/2	5	4
3.	24MA221	Differential Equations and Complex functions	3/1/0	4	4
4.	24AP225	Physics for Computing sciences	3/0/2	5	4
5.	24MA231	Discrete Mathematics	3/1/0	4	4
6.	24MA242	Probability and Statistics	3/1/0	4	4

ENGINEERING SCIENCES (34 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.	24EG315	Engineering Graphics	1/0/4	5	3
3.	24CS316	Programming in C Laboratory	0/0/4	4	2
4.	24EE312	Basic Electrical and Electronics Engineering	3/0/0	3	3
5.	24CS423	Object Oriented Programming and Java	3/0/0	3	3
6.	24EP315	Engineering Practices Laboratory	0/0/4	4	2
7.	24CS427	Object Oriented Programming and Java Laboratory	0/0/4	4	2
8.	24CC344	Database Design and Management	3/0/0	3	3
9.	24EC336	Digital Principles and Computer Organization	3/0/2	5	4
10.	24CC349	Database Design and Management Laboratory	0/0/4	4	2
11.	24CS442	Operating Systems	3/0/0	3	3
12.	24EC366	Embedded Systems and Internet of Things	3/0/2	5	4

PROGRAM CORE (60 Credits)

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits
1.	24AD432	Artificial Intelligence I	3/0/0	3	3
2.	24CS433	Python Programming	3/0/0	3	3
3.	24CC336	Data Structures and Algorithms	3/0/0	3	3
4.	24AD435	Data Exploration and Visualization	3/0/2	5	4
5.	24AD436	Artificial Intelligence I Laboratory	0/0/4	4	2
6.	24CS437	Python Programming Laboratory	0/0/4	4	2
7.	24CS339	Data Structures and Algorithms Laboratory	0/0/4	4	2
8.	24AM442	Machine Learning	3/0/0	3	3
9.	24AD443	Fundamentals of Data Science and Analytics	3/0/0	3	3
10.	24CS456	Computer Networks	3/0/2	5	4
11.	24AM447	Machine Learning Laboratory	0/0/4	4	2
12.	24AD448	Data Science and Analytics Laboratory	0/0/4	4	2
13.	24AD451	Deep Learning	3/0/0	3	3
14.	24AD452	Network Security	3/0/0	3	3
15.	24CS356	Cloud Computing	3/0/2	5	4
16.	24AD457	Deep Learning Laboratory	0/0/4	4	2
17.	24AD461	Artificial Intelligence II	3/0/0	3	3
18.	24AD466	Computer Vision	3/0/2	5	4
19.	24AD467	Big Data Analytics	3/0/2	5	4
20.	24AD477	Quantum Computing	3/0/2	5	4

PROFESSIONAL ELECTIVE COURSES

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits
VERTICAL I: ANALYTICS ENGINEERING					
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
VERTICAL II: FULL STACK DEVELOPMENT					
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
VERTICAL III: CLOUD COMPUTING AND DATA CENTER TECHNOLOGIES					
13.	24CS507	Data Warehousing	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
VERTICAL IV: EMERGING TECHNOLOGIES					
19.	24AD508	Augmented Reality/Virtual Reality	3/0/0	3	3
20.	24AD509	Robotic Process Automation	3/0/0	3	3
21.	24AD510	Cyber Security	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
VERTICAL V: LANGUAGE MODELLING					
25.	24AM506	Linguistics Engineering	3/0/0	3	3
26.	24AM507	Soft Computing	3/0/0	3	3
27.	24AM508	Cognitive Science	3/0/0	3	3
28.	24AM509	Ethical Hacking	3/0/0	3	3
29.	24AM510	Optimization Techniques	3/0/0	3	3
30.	24AM511	Recommender Systems	3/0/0	3	3

INDUSTRY PRACTICES (2 Credits)

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits
1.	24AD861	Internship	0/0/0	-	2

PROJECT WORK (12 Credits)

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits
1.	24AD781	Project Work	0/0/24	24	12

SYLLABUS OF FIFTH SEMESTER

Course Code	Course Name	Category	Hours/Week			C	
			L	T	P		
24AD451	Deep Learning	PC	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)					
Machine Learning		Deep Learning Lab					
Course Objectives							
1	To understand and need and principles of deep neural network						
2	To understand CNN and RNN architectures of deep neural networks						
3	To comprehend advanced deep learning models						
4	To learn the evaluation metrics for deep learning models						
5	To know about Auto Encoders and Generative models						
Course Outcomes							
Upon completion of the course, students will be able to							
C451.1	Explain the basics in deep neural networks					[U]	
C451.2	Apply Convolution Neural Network for image processing					[AP]	
C451.3	Apply Recurrent Neural Network and its variants for text analysis					[AP]	
C451.4	Apply model evaluation for various applications					[AP]	
C451.5	Apply auto-encoders and generative models for suitable applications					[AP]	
Course Contents							
Unit – 1	DEEP NETWORKS BASICS					C01	9 Hrs
Linear Algebra: Scalars -- Vectors -- Matrices and tensors; Probability Distributions -- Gradient-based Optimization -- Machine Learning Basics: Capacity -- Overfitting and underfitting --Hyperparameters and validation sets -- Estimators -- Bias and variance -- Stochastic gradient descent -- Back propagation - Challenges motivating deep learning; Deep Networks: Deep feedforward networks; Regularization -- Optimization.							
Unit – 2	CONVOLUTIONAL NEURAL NETWORKS					C02	9 Hrs
Convolution Operation -- Sparse Interactions -- Parameter Sharing -- Equivariance -- Pooling -- Convolution Variants: Strided -- Tiled -- Transposed and dilated convolutions; CNN Learning: Nonlinearity Functions -- Loss Functions -- Regularization -- Optimizers --Gradient Computation.							
Unit – 3	RECURRENT NEURAL NETWORKS					C03	9 Hrs
Unfolding Graphs -- RNN Design Patterns: Acceptor -- Encoder --Transducer; Gradient Computation -- Sequence Modeling Conditioned on Contexts -- Bidirectional RNN -- Sequence to Sequence RNN – Deep Recurrent Networks -- Recursive Neural Networks -- Long Term Dependencies; Leaky Units: Skip connections and dropouts; Gated Architecture: LSTM.							
Unit – 4	MODEL EVALUATION					C04	9 Hrs
Performance metrics -- Baseline Models -- Hyperparameters: Manual Hyperparameter -- Automatic Hyperparameter -- Grid search -- Random search -- Debugging strategies.							
Unit – 5	AUTOENCODERS AND GENERATIVE MODELS					C05	9 Hrs
Autoencoders: Undercomplete autoencoders -- Regularized autoencoders -- Stochastic encoders and decoders -- Learning with autoencoders; Deep Generative Models: Variational autoencoders – Generative adversarial networks.							
Total Hours						45	
Textbooks:							
1	Ian Goodfellow, Yoshua Bengio, Aaron Courville, ``Deep Learning'', MIT Press, 2016						
2	Andrew Glassner, “Deep Learning: A Visual Approach”, No Starch Press, 2021.						
3	Josh Patterson, Adam Gibson, ``Deep Learning: A Practitioner's Approach'', O'Reilly Media, 2017.						
Reference Books:							
1	Salman Khan, Hossein Rahmani, Syed Afaq Ali Shah, Mohammed Bennamoun, ``A Guide to Convolutional Neural Networks for Computer Vision'', Synthesis Lectures on Computer Vision, Morgan & Claypool publishers. 2018.						

2	Yoav Goldberg, "Neural Network Methods for Natural Language Processing", Synthesis Lectures on Human Language Technologies, Morgan & Claypool publishers, 2017.
3	Francois Chollet, "Deep Learning with Python", Manning Publications Co, 2018
4	Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer International Publishing, 2018.
Web References:	
1	https://www.deeplearning.ai/
2	https://nptel.ac.in/courses/106106184

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						
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/ 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
C451.1	3	2	2	3	2	-	-	-	-	-	2	3	3	3
C451.2	3	2	2	3	2	-	-	-	-	-	2	3	3	3
C451.3	3	3	3	3	2	-	-	-	-	-	2	3	3	3
C451.4	3	3	1	1	2	-	-	-	-	-	2	3	3	3
C451.5	3	2	2	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		
24AD452	NETWORK SECURITY	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)					
Computer Networking		--					
Course Objectives							
1	To learn the fundamentals of cryptography.						
2	To learn the key management techniques and authentication approaches.						
3	To explore the network and transport layer security techniques.						
4	To understand the application layer security standards.						
5	To learn the real time security practices.						
Course Outcomes							
Upon completion of the course, students will be able to							
C452.1	Classify the encryption techniques					[U]	
C452.2	Illustrate the key management technique and authentication.					[AP]	
C452.3	Use the security techniques applied to network and transport layer					[AP]	
C452.4	Examine the application layer security standards.					[AP]	
C452.5	Apply security practices for real time applications.					[AP]	
Course Contents							
UNIT I	INTRODUCTION					C01	9 Hrs
Basics of cryptography, The OSI Security Architecture, Security Attacks, Security Services and Security Mechanisms, A model for Network security, conventional and public-key cryptography, hash function, authentication, and digital signatures.							
UNIT II	KEY MANAGEMENT AND AUTHENTICATION DESCRIPTIVE ANALYTICS					C02	9 Hrs
Key Management and Distribution: Symmetric Key Distribution, Distribution of Public Keys, X.509 Certificates, Public-Key Infrastructure. User Authentication: Remote User-Authentication Principles, Remote User-Authentication Using Symmetric Encryption, Kerberos Systems, Remote User Authentication Using Asymmetric Encryption.							
UNIT III	ACCESS CONTROL AND SECURITY					C03	9 Hrs
Network Access Control: Network Access Control(NAC), Extensible Authentication Protocol(EAP), IEEE 802.1X Port-Based Network Access Control - IP Security(IPSec)- Authentication Header (AH), Encapsulating Security Payload (ESP)- Internet Key Exchange (IKE). Transport-Level Security: Web Security Considerations, Secure Sockets Layer (SSL), Transport Layer Security (TLS), HTTPS standard, Secure Shell (SSH) application, Packet Capturing and Network Traffic Analysis using Wireshark, Port Scanning and Network Monitoring using Nmap and tcpdump, SSL/TLS Handshake Analysis, VPN Traffic Inspection and Secure Remote Access Monitoring using Network Security Tools.							
UNIT IV	APPLICATION LAYER SECURITY					C04	9 Hrs
Electronic Mail Security: Pretty Good Privacy, S/MIME, Domain Keys Identified Mail. Wireless Network Security: Mobile Device Security, Electronic passports and ID cards, SDA/DDA/CDA Bank Cards.							
UNIT V	SECURITY PRACTICES					C05	9 Hrs
Firewalls and Intrusion Detection Systems: Intrusion Detection Password Management, Firewall Characteristics Types of Firewalls, Firewall Basing, Firewall Location and Configurations. Blockchains, Cloud Security and IoT security.							
Total Hours						45	
Textbooks:							
1	Cryptography and Network Security: Principles and Practice, 6th Edition, William Stallings, 2014, Pearson, ISBN 13:9780133354690.						
2	Network Security: Private Communications in a Public World, M. Speciner, R. Perlman, C. Kaufman, Prentice Hall, 2002.						
3	Bragg et al., Network security – The complete reference, Tata Mc Graw Hill, 2012.						

Reference Books:	
1	Bernard Menezes , “Network Security and Cryptography”, Cengage Learning India, Third impression, 2014.
2	Linux iptables Pocket Reference, Gregor N. Purdy, O'Reilly, 2004, ISBN-13: 978- 0596005696.
3	Linux Firewalls, by Michael Rash, No Starch Press, October 2007, ISBN: 978-1-59327-141- 1.
4	Network Security, Firewalls And VPNs, J. Michael Stewart, Jones & Bartlett Learning, 2013, ISBN-10: 1284031675, ISBN-13: 978-1284031676.
Web References:	
1	https://onlinecourses.nptel.ac.in/noc25_ee54/preview
2	https://www.coursera.org/learn/-network-security

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						
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/ 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
C452.1	3	3	2	2	-	-	-	-	-	-	2	2	3	2
C452.2	3	3	3	2	-	-	-	-	-	-	2	3	2	2
C452.3	3	2	3	3	-	-	-	-	-	-	2	2	2	3
C452.4	2	2	3	2	-	-	-	-	-	-	2	2	2	3
C452.5	2	3	3	2	-	-	-	-	-	-	2	2	2	2

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

Course Code	Course Name	Category	Hours/Week			C	
			L	T	P		
24CS345	OPERATING SYSTEMS	PC	3	0	0	3	
Pre-requisite Course(s)		Co-requisite Course(s)					
Computer System Organization		Fundamentals of Computer Science					
Course Objectives							
1.	To understand the functions of operating systems.						
2.	To understand various scheduling algorithms and process management.						
3.	To analyze various memory management schemes.						
4.	To be familiar with I/O management and File systems.						
5.	To be familiar with the basics of virtual machines and Mobile OS like iOS and Android.						
Course Outcomes							
Upon completion of the course, students will be able to							
C345.1	Understand architecture and functions of operating systems.					U	
C345.2	Describe process management, deadlock handling methods					U	
C345.3	Demonstrate storing techniques and page replacement algorithms					AP	
C345.4	Examine various file systems I/O systems handling techniques					AP	
C345.5	Illustrate the features of mobile operating systems.					AP	
Course Contents							
Unit – 1	INTRODUCTION TO OPERATING SYSTEM					C01	9
Computer System - Elements and organization; Operating System Overview - Objectives and Functions - Evolution of Operating System; Operating System Structures – Operating System Services - User Operating System Interface - System Calls – System Programs - Design and Implementation - Structuring methods.							
Unit – 2	PROCESS MANAGEMENT					C02	9
Processes - Process Concept - Process Scheduling - Operations on Processes - Inter-process Communication; CPU Scheduling - Scheduling criteria - Scheduling algorithms: Process Synchronization - The critical-section problem - Synchronization hardware – Semaphores – Mutex - Classical problems of synchronization - Monitors; Deadlock - Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from deadlock.							
Unit – 3	MEMORY MANAGEMENT					C03	9
Main Memory - Swapping - Contiguous Memory Allocation – Paging - Structure of the Page Table - Segmentation, Segmentation with paging; Virtual Memory - Demand Paging – Copy on Write - Page Replacement - Allocation of Frames –Thrashing.							
Unit – 4	STORAGE MANAGEMENT					C04	9
Mass Storage system – Disk Structure - Disk Scheduling and Management; File-System Interface - File concept - Access methods - Directory Structure - Directory organization - File system mounting - File Sharing and Protection; File System Implementation - File System Structure - Directory implementation - Allocation Methods - Free Space							

Management; I/O Systems – I/O Hardware, Application I/O interface, Kernel I/O subsystem.			
Unit – 5	VIRTUAL MACHINES AND MOBILE OS	C05	9
Virtual Machines – History, Benefits and Features, Building Blocks, Types of Virtual Machines and their Implementations, Virtualization and Operating-System Components; Mobile OS - iOS and Android.			
Total Hours			45
Textbooks:			
1	Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, “Operating System Concepts”, 9 th Edition, John Wiley and Sons Inc., 2018.		
2	Andrew S Tanenbaum, "Modern Operating Systems", Pearson, 4th Edition, New Delhi, 2016.		
Reference Books:			
1	Ramaz Elmasri, A. Gil Carrick, David Levine, “Operating Systems – A Spiral Approach”, Tata McGraw Hill Edition, 2010.		
2	William Stallings, "Operating Systems: Internals and Design Principles", 7th Edition, Prentice Hall, 2018.		
3	Achyut S.Godbole, Atul Kahate, “Operating Systems”, McGraw Hill Education, 2016.		
Web References:			
1	https://www.geeksforgeeks.org/		
2	https://www.tpointtech.com/		
3	https://www.tutorialspoint.com/		

Assessment based on Continuous and End Semester Examination						
Bloom's Level	Continuous Assessment			ASSIGNMENT	ATTENDANCE	End Semester Examination (60 Marks)
	CIA1 (6 Marks)	CIA2 (6 Marks)	Model Exam (8 Marks)	(10 Marks)	(10 Marks)	
Remember				10	10	60
Understand	100%		40%			
Apply		100%	60%			
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/ 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
C345.1	3	3	3	3	-	-	-	-	-	-	2	3	3	3
C345.2	3	3	3	3	-	-	-	-	-	-	2	3	3	3
C345.3	3	3	3	3	-	-	-	-	-	-	2	3	3	3
C345.4	3	3	3	3	-	-	-	-	-	-	2	3	3	3
C345.5	3	3	3	3	-	-	-	-	-	-	2	3	3	3

Course Code	Course Name	Category	Hours/Week			C	
			L	T	P		
24CS356	CLOUD COMPUTING	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)					
-		-					
Course Objectives							
1	To understand the fundamentals and architecture of cloud computing.						
2	To explore virtualization technologies and cloud platforms.						
3	To implement cloud storage, containerization, and orchestration.						
4	To analyze cloud security mechanisms and risk management.						
5	To examine modern cloud technologies including Hadoop, Fog and Edge computing.						
Course Outcomes							
Upon completion of the course, students will be able to							
C356.1	Explain cloud computing models, architecture and deployment strategies					[U]	
C356.2	Apply virtualization and cloud platform concepts					[AP]	
C356.3	Implement cloud storage and containerized applications					[AP]	
C356.4	Configure cloud security protection mechanisms					[AP]	
C356.5	Deploy Hadoop and demonstrate concepts of Federation, Fog and Edge computing					[AP]	
Course Contents							
Unit – 1	CLOUD COMPUTING BASICS					CO1	9+3
Introduction to Cloud Computing – Evolution of Cloud Computing – Cloud Types – Cloud Characteristics – NIST Reference Cloud Architecture – Architectural Design Challenges – Cloud Computing Stack – Deployment models – Service Models – Benefits of Cloud Computing							
PRACTICAL:							
1. Study and comparison of cloud service models (IaaS, PaaS, SaaS)							
Unit – 2	VIRTUALIZATION AND PLATFORMS					CO2	9+9
Abstraction and Virtualization – Virtualization Structures and Mechanisms – Virtualization of CPU, Memory and I/O Devices – Types of CPU Virtualization – Virtualization Support and Disaster Recovery – Cloud Platforms – Features of Cloud Platforms – Overview of Open-source Platforms – Eucalyptus and OpenNebula – An Insight into OpenStack Architecture and Components							
PRACTICAL:							
2. Install Virtualbox/VMware/ Equivalent open source cloud Workstation with different flavours of Linux or Windows OS on top of windows 8 and above.							
3. Install a C compiler in the virtual machine created using a virtual box and execute Simple Programs							
4. Find a procedure to transfer the files from one virtual machine to another virtual machine.							
Unit – 3	CLOUD STORAGE AND CONTAINERS					CO3	9+6
Introduction to Cloud Storage – Digital Universe – Provisioning Cloud Storage – Unmanaged and Managed Cloud Storage – Creating Cloud Storage Systems – Cloud Backup Types and Features – Cloud Attached Backup and Solutions – Cloud Storage Interoperability, CDMI, OCCL – Introduction to Containers – Kubernetes – Heroku and Docker Containers							
PRACTICAL:							
5. Install Docker and Deploy a Simple Application Using Docker Image							
6. Demonstrate Docker Volume Creation and Data Persistence							
Unit – 4	CLOUD SECURITY					CO4	9+4

Cloud Security Defense Strategies – Securing the Cloud & Data – Distributed Intrusion and Anomaly Detection – Data and Software Protection Techniques – Data Security in the Cloud – Current State and Future Trends in the Cloud – Cloud Security Risks – The Cloud, Digital Identity, and Data Security Standards – Establishing Identity and Presence in Cloud

PRACTICAL:

7. Implement User Access Control and File Permission Mechanism in Linux

Unit – 5	CLOUD TECHNOLOGIES AND ADVANCEMENTS	CO5	9+8
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Hadoop – Map Reduce – Google App Engine (GAE) – Programming Environment for GAE – OpenStack – Federation in the Cloud – Four Levels of Federation – Federated Services and Applications – Future of Federation – Introduction to Fog Computing – Introduction to Edge Computing

PRACTICAL:

8. Install Hadoop and Execute MapReduce Program

9. Develop and Deploy a Containerized Web Application in Virtualized Environment

Total Theory Hours **45**

Total Practical Hours **30**

Textbooks:

1	Dac-Nhuong Le, Raghvendra Kumar, Gia Nhu Nguyen, Jyotir Moy Chatterjee, "Cloud Computing and Virtualization", 2nd Edition, Wiley Publishers, 2018
2	Nick, Gillam, Lee, "Cloud Computing - Principles, Systems and Applications", 2nd Edition, Springer, 2017

Reference Books:

1	Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, "Mastering the Cloud Computing", Morgan Kaufmann, 2013
2	John W. Rittinghouse and James F. Ransome, "Cloud Computing: Implementation Management, and Security", CRC Press, 2016.
3	Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
4	Barrie Sosinsky, "Cloud Computing Bible", 1st Edition, Wiley Publishing, 2015

Web References:

1	NPTEL – Cloud Computing: https://onlinecourses.nptel.ac.in/noc26_cs55/preview/
2	Docker Official Documentation: https://docs.docker.com/
3	Kubernetes Official Documentation: https://kubernetes.io/docs/
4	OpenStack Documentation: https://docs.openstack.org/
5	Hadoop Documentation: https://hadoop.apache.org/docs/

BLOOM'S TAXONOMY LEVEL	ASSESSMENT-1			ASSESSMENT-2		ASSIGNMENT	ATTENDANCE	END SEMESTER EXAMINATION
	CIA1	CIA2	MODEL	LAB EXPERIM ENTS	MODEL LAB EXAM			
	6	6	8	10	10			
Remember				10	10	10	10	40
Understand	60		20					
Apply	40	100	80					
Analyze								
Evaluate								
Create								
Total (100Marks)	6	6	8	15	5	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
C356.1	3	2	2	2	2	-	-	-	2	2	2	2	2	2
C356.2	3	3	2	2	3	-	-	-	2	3	2	3	2	3
C356.3	3	3	3	2	3	-	-	-	3	3	2	3	3	3
C356.4	3	2	2	3	2	-	-	-	3	3	2	2	2	3
C356.5	2	2	2	2	2	-	-	-	3	3	2	2	2	3

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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24AD457	Deep Learning Laboratory	PC	0	0	4	2
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
2024	Laboratory		-----			
Pre-requisite Course(s)		Co-requisite Course(s)				
Machine Learning		Deep Learning				
Course Objectives						
1	To understand the tools and techniques to implement deep neural networks					
2	To apply different deep learning architectures for solving problems					
3	To implement generative models for suitable applications					
4	To learn to build and validate different models					
5	To develop real world solutions					
Course Outcomes						
Upon completion of the course, students will be able to						
C457.1	Apply deep neural network for simple problems					[AP]
C457.2	Apply Convolution Neural Network for image processing					[AP]
C457.3	Apply Recurrent Neural Network and its variants for text analysis					[AP]
C457.4	Apply generative models for data augmentation					[AP]
C457.5	Develop real-world solutions using suitable deep neural networks					[AP]
List of Experiments:						CO
1	Solving XOR problem using DNN					CO1
2	Character recognition using CNN					CO2
3	Face recognition using CNN					CO2
4	Language modeling using RNN					CO3
5	Sentiment analysis using LSTM					CO3
6	Parts of speech tagging using Sequence to Sequence architecture					CO4
7	Machine Translation using Encoder-Decoder model					CO4
8	Image augmentation using GANs					CO5
9	Study of activation functions and its role.					CO5
10	Mini-project on real world applications					CO5
Total Hours						60

BLOOM'S TAXONOMY LEVEL	ASSESSMENT		ATTENDANCE	END SEMESTER EXAMINATION
	EVALUATION OF LAB OBSERVATION, RECORD [75%]	MODEL LAB EXAM [25%]		
	38	12		
Remember			10	40
Understand				
Apply	100%	100%		
Analyze				
Evaluate				
Create				
Total (100 Marks)	38	12	10	40

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PS01	PS02	PS03
C457.1	3	3	3	3	3	-	-	-	-	-	2	3	3	3
C457.2	3	3	3	3	3	-	-	-	-	-	2	3	3	3
C457.3	3	3	3	3	3	-	-	-	-	-	2	3	3	3
C457.4	3	3	3	3	3	-	-	-	-	-	2	3	3	3
C457.5	3	3	3	3	3	-	-	-	-	-	2	3	3	3

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

SYLLABUS OF SIXTH SEMESTER

Course Code	Course Name	Category	Hours/Week			C	
			L	T	P		
24AD461	ARTIFICIAL INTELLIGENCE – II	PC	3	0	0	3	
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards				
2024	THEORY	VI	Nil				
Pre-requisite Course(s)		Co-requisite Course(s)					
ARTIFICIAL INTELLIGENCE – I		Nil					
Course Objectives							
1	To know the underlying structure behind intelligence mathematically.						
2	To know the logical implications in probabilistic Reasoning.						
3	To know the automated learning techniques.						
4	To explore the techniques in Reinforcement Learning.						
5	To explore artificial intelligence techniques for Robotics.						
Course Outcomes							
Upon completion of the course, students will be able to							
C461.1	Explain the probabilistic reasoning using Bayesian inference.					[U]	
C461.2	Apply appropriate Probabilistic reasoning techniques for solving uncertainty problems.					[AP]	
C461.3	Apply probabilistic models for various use cases.					[AP]	
C461.4	Apply Reinforcement Learning Techniques.					[AP]	
C461.5	Apply AI techniques for robotics.					[AP]	
Course Contents							
Unit – 1	PROBABILISTIC REASONING I					C01	9 Hrs
Acting under uncertainty – Bayesian inference – naïve bayes models Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks							
Unit – 2	PROBABILISTIC REASONING II					C02	9 Hrs
Probabilistic reasoning over time – time and uncertainty – inference in temporal models – Hidden Markov Models – Kalman filters – Dynamic Bayesian networks Probabilistic programming							
Unit – 3	DECISIONS UNDER UNCERTAINTY AND LEARNING PROBABILISTIC MODELS					C03	10 Hrs
Basis of utility theory – utility functions – Multiattribute utility functions – decision networks – value of information – unknown preferences.							
Statistical learning theory – maximum-likelihood parameter learning – naïve bayes models – generative and descriptive models – continuous models – Bayesian parameter learning – Bayesian linear regression –EM Algorithm – unsupervised clustering – Gaussian mixture models – learning HMM							
Unit – 4	REINFORCEMENT LEARNING					C04	9 Hrs
Learning from rewards – passive reinforcement learning – active reinforcement learning – generalization in reinforcement learning – policy search – inverse reinforcement learning – applications							
Unit – 5	ROBOTICS					C05	8 Hrs
Robots – robotic perception – planning movements – reinforcement learning in robotics – robotic frameworks -- applications of robotics Philosophy, ethics, and safety of AI – the future of AI							
Total Hours						45	
Textbooks:							
1	Stuart Russel and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Fourth Edition, Pearson Education, 2020.						
2	Dan W. Patterson, “Introduction to AI and ES”, Pearson Education, 2007						
Reference Books:							
1	Kevin Night, Elaine Rich, and Nair B., “Artificial Intelligence”, McGraw Hill, 2008						
2	Patrick H. Winston, "Artificial Intelligence", Third edition, Pearson Edition, 2006						
3	Deepak Khemani, “Artificial Intelligence”, Tata McGraw Hill Education, 2013						
Web References:							
1	https://www.ibm.com/think/topics/artificial-intelligence						
2	https://onlinecourses.nptel.ac.in/noc25_cs159/preview						

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%					
Apply	20%	100%	100%			
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/ 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
C461.1	3	2	2	3	2	-	-	-	-	-	2	3	3	3
C461.2	3	2	2	3	2	-	-	-	-	-	2	3	3	3
C461.3	3	3	3	3	2	-	-	-	-	-	2	3	3	3
C461.4	3	3	1	1	2	-	-	-	-	-	2	3	3	3
C461.5	3	2	2	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	
24MB151	PRINCIPLES OF MANAGEMENT		3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	THEORY	VII	-----			
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 motivate employees					
5	To acquire skills in coordination and controlling manpower and apply them in business scenario					
Course Outcomes						
Upon completion of the course, students will be able 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 th Edition, Tata McGraw Hill Education Pvt Ltd, NewDelhi (2023)					
2	Harold Knootz, Heinz Weinhrich, Essential of Management, 11 th Edition, Tata McGraw Hill Education Pvt Ltd, New Delhi. (2021)					

Reference Books:	
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)
Web References:	
1	https://file-dhaka.portal.gov.bd/uploads/0283d03a-254c-4b8c-9db4-4060c02f16c2/629/c3c/ee6/629c3cee6adc6386614665.pdf
2	https://www.freebookcentre.net/business-books-download/Introduction-to-Principles-of-Management.html
3	https://s3.amazonaws.com/lumenlearning/success/waymaker/Waymaker-Principles-of-Management_regexified.pdf

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				10	10	60
Understand	60%		20%			
Apply	40%	100%	80%			
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/ 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		
24AD466	COMPUTER VISION	PC	3	0	2	4	
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards				
2024	THEORY CUM PRACTICAL	VI	-				
Pre-requisite Course(s)		Co-requisite Course(s)					
-		-					
Course Objectives							
1	To understand the fundamental concepts related to Image formation and processing.						
2	To learn feature detection, matching and detection						
3	To become familiar with feature-based alignment and motion estimation						
4	To demonstrate skills on 3D reconstruction						
5	To Implement image-based rendering and recognition						
Course Outcomes							
Upon completion of the course, students will be able to							
C466.1	Describe mathematical principles and algorithms behind computer vision.					U	
C466.2	Implement feature detection, description and image segmentation techniques using Standard computer vision algorithms.					AP	
C466.3	Demonstrate geometric transformations, image alignment and motion estimation techniques					AP	
C466.4	Apply stereo vision and basic 3D reconstruction principles to estimate depth and Recover scene structure.					AP	
C466.5	Apply suitable recognition techniques in various applications.					AP	
Course Contents							
Unit – 1	IMAGE FORMATION AND LOW-LEVEL PROCESSING					CO1	8+4
Introduction to vision challenges - Classical filtering operations: mode, median, rank order filters - Gaussian filters - Geometric primitives and transformations - Photometric image formation - The digital camera - Point operators - Linear filtering - More neighborhood operators - Fourier transforms - Pyramids and wavelets - Geometric transformations - Global optimization.							
PRACTICAL: (4)							
1. Installation of OpenCV and environment setup							
2. Image loading, cropping, resizing and color conversion.							
3. Image Annotation – Drawing lines, text circle, rectangle, ellipse on images							
Unit – 2	FEATURE DETECTION AND SEGMENTATION					CO2	8+4
Points and Patches: Feature detectors, Feature descriptors, Feature Matching, Feature Tracking Edges: Edge detection, Edge linking – Lines : Successive approximation – Hough Transforms- Vanishing Points.- Region-based segmentation – Mean shift – Graph-cut and energy based methods.							
PRACTICAL: (4)							
4. Image Enhancement - Understanding Color spaces, color space conversion, Histogram equalization, Convolution, Image smoothing, Gradients, Edge Detection							
5. Image Features and Image Alignment – Image transforms – Fourier, Hough, Extract ORB							
6. Image segmentation using Graphcut							
Unit – 3	MOTION ESTIMATION AND ALIGNMENT					CO3	8+4
2D and 3D feature – based alignment – Pose estimation – Geometric intrinsic calibration – Constrained structure and motion - Translational alignment - Parametric motion - Spline-based motion - Optical flow – Layered motion – Global alignment – Compositing.							
PRACTICAL: (4)							

7. Image features, Feature matching, cloning, Feature matching based image alignment			
8. Pose estimation			
Unit – 4	3D VISION AND RECONSTRUCTION	CO4	8+4
Shape from X - Active rangefinding - Surface representations - Point-based representations- Volumetric representations - Model-based reconstruction - Recovering texture maps and albedos.			
PRACTICAL (3)			
9. 3D Reconstruction – Creating Depth map from stereo images			
Unit – 5	RECOGNITION	CO5	8+4
Object detection fundamentals – Face recognition basics – Feature-based recognition – category recognition – context and scene understanding-Recognition databases and test sets.			
PRACTICAL:(2)			
10. Object detection and Object tracking using Kalman Filter / CamShift			
Total Hours			40
Practical			20
Textbooks:			
1	Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer- Texts in Computer Science, Second Edition, 2022.		
2	Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, Second Edition, 2015		
Reference Books:			
1.	Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.		
2.	Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, 4th Edition, Pearson.		
3.	Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006		
4.	E. R. Davies, Computer and Machine Vision, Fourth Edition, Academic Press, 2012.		
Web References:			
1.	docs.opencv.org: https://opencv.org/opencv-free-course/		
2	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ee74		

BLOOM'S TAXONOMY LEVEL	ASSESSMENT-1			ASSESSMENT-2		ASSIGNMENT	ATTENDANCE	END SEMESTER EXAMINATION
	CIA1	CIA2	MODEL	LAB EXPERIM ENTS	MODEL LAB EXAM			
	6	6	8	15	5			
Remember				15	5	10	10	40
Understand	60		20					
Apply	40	100	80					
Analyze								
Evaluate								
Create								
Total (100Marks)	6	6	8	15	5	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 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/ 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
C466.1	3	2	1	1	2	-	-	-	-	-	1	2	2	2
C466.2	3	3	2	2	3	-	-	-	-	-	1	2	3	2
C466.3	3	3	2	3	2	-	-	-	-	-	1	2	3	2
C466.4	3	3	3	3	2	-	-	-	-	-	1	2	3	2
C466.5	2	2	3	2	3	1	1	1	-	-	3	3	3	3

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	
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards				
2024	THEORY CUM PRACTICAL	V	-				
Pre-requisite Course(s)		Co-requisite Course(s)					
-		-					
Course Objectives							
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	Apply MongoDB and Apache Spark for efficient big data storage and processing.						
Course Outcomes							
Upon completion of the course, students will be able to							
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	Apply MongoDB database operations and Apache Spark concepts for efficient storage, querying, and processing of big data.					[AP]	
Course Contents							
Unit – 1	Fundamentals of Big Data					CO1	9
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							
PRACTICAL:							
1. Downloading and installing Hadoop; Understanding different Hadoop modes. Startup scripts, Configuration files.							
Unit – 2	NoSQL Databases and Cassandra Architecture					CO2	9
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.							
PRACTICAL:							
2. Hadoop Implementation of file management tasks, such as Adding files and directories, retrieving files and Deleting files.							
Unit – 3	Data Preprocessing and Map Reduce Applications					CO3	9
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.							
PRACTICAL:							
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.							
Unit – 4	Basics of Hadoop and Hive Framework					CO4	9

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.

PRACTICAL:

8. Installation of Hive along with practice examples.

Unit – 5	Modern Big Data Frameworks and Tools	CO5	9
Introduction – Features – Data types – Mongo DB Query language – CRUD operations – Arrays – Functions: Count – Sort – Limit – Skip – Aggregate – Map Reduce. Indexes-Mongo Import – Mongo Export-Introduction to Spark, Spark Architecture and its components, Features of Spark, Spark vs Hadoop.			

PRACTICAL:

9. Implement NoSQL Database Operations: CRUD operations, Arrays using MongoDB.

10. Implement Functions: Count – Sort – Limit – Skip – Aggregate using MongoDB.

Total Hours			45
Practical			30

Textbooks:

1	Ramesh Sharda, Dursun Delen and Efraim Turban, Business Intelligence, Analytics, Data Science, and AI, 5th Edition, Pearson, 2025.
2	Rathinaraja Jeyaraj, Ganesh Kumar Pugalendhi, 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.
4	Fru Nde, "The Ultimate Guide to Programming Apache Hive", NextGen Publishing, 2015.
5	Lars George, "HBase: The Definitive Guide", O'Reilley, 2nd Edition (2017)
6	Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilley, 2nd Edition (2022)
7	Holden Karau, Andy Konwinski, Patrick Wendell and Matei Zaharia, <i>Learning Spark: Lightning-Fast Big Data Analysis</i> , 2nd Edition, O'Reilly Media, 2020.

Reference Books:

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	Joe Reis and Matt Housley, <i>Fundamentals of Data Engineering</i> , O'Reilly Media, 2022.

Web References:

1	https://onlinecourses.nptel.ac.in/noc26_cs09/preview
2	https://onlinecourses.nptel.ac.in/noc25_cs131/preview

BLOOM'S TAXONOMY LEVEL	ASSESSMENT-1			ASSESSMENT-2		ASSIGNMENT	ATTENDANCE	END SEMESTER EXAMINATION
	CIA1	CIA2	MODEL	LAB EXPERI MENTS	MODEL LAB EXAM			
	6	6	8	10	10			
Remember				10	10	10	10	40
Understand	70	70	30					
Apply	30	30	70					
Analyze								
Evaluate								
Create								
Total (100Marks)	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	PS O 2	PSO 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

SCHEME
SCHEME OF PROFESSIONAL ELECTIVES

VERTICAL I
ANALYTICS ENGINEERING

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	
Textbooks:							
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
Reference Books:	
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.
Web References:	
1	Kaggle – https://www.kaggle.com/learn
2	Towards Data Science – https://towardsdatascience.com
3	Scikit-learn Documentation – https://scikit-learn.org
4	Pandas Documentation – https://pandas.pydata.org
5	Matplotlib Documentation – https://matplotlib.org
6	Seaborn Documentation – https://seaborn.pydata.org

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						
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/ 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, Fatih Porikli, 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	https://nptel.ac.in/courses/106101061
2	https://nptel.ac.in/courses/106105087
3	https://nptel.ac.in/courses/106105182

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)			
Remember				(10 Marks)	(10 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/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 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

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					CO1	9
Overview - History of Healthcare Analysis Parameters on medical care systems- Need for Healthcare Analytics - Foundations of Healthcare Analytics - Health care privacy and ethics ,Health care laws and Acts- Standardized code sets – Machine Learning Foundations: Tree Like reasoning , Probabilistic reasoning and Bayes Theorem							
Unit – 2	ANALYTICS ON MACHINE LEARNING					CO2	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 Introduction - Pandas Data Frame Operations –Seaborn introduction,SeabornVs Matplotlib- Plots for categorical data.							
Unit – 3	HEALTH CARE MANAGEMENT					CO3	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					CO4	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					CO5	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 https://doi.org/10.1007 (2018)
4	El Morr, Christo, and Hossam Ali-Hassan. Analytics in healthcare: a practical introduction. Springer, 2019.
Web References:	
1	https://scikit-learn.org/stable
2	https://www.tensorflow.org/

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%	100%	20%			
Apply	20%		80%			
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/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PS01	PS02	PS03
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 – Recurrent Neural Networks (RNN) – Long Short-Term Memory (LSTM) – Transformers Architecture – Attention Mechanism – Introduction to BERT – Applications of BERT in Text Classification – 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 – Classical QA Models – Transformer-based Question Answering – BERT-based QA Models – Chatbots – Design of Dialogue Systems – Evaluation of 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 (Hidden Markov Models), 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, <i>Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition with Language Models</i> , Third Edition Draft, January 2026.					
2	Steven Bird, Ewan Klein, and Edward Loper, <i>Natural Language Processing with Python: Analyzing Text with the Natural Language Toolkit</i> , O'Reilly Media, Updated Reprint Edition, 2017.					

Reference Books:	
1	Lewis Tunstall, Leandro von Werra, and Thomas Wolf, <i>Natural Language Processing with Transformers: Building Language Applications with Hugging Face, Revised Edition</i> , O'Reilly Media, 2022.
2	Ian Goodfellow, Yoshua Bengio, and Aaron Courville, <i>Deep Learning</i> , The MIT Press, 2016 (latest widely used edition).
3	Lawrence Rabiner and Bing-Hwang Juang, <i>Fundamentals of Speech Recognition</i> , Prentice Hall, 1993 (classic foundational edition).
4	Christopher D. Manning, Prabhakar Raghavan, and Hinrich Schütze, <i>Introduction to Information Retrieval</i> , Cambridge University Press, Updated Digital Edition, 2022.
5	Paul Taylor, <i>Text-to-Speech Synthesis</i> , Cambridge University Press, 2009 (standard reference for TTS).
Web References:	
1	https://onlinecourses.nptel.ac.in/noc26_cs45/preview?
2	https://www.coursera.org/specializations/natural-language-processing?

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						
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/ 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 and 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 – Introduction to Real-World Business Case Studies in Analytics.						
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-Introduction to Data Visualization Tools: Power BI and Tableau – Dashboard Creation and Business Reporting.						
Unit – 3	BUSINESS FORECASTING					C03 9 Hrs
Introduction to Business Forecasting and Predictive Analytics – Logic and Data-driven Models – Data Mining and Predictive Analysis Modeling – Machine Learning for Predictive Analytics – Time Series Forecasting Models – Trend Analysis – Moving Average and Exponential Smoothing Methods.						
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 – Real-world Case Studies in HR and Supply Chain Analytics.						
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 Customer Behaviour – Customer Segmentation – Marketing and Sales Case Studies using Business Analytics Tools.						
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	https://onlinecourses.nptel.ac.in/noc26_cs64/preview?
2	https://www.ibm.com/topics/business-analytics

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%	50%	40%			
Apply		50%	60%			
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/ 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
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
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
2024	THEORY		-----			
Pre-requisite Course(s)		Co-requisite Course(s)				
Artificial Intelligence – 1		-				
Course Objectives						
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					
Course Outcomes						
Upon completion of the course, students will be able to						
C506.1	Understand the concepts of morality, ethics, and ethical harms in Artificial Intelligence.					[U]
C506.2	Apply knowledge of real-time AI applications to identify and address associated ethical issues and implementation challenges in practical scenarios.					[AP]
C506.3	Examine AI standards and regulations					[AP]
C506.4	Illustrate roboethics including AI agents and the safe design of autonomous and semi-autonomous systems.					[AP]
C506.5	Use the principles of roboethics, morality, and professional responsibilities in AI development and deployment.					[AP]
Course Contents						
Unit – 1	INTRODUCTION TO ETHICAL INITIATIVES IN AI					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						
Unit – 2	ETHICAL HARMS AND APPLICATIONS					9
International ethical initiatives-Ethical harms and concerns-Case study: healthcare robots, Autonomous Vehicles, Warfare and weaponization.						
Unit – 3	AI STANDARDS AND REGULATION					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						
Unit – 4	ROBOETHICS: SOCIAL AND ETHICAL IMPLICATION OF ROBOTICS					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.						
Unit – 5	AI AND ETHICS- CHALLENGES AND OPPORTUNITIES					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.						
Total Hours						45
Textbooks:						
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.					
Reference Books:						
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					

Web References:	
1	https://sci-hub.mkssa.top/10.1007/978-3-540-30301-5_65
2	https://www.scu.edu/ethics/all-about-ethics/artificial-intelligence-and-ethics-sixteen-challenges-and-opportunities/
3	https://www.weforum.org/agenda/2016/10/top-10-ethical-issues-in-artificial-intelligence/
4	https://sci-hub.mkssa.top/10.1159/000492428

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)			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand	80%		20%			
Apply	20%	100%	80%			
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/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 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

VERTICAL II
FULL STACK DEVELOPMENT

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.
Web References:	
1	https://nptel.ac.in/courses/106105084 - web architecture, HTTP, web protocols, and internet fundamentals
2	https://developer.mozilla.org - 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						
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/ 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				CO1	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				CO2	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				CO3	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				CO4	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				CO5	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
Web References:	
1	Android Developer Documentation: https://developer.android.com/docs
2	Flutter Documentation: https://flutter.dev/docs

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						
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/ 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
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					CO1	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					CO2	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					CO3	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					CO4	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					CO5	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 Cocchiaro, 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	https://onlinecourses.nptel.ac.in/noc25_cs66/preview
2	https://www.udemy.com/course/automation-testing-online-course-with-certificate

Assessment based on Continuous and End Semester Examination						
BLOOM'S LEVEL	CONTINUOUS ASSESSMENT			ASSIGNMENT (10 Marks)	ATTENDANCE (10 Marks)	END SEMESTER EXAMINATION (60 Marks)
	CIA1 (6 MARKS)	CIA2 (6 MARKS)	MODEL EXAM (8 MARKS)			
Remember				10	10	60
Understand	80		20			
Apply	20	100	80			
Analyze						
Evaluate						
Create				10	10	60
Total (100 Marks)	6	6	8			

- 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
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.
Reference Books:	
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.
Web References:	
1	https://www.udemy.com/topic/web-application-security-tester/
2	https://onlinecourses.nptel.ac.in/noc26_cs83/preview

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						
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/ 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
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
2024	THEORY	-	-			
Pre-requisite Course(s)		Co-requisite Course(s)				
Programming in C , Object Oriented Programming and Java		-				
Course Objectives						
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.					
Course Outcomes						
Upon completion of the course, students will be able to						
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]
Course Contents						
Unit – 1	SYNTAX AND SEMANTICS				C01	9 Hrs
Evolution of programming languages – describing syntax – context-free grammars – attribute grammars – describing semantics – lexical analysis – parsing – recursive-descent – bottom up parsing						
Unit – 2	DATA, DATA TYPES, AND BASIC STATEMENTS				C02	9 Hrs
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						
Unit – 3	SUBPROGRAMS AND IMPLEMENTATIONS				C03	9 Hrs
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						
Unit – 4	OBJECT-ORIENTATION, CONCURRENCY, AND EVENT HANDLING				C04	9 Hrs
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						
Unit – 5	FUNCTIONAL AND LOGIC PROGRAMMING LANGUAGES				C05	9 Hrs
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						
Total Hours						45
Textbooks:						
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.					
Reference Books:						

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).
Web References:	
1	https://www.nptel.ac.in/courses/106102067 .
2	https://www.nptelprep.in/courses/106102067/materials

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						
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/ 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
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					CO4	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					CO5	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
Reference Books:	
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.
Web References:	
1	https://www.coursera.org/learn/modern-databases-odc?utm_source=chatgpt.com
2	https://www.udemy.com/course/certified-nosql-graph-databases/?utm_source=chatgpt.com

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						
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/ 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

VERTICAL III
CLOUD COMPUTING AND DATA CENTER
TECHNOLOGIES

Course Code	Course Name	Category	Hours/Week			C	
			L	T	P		
24CS507	DATA WAREHOUSING	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 know the details of data warehouse Architecture						
2	To understand the OLAP Technology						
3	To understand the partitioning strategy						
4	To differentiate various schema						
5	To understand the roles of process manager & system manager						
Course Outcomes							
Upon completion of the course, students will be able to							
C507.1	Explain the concepts, components, and architecture of a data warehouse including modern and autonomous data warehouses.					[U]	
C507.2	Illustrate ETL processes and analyze OLAP technologies and their operations in data warehousing systems.					[U]	
C507.3	Apply metadata management concepts, design data marts, and implement partitioning strategies in data warehouse design.					[AP]	
C507.4	Apply dimensional modeling techniques and design schemas for efficient data warehouse implementation.					[AP]	
C507.5	Frame roles of process manager & system manager					[AP]	
Course Contents							
Unit – 1	INTRODUCTION TO DATA WAREHOUSE					CO1	9
Data warehouse Introduction - Data warehouse components- operational database Vs data warehouse – Data warehouse Architecture – Three-tier Data Warehouse Architecture - Autonomous Data Warehouse- Autonomous Data Warehouse Vs Snowflake - Modern Data Warehouse-Data Warehouse Administration And Management-Types of distributed Data Warehouse							
Unit – 2	ETL AND OLAP TECHNOLOGY					CO2	9
What is ETL – ETL Vs ELT – Types of Data warehouses - Data warehouse Design and Modeling - Delivery Process - Online Analytical Processing (OLAP) - Characteristics of OLAP - OLAP Guidelines-Online Transaction Processing (OLTP) Vs OLAP - OLAP operations- Types of OLAP- ROLAP Vs MOLAP Vs HOLAP-OLAP Tools and Internert-The Data warehouse and the web.							
Unit – 3	META DATA, DATA MART AND PARTITION STRATEGIES					CO3	9
Meta Data – Categories of Metadata – Role of Metadata – Metadata Repository – Metadata Management-Challenges for Meta Management - Data Mart – Need of Data Mart- Cost Effective Data Mart- Designing Data Marts- Cost of Data Marts- Partitioning Strategy – Vertical partition – Normalization – Row Splitting – Horizontal Partition							
Unit – 4	DIMENSIONAL MODELING AND SCHEMA					C04	9
Dimensional Modeling- Multi-Dimensional Data Modeling – Data Cube- Star Schema- Snowflake schema- Star Vs Snowflake schema- Fact constellation Schema- Schema Definition - Process Architecture- Types of Data Base Parallelism – Data warehouse Tools							
Unit – 5	SYSTEM & PROCESS MANAGERS					C05	9
Data Warehousing System Managers: System Configuration Manager- System Scheduling Manager – System Event Manager - System Database Manager - System Backup Recovery Manager - Data Warehousing Process Managers: Load Manager – Warehouse Manager- Query Manager – Hardware Architecture-Physical Layout-Security-Tuning – Testing							
Total Hours						45	
Textbooks:							

1	Alejandro Vaisman and Esteban Zimányi, Data Warehouse Systems: Design and Implementation, Springer, 2022.
2	Ralph Kimball, “The Data Warehouse Toolkit: The Complete Guide to Dimensional Modeling”, Third edition, 2013.
Reference Books:	
1	Paul Raj Ponniah, “Data warehousing fundamentals for IT Professionals”, 2012.
2	K.P. Soman, ShyamDiwakar and V. Ajay “Insight into Data mining Theory and Practice”, Easter Economy Edition, Prentice Hall of India, 2006.
3	W. H. Inmon, “DW 2.0: The Architecture for the Next Generation of Data Warehousing Morgan Kaufmann (Elsevier)”, 2008
4	William H. Inmon, “Building The Data Warehouse”, 2005
Web References:	
1	https://www.acte.in/data-warehouse-basics-for-beginners
2	https://holowczak.com/introduction-data-warehousing

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						
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/ 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	PS 02
C507.1	3	2			1						1	2	1
C507.2	3	3		1	2							2	2
C507.3	2	3	3	1	2							3	2
C507.4	2	2	3	1	2							3	3
C507.5	1	2	2	1	2				2	2	1	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	-	-			
Pre-requisite Course(s)		Co-requisite Course(s)				
Operating Systems, Database management system		-				
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						
C501.1	Explain the fundamental concepts of cloud service management including cloud ecosystem, characteristics, service models, and deployment models.					[U]
C501.2	Describe cloud service strategies and management frameworks for effective adoption and implementation of cloud services.					[U]
C501.3	Apply cloud service management techniques such as service lifecycle, capacity planning, migration, and operational management.					[AP]
C501.4	Apply cloud service economic models to analyze pricing strategies, billing mechanisms, and cost management in cloud environments.					[AP]
C50.5	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				C01	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				C02	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				C03	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				C04	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				C05	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	https://www.startertutorials.com/blog/cloud-computing-essentials.html
2	https://www.linkedin.com/top-content/training-development/digital-literacy-training/cloud-computing-essentials/

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	20			
Apply		80	80			
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/ 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	-	-				
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	https://www.vmware.com						

2	https://learn.microsoft.com/en-us/virtualization/
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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	
Understand	20	20	20			
Apply	80	80	80			
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/ 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
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	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)					
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							
Unit – 1	FUNDAMENTALS OF CLOUD SECURITY					C01	9 Hrs
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					C02	9 Hrs
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					C03	9 Hrs
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					C04	9 Hrs
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					C05	9 Hrs
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 Hours						45	
Textbooks:							

1	Tim Mather, Subra Kumaraswamy, Shahed Latif, Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, 1st Edition, O'Reilly Media, 2009, 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.

Reference Books:

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.

Web References:

1	National Institute of Standards and Technology, NIST SP 800-145: The NIST Definition of Cloud Computing, NIST Publications, 2011, Available at: https://www.nist.gov .
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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						
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/ 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
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 Systems		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	https://spark.apache.org/docs/latest/streaming-programming-guide.html
2	https://spark.apache.org/docs/latest/streaming-kafka-integration.html

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						
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/ 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
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	-	-			
Pre-requisite Course(s)		Co-requisite Course(s)				
Database Design and Management Systems		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	https://flink.apache.org/
2	https://docs.databricks.com/

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						
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/ 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
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

VERTICAL IV
EMERGING TECHNOLOGIES

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 devises 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	https://techooid.com/input-devices-vr https://www.marxentlabs.com/what-is-virtual-reality/
2	https://www.techtarget.com/whatis/definition/virtual-rea

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						
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/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PS01	PS02	PS03
C508.1	3	2	2	-	-	-	-	-	-	-	1	2	2	2
C508.2	3	2	2	2	-	-	-	-	-	-	2	3	2	2
C508.3	3	3	2	2	-	-	-	-	-	-	1	3	2	2
C508.4	3	3	3	2	-	-	-	-	-	-	2	3	2	2
C508.5	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		
24AD510	CYBER 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)					
Computer Network, Network Security		-					
Course Objectives							
1	To understand the fundamental concepts of cyber security, security goals, threat landscape and cyber laws including the Indian IT Act.						
2	To analyze various cyber threats, malware types, social engineering techniques and web/network attacks.						
3	To perform reconnaissance, scanning and vulnerability assessment using standard security tools.						
4	To understand intrusion detection systems, monitoring techniques and security event management concepts.						
5	To configure and implement firewall technologies and intrusion prevention mechanisms in controlled environments.						
Course Outcomes							
Upon completion of the course, students will be able to							
C510.1	Explain the fundamental principles of cyber security, security goals and cyber laws.					U	
C510.2	Examine various cyber threats, vulnerabilities and attack mechanisms in computing systems.					AP	
C510.3	Apply various tools to perform information gathering.					AP	
C510.4	Use intrusion techniques to detect intrusion					AP	
C510.5	Demonstrate intrusion prevention techniques to prevent intrusion					AP	
Course Contents							
Unit – 1	UNIT I – FOUNDATIONS OF CYBER SECURITY					C01	9
Introduction to Cyber Security – Evolution of Internet and its Impact – Security Goals (Confidentiality, Integrity, Availability) – Need for Cyber Security – Threat Landscape – Cyber Crime: History and Classification – Cybercriminals and Motivations – Global Perspective on Cyber Crimes – Cyber Laws – The Indian IT Act –Data Privacy Act- Cybercrime Investigation and Punishment.							
Unit – 2	CYBER THREATS AND DEFENSE MECHANISMS					C02	9
Overview of OWASP – Security Breaches and Case Studies – Threats and Vulnerabilities – Types of Malicious Attacks – Malware (Virus, Worm, Trojan, Ransomware, Spyware) –Social Engineering Techniques – Data poisoning Attacks-adversarial attacks-Wireless Network Attacks – Web Application Attacks – Common Attack Vectors –Attack Tools and Basic Countermeasures – Security of AI Systems.							
Unit – 3	RECONNAISSANCE AND VULNERABILITY SCANNING					C03	9
Foot printing and Information Gathering – Harvester – Whois – Netcraft – Host – DNS Information Extraction – Email Server Information Extraction – Scanning Concepts – Port Scanning and Network Scanning – Vulnerability Scanning – Scanning Methodology – Ping Sweep Techniques – Nmap Command Switches – SYN, Stealth, XMAS, NULL, IDLE, FIN Scans – Banner Grabbing – OS Fingerprinting Techniques.							
Unit – 4	INTRUSION DETECTION AND SECURITY MONITORING					C04	9
Host-Based Intrusion Detection Systems – Network-Based Intrusion Detection Systems – Distributed and Hybrid IDS – Intrusion Detection Exchange Format – Honeypots – Snort Architecture and Configuration – Basic Security Event Monitoring Concepts							

Unit – 5	INTRUSION PREVENTION AND FIREWALL TECHNOLOGIES	C05	9
Firewalls and Intrusion Prevention Systems – Need for Firewalls – Firewall Characteristics – Access Control Policies – Types of Firewalls – Firewall Placement and Configurations – Next Generation Firewalls-Intrusion Prevention Systems – Unified Threat Management (UTM)			
Total Hours			45
Textbooks:			
1	Anand Shinde, <i>Introduction to Cyber Security: Guide to the World of Cyber Security</i> , Notion Press, 2021.		
2	Nina Godbole and Sunit Belapure, <i>Cyber Security</i> , Wiley India.		
3	Charles P. Pfleeger & Shari Lawrence Pfleeger, <i>Security in Computing</i> , Pearson		
Reference Books:			
1	William Stallings, <i>Cryptography and Network Security</i> , Pearson.		
2	Michael E. Whitman & Herbert J. Mattord, <i>Principles of Information Security</i> , Cengage.		
3	Ric Messier, <i>CEH v11 Study Guide</i> , Wiley.		
4	The Information Technology Act, 2000 (Amended 2008), Government of India		
Web References:			
1	https://owasp.org/www-project-top-ten/		

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						
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/ 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
C510.1	3	2	1	1	-	-	-	-	-	-	1	2	2	2
C510.2	2	3	2	2	-	-	-	-	-	-	1	3	2	1
C510.3	2	3	2	3	-	-	-	-	-	-	1	3	2	2
C510.4	2	3	2	3	-	-	-	-	-	-	1	3	2	2
C510.5	2	2	3	2	-	-	-	-	-	-	1	2	2	1

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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
25AM501	Cryptocurrency and Blockchain Technology	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)				
Computer Networks, Data Structures and Algorithms		Cryptography and Network Security				
Course Objectives						
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.					
Course Outcomes						
Upon completion of the course, students will be able to						
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]
Course Contents						
Unit – 1	INTRODUCTION TO CRYPTOCURRENCIES				C01	9
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) .						
Unit – 2	BITCOIN AND CRYPTOCURRENCY				C02	9
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.						
Unit – 3	BITCOIN CONSENSUS				C03	9
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						
Unit – 4	BLOCH CHAIN SECURITY				C04	9
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.						
Unit – 5	EMERGING TRENDS AND FUTURE DEVELOPMENTS				C05	9
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.						
					Total Hours	45
Textbooks:						
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.					
Reference Books:						
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.
Web References:	
1	Bitcoin and Cryptocurrency Technologies – https://bitcoinbook.cs.princeton.edu
2	Ethereum Foundation Documentation – https://ethereum.org/en/developers/docs/
3	Mastering Bitcoin by Andreas M. Antonopoulos – https://github.com/bitcoinbook/bitcoinbook

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/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	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 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	https://digitalnz.org/make-it-digital/creating-digital-content/creating-digital-video
2	https://www.agitraining.com/

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%			
Apply	80%	100%	80%			
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.
- 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	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	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)				
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 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.
Web References:	
1	https://nptel.ac.in/courses/110105920
2	https://swayam.gov.in/search_courses?searchText=digital%20marketing
3	https://skillshop.exceedlms.com/student/catalog/list?category_ids=7879-google-digital-garage

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						
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/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO2
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

VERTICAL V
LANGUAGE MODELLING

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24AM506	LINGUISTIC ENGINEERING	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 of linguistics and computational linguistics.					
2	To learn lexical, syntactic and semantic analysis techniques used in language processing.					
3	To apply statistical and machine learning approaches in natural language processing.					
4	To implement language models and text processing techniques.					
5	To develop AI based language applications such as chatbots, translation and sentiment analysis.					
Course Outcomes						
Upon completion of the course, students will be able to						
C506.1	Explain linguistic concepts and structure of natural language					U
C506.2	Apply lexical and syntactic processing techniques					AP
C506.3	Implement semantic analysis and language models					AP
C506.4	Analyze NLP techniques using machine learning methods					AN
C506.5	Develop AI-based language applications					AP
Course Contents						
Unit – 1	FUNDAMENTALS OF LINGUISTICS AND NLP					9
Introduction to Linguistic Engineering – Natural Language vs Formal Language – Applications of NLP – Levels of Language Analysis – Morphology – Phonology – Syntax – Semantics – Pragmatics – Corpus Linguistics – Text Corpora and Annotation – Overview of NLP pipeline – Challenges in Natural Language Processing.						
Unit – 2	LEXICAL ANALYSIS AND MORPHOLOGY					9
Word structure and morphology – Tokenization – Stemming and Lemmatization – Stop word removal – Regular expressions in NLP – Finite State Automata for morphology – Part of Speech (POS) tagging – Rule-based and statistical POS tagging – N-gram models – Language modeling basics.						
Unit – 3	SYNTACTIC ANALYSIS					9
Context Free Grammar (CFG) – Parsing techniques – Top-down parsing – Bottom-up parsing – Chart parsing – Dependency parsing – Treebanks – Syntactic ambiguity – Parsing algorithms – Applications of syntactic analysis.						
Unit – 4	SEMANTIC AND DISCOURSE PROCESSING					9
Semantic representation – First order predicate logic – Word sense disambiguation – Semantic role labeling – Named Entity Recognition – Coreference resolution – Discourse analysis – Pragmatic processing – Information extraction techniques.						
Unit – 5	MACHINE LEARNING FOR NLP APPLICATIONS					9
Text classification – Sentiment analysis – Topic modeling – Information retrieval basics – Machine learning techniques in NLP – Deep learning for NLP – Word embeddings – Transformers and language models – Chatbots – Machine translation – Question answering systems.						
Total Hours						45
Text books:						
1	Daniel Jurafsky and James H. Martin, Speech and Language Processing, Pearson Education.					
2	James Allen, Natural Language Understanding, Pearson.					
Reference Books:						
1	Christopher Manning and Hinrich Schütze, Foundations of Statistical Natural Language Processing, MIT Press.					
2	Steven Bird, Ewan Klein, Edward Loper, Natural Language Processing with Python, O'Reilly.					

3	Yoav Goldberg, Neural Network Methods in Natural Language Processing, Morgan & Claypool.
4	Jacob Eisenstein, Introduction to Natural Language Processing, MIT Press.

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)			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand	80%	20%	20%			
Apply	20%	80%	80%			
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/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PS01	PS02
C506.1	3	2	-	-	-	-	-	-	-	-	2	-	3
C506.2	3	3	2	-	2	-	-	-	-	-	2	-	3
C506.3	3	3	2	2	2	-	-	-	-	-	2	-	3
C506.4	3	3	2	2	2	-	-	-	-	-	2	-	3
C506.5	3	2	3	2	3	-	-	-	-	-	2	-	3

3 - Strong 2 - Moderate 1 - Weak - - no correlation

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24AM507	SOFT COMPUTING	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)				
Artificial Intelligence		Nil				
Course Objectives						
1	To understand the fundamental concepts of soft computing and its components such as neural networks, fuzzy logic, and genetic algorithms.					
2	To study the structure and learning mechanisms of artificial neural networks and their applications.					
3	To learn the principles of fuzzy logic and apply fuzzy systems to solve real-world problems.					
4	To understand the working of genetic algorithms and their use in optimization problems.					
5	To explore hybrid soft computing techniques and their applications in various domains.					
Course Outcomes						
Upon completion of the course, students will be able to						
C507.1	Understand the basic concepts and components of soft computing.					[U]
C507.2	Explain the structure and working of artificial neural networks.					[U]
C507.3	Apply fuzzy logic concepts to solve simple problems.					[AP]
C507.4	Analyze genetic algorithms and their operations.					[U]
C507.5	Evaluate hybrid soft computing techniques and their applications.					[AP]
Course Contents						
Unit – 1	INTRODUCTION TO SOFT COMPUTING					C01 9 Hrs
Introduction to Soft Computing – Difference between Soft Computing and Hard Computing – Applications of Soft Computing – Components of Soft Computing – Neural Networks – Fuzzy Logic – Genetic Algorithms – Hybrid Systems – Advantages of Soft Computing Techniques.						
Unit – 2	ARTIFICIAL NEURAL NETWORKS					C02 9 Hrs
Biological Neural Network – Artificial Neuron Model – Neural Network Architecture – Activation Functions – Learning Methods – Supervised Learning – Unsupervised Learning – Single Layer Perceptron – Multi Layer Perceptron – Applications of Neural Networks.						
Unit – 3	FUZZY LOGIC					C03 9 Hrs
Introduction to Fuzzy Logic – Crisp Sets and Fuzzy Sets – Membership Functions – Fuzzy Operations – Fuzzy Rules – Fuzzy Inference System – Defuzzification Methods – Applications of Fuzzy Logic in Control Systems.						
Unit – 4	GENETIC ALGORITHMS					C04 9 Hrs
Introduction to Genetic Algorithms – Basic Concepts – Genetic Representation – Fitness Function – Selection Methods – Crossover Operation – Mutation Operation – Genetic Algorithm Cycle – Applications of Genetic Algorithms.						
Unit – 5	HYBRID SYSTEMS AND APPLICATIONS					C05 9 Hrs
Neuro-Fuzzy Systems – Genetic Neural Networks – Hybrid Soft Computing Techniques – Applications of Soft Computing in Pattern Recognition – Image Processing – Optimization Problems – Data Mining – Future Trends in Soft Computing.						
Total Hours						45
Textbooks:						
1	S. Rajasekaran & G.A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms , PHI.					
2	S. N. Sivanandam & S. N. Deepa, Principles of Soft Computing , Wiley.					
3	Timothy J. Ross, Fuzzy Logic with Engineering Applications , Wiley.					
Reference Books:						
1	David E. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning , Addison Wesley.					
2	Jang, Sun & Mizutani, Neuro-Fuzzy and Soft Computing , PHI Learning Pvt.Ltd.,2003					
3	Simon Haykin, Neural Networks and Learning Machines , Pearson.					
4	George J. Klir & Bo Yuan, <i>Fuzzy Sets and Fuzzy Logic: Theory and Applications</i> , Prentice Hall.					
Web References:						
1	https://nptel.ac.in/courses/106105173					
2	https://swayam.gov.in					

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	80	20	20			
Apply	20	80	80			
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/ 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
C507.1	3	2	-	-	-	-	-	-	-	-	1	2	1	-
C507.2	3	3	2	-	-	-	-	-	-	-	1	3	2	-
C507.3	3	3	3	2	-	-	-	-	-	-	2	3	2	1
C507.4	3	3	2	2	1	-	-	-	-	-	2	3	2	1
C507.5	3	3	3	2	2	-	-	-	-	-	2	3	3	2

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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24AM508	COGNITIVE SCIENCE	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)				
ARTIFICIAL INTELLIGENCE		Nil				
Course Objectives						
1	Understand the basic concepts and interdisciplinary nature of cognitive science.					
2	Understand cognitive processes such as perception, memory, and problem solving.					
3	Understand the structure and functions of the human brain related to cognition.					
4	Apply computational models and artificial intelligence techniques in cognitive science.					
5	Apply cognitive science concepts in language processing and real-world applications.					
Course Outcomes						
Upon completion of the course, students will be able to						
C508.1	Explain the fundamental concepts and interdisciplinary aspects of cognitive science.					[U]
C508.2	Describe various cognitive processes such as attention, perception, and memory.					[U]
C508.3	Illustrate the role of the human brain and neural mechanisms in cognition.					[U]
C508.4	Apply computational models and reasoning techniques to simulate cognitive processes.					[AP]
C508.5	Demonstrate the use of cognitive science principles in real-world applications such as AI and human-computer interaction.					[AP]
Course Contents						
Unit – 1	INTRODUCTION TO COGNITIVE SCIENCE					C01 9 Hrs
Introduction to Cognitive Science – Interdisciplinary Nature – Relationship between Psychology, AI, Neuroscience, Linguistics and Philosophy – Human Cognition – Information Processing – Perception – Learning – Memory – Language Processing.						
Unit – 2	COGNITIVE PSYCHOLOGY					C02 9 Hrs
Cognitive Psychology – Attention – Perception – Memory – Problem Solving – Decision Making – Representation of Knowledge – Cognitive Architecture – Information Processing Models.						
Unit – 3	COGNITIVE NEUROSCIENCE					C03 9 Hrs
Brain and Cognition – Structure and Function of Nervous System – Neurons – Brain Mapping Techniques – Neural Representation – Cognitive Functions of Brain – Neuroplasticity – Case Studies.						
Unit – 4	COMPUTATIONAL MODELS OF COGNITION					C04 9 Hrs
Artificial Intelligence and Cognition – Knowledge Representation – Logical Reasoning – Inference Models – Probabilistic Models – Machine Learning Basics – Cognitive Architectures.						
Unit – 5	LANGUAGE AND APPLICATIONS OF COGNITIVE SCIENCE					C05 9 Hrs
Language Acquisition – Semantics – Cognitive Models of Language Processing – Applications in AI – Pattern Recognition – Human-Computer Interaction – Cognitive Systems – Future Trends.						
Total Hours						45
Textbooks:						
1	Margaret W. Matlin, Cognition , Wiley.					
2	José Luis Bermúdez, Cognitive Science: An Introduction to the Science of the Mind , Cambridge University Press.					
3	Paul Thagard, Mind: Introduction to Cognitive Science , MIT Press.					
Reference Books:						
1	Jay Friedenberg & Gordon Silverman, Cognitive Science: An Introduction to the Study of Mind , Sage Publications.					
2	Daniel Reisberg, Cognition: Exploring the Science of the Mind , W.W. Norton.					
3	Michael S. Gazzaniga, Richard B. Ivry & George R. Mangun, Cognitive Neuroscience: The Biology of the Mind , W.W. Norton.					
4	E. Bruce Goldstein, Cognitive Psychology: Connecting Mind, Research, and Everyday Experience , Cengage Learning.					
Web References:						
1	https://nptel.ac.in					
2	https://swayam.gov.in					
3	https://ocw.mit.edu					

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	80	20			
Apply	20	20	80			
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/ 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
C508.1	3	2	-	-	-	-	-	-	-	-	1	2	1	-
C508.2	3	3	2	-	-	-	-	-	-	-	1	3	2	-
C508.3	3	3	2	2	-	-	-	-	-	-	2	3	2	1
C508.4	3	3	3	2	1	-	-	-	-	-	2	3	3	1
C508.5	3	3	3	2	2	-	-	-	-	-	2	3	3	2

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

Course Code	Course Name	Category	Hours/Week			C	
			L	T	P		
24AM509	ETHICAL HACKING	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)					
OPERATING SYSTEMS		Nil					
Course Objectives							
1	To understand the fundamentals of cyber security and ethical hacking.						
2	To identify vulnerabilities and security threats in computer networks and systems.						
3	To learn various hacking techniques and penetration testing methods.						
4	To analyze web application security vulnerabilities.						
5	To understand security policies, cyber laws, and ethical practices.						
Course Outcomes							
Upon completion of the course, students will be able to							
C509.1	Explain Cyber security principles and ethical hacking concepts.					[U]	
C509.2	Apply network scanning and vulnerability assessment techniques.					[AP]	
C509.3	Analyze system security threats and malware attacks.					[AN]	
C509.4	Evaluate web application vulnerabilities and security mechanisms.					[AN]	
C509.5	Perform penetration testing and implement security policies.					[AN]	
Course Contents						Hrs	
Unit – 1	FUNDAMENTALS OF ETHICAL HACKING					CO1	9
Introduction to Cyber Security and Ethical Hacking, Types of Hackers: White Hat, Black Hat, Grey Hat, Ethical Hacking Methodology and Phase, Cyber Threats and Vulnerabilities, Footprinting and Reconnaissance, Open Source Intelligence (OSINT), Information Gathering Techniques, Security Policies and Security Frameworks.							
Unit – 2	NETWORK SCANNING AND VULNERABILITY ANALYSIS					CO2	9
Network Scanning Techniques, Port Scanning and Network Mapping, Enumeration Techniques, Vulnerability Assessment and Risk Analysis, Packet Sniffing and Traffic Analysis, Intrusion Detection and Prevention Systems (IDS/IPS), Firewall Concepts and Network Security Protocols.							
Unit – 3	SYSTEM HACKING AND MALWARE ATTACKS					CO3	9
Password Cracking Techniques, Privilege Escalation, Malware Threats: Virus, Worms, Trojans, Ransomware, Rootkits and Backdoors, Keyloggers and Spyware, Steganography Concepts, System Security Countermeasures.							
Unit – 4	WEB APPLICATION HACKING					CO4	9
Web Application Architecture, Web Application Vulnerabilities, SQL Injection Attacks, Cross-Site Scripting (XSS), Cross-Site Request Forgery (CSRF), Session Hijacking and Cookie Attacks, Web Server Security, Secure Coding Practices.							
Unit – 5	PENETRATION TESTING AND SECURITY MANAGEMENT					CO5	9
Penetration Testing Methodology, Ethical Hacking Tools (Kali Linux, Nmap, Wireshark, Metasploit), Security Testing and Reporting, Incident Response and Risk Management, Digital Forensics Basics, Security Policies and Compliance, Cyber Laws and Ethical Issues.							
Total Theory Hours						45	
Textbooks:							
1	Michael T. Simpson, Kent Backman and James Corley, Hands-On Ethical Hacking and Network Defense, 3rd Edition, Cengage Learning, 2016, ISBN: 978-1305078420.						
2	Patrick Engebretson, The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made Easy, 2nd Edition, Syngress (Elsevier), 2013, ISBN: 978-0124116443.						
3	Kimberly Graves, CEH Official Certified Ethical Hacker Review Guide, 3rd Edition, Wiley, 2021, ISBN: 978-1119800286.						
Reference Books:							
1	Jon Erickson, Hacking: The Art of Exploitation, 2nd Edition, No Starch Press, 2008, ISBN: 978-1593271442.						
2	Kevin Mitnick and William L. Simon, The Art of Deception: Controlling the Human Element of Security, 1st Edition, Wiley, 2002, ISBN: 978-0764542800.						
3	Rafay Baloch, Ethical Hacking and Penetration Testing Guide, 1st Edition, CRC Press (Taylor & Francis), 2017, ISBN: 978-1138190238.						
Web References:							

1	https://nptel.ac.in/courses/106105217
2	https://owasp.org/search/?searchString=ethical+hacking
3	https://kali.org/

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						
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/ 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
C509.1	3	2	-	-	1	-	-	-	-	-	2	2	2
C509.2	2	3	1	2	3	-	-	-	-	-	2	2	3
C509.3	2	3	1	2	2	-	-	-	-	-	2	1	3
C509.4	2	2	2	2	3	-	-	-	-	-	2	1	3
C509.5	3	2	2	2	3	-	-	-	-	-	2	2	3

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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24AM510	OPTIMIZATION 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)				
Artificial Intelligence, Machine Learning		Deep learning				
Course Objectives						
1	To formulate linear programming problems (LPP)					
2	To evaluate Integer Programming Problems, Transportation and Assignment Problems					
3	To obtain a solution to network problems using CPM and PERT techniques					
4	To optimize the function subject to the constraints					
5	To identify and solve problems under Markovian queuing models					
Course Outcomes						
Upon completion of the course, students will be able to						
C510.1	Solve linear programming problems (LPP)					[AP]
C510.2	Evaluate Integer Programming Problems, Transportation and Assignment Problems					[AP]
C510.3	Obtain a solution to network problems using CPM and PERT techniques					[AN]
C510.4	Able to optimize the function subject to the constraints					[AN]
C510.5	Solve problems under Markovian queuing models					[AP]
Course Contents						
Unit – 1	LINEAR MODELS					CO1 9 Hrs
Introduction of Operations Research - mathematical formulation of LPP- Graphical Methods to solve LPP- Simplex Method- Two-Phase method.						
Unit – 2	INTEGER PROGRAMMING AND TRANSPORTATION PROBLEMS					CO2 9 Hrs
Integer programming: Branch and bound method- Transportation and Assignment problems - Traveling salesman problem.						
Unit – 3	PROJECT SCHEDULING					CO3 9 Hrs
Project network -Diagram representation – Floats - Critical path method (CPM) – PERT- Cost considerations in PERT and CPM.						
Unit – 4	CLASSICAL OPTIMIZATION THEORY					CO4 9 Hrs
Unconstrained problems – necessary and sufficient conditions - Newton-Raphson method, Constrained problems – equality constraints – inequality constraints - Kuhn-Tucker conditions.						
Unit – 5	QUEUING MODELS					CO5 9 Hrs
Introduction, Queuing Theory, Operating characteristics of a Queuing system, Constituents of a Queuing system, Service facility, Queue discipline, Single channel models, multiple service channels.						
Total Hours						45
Textbooks:						
1	Edwin K.P. Chong, Stanislaw H. Zak, “An Introduction to Optimization: With Applications to Machine Learning”, 5th Edition, Wiley, 2023					
2	Faiz Hamid, “Optimization Essentials: Theory, Tools, and Applications “, Springer Nature,2025.					
3	Dr. Alaa Khamis, “Optimization Algorithms: AI techniques for design, planning, and control problems”, Manning Publications., 2024.					
Reference Books:						
1	Alessandro Zocca, Jeffrey C. Kantor, Krzysztof Postek, Joaquim A. S. Gromicho, “Hands-On Mathematical Optimization with Python”, Cambridge University Press,2025.					
2	Debashish Das, Ali Safaa Sadiq, Seyedali Mirjalili, “Optimization Algorithms in Machine Learning: A Meta-heuristics Perspective”, Springer Singapore,2025.					
3	Anton Ermeev, et al,” Mathematical Optimization Theory and Operations Research: Recent Trends “, Springer Nature Switzerland,2024.					
Web References:						
1	https://www.google.com/search?q=web+references+for+Introduction%2C+Queuing+Theory%2C+Operating+characteristics					
2	https://qiml.radiology.wisc.edu/wp-content/uploads/sites/760/2021/03/lecture_A1_07_LineSearch.pdf					

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	40			
Apply	60	40	30			
Analyze		40	30			
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/ 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
C510.1	3	3	2	1	1	-	-	-	2	1	2	3	3
C510.2	3	2	2	2	3	-	-	-	2	2	3	2	1
C510.3	2	3	2	2	2	-	-	-	3	3	3	2	3
C510.4	2	2	3	3	3	-	-	-	2	2	3	2	2
C510.5	2	2	2	2	3	-	-	-	2	2	3	2	3

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

Course Code	Course Name	Category	Hours/Week			C	
			L	T	P		
24AM511	RECOMMENDER SYSTEMS	PEC	3	0	0	3	
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards				
2024	THEORY	-	-				
Pre-requisite Course(s)		Co-requisite Course(s)					
Machine Learning, Data Structures and Algorithms							
Course Objectives							
1	To understand the foundations of the recommender system.						
2	To learn the significance of machine learning and data mining algorithms for Recommender systems						
3	To learn about collaborative filtering						
4	To make students design and implement a recommender system.						
5	To learn collaborative filtering.						
Course Outcomes							
Upon completion of the course, students will be able to							
C511.1	Understand and learn the basic concepts of recommender systems.					U	
C511.2	Implement machine-learning and data-mining algorithms in recommender systems data sets					AP	
C511.3	Implementation of Collaborative Filtering in carrying out performance evaluation of recommender systems based on various metrics.					AP	
C511.4	Design and implement attack-resistant and knowledge based recommender sytems.					AP	
C511.5	Apply different metrics to evaluate recommender systems					AP	
Course Contents							
Unit – 1	INTRODUCTION					C01	9
Introduction and basic taxonomy of recommender systems - Traditional and non-personalized Recommender Systems - Linear Algebra notation: Matrix addition, Multiplication, transposition, and inverses; covariance matrices - Overview of data mining methods for recommender systems- similarity measures- Dimensionality reduction – Singular Value Decomposition (SVD)							
Unit – 2	CONTENT-BASED RECOMMENDATION SYSTEMS					C02	9
High-level architecture of content-based systems - Item profiles, Representing item profiles, Methods for learning user profiles, Similarity-based retrieval, and Classification algorithms - Hybrid approaches: Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies.							
Unit – 3	COLLABORATIVE FILTERING					C03	9
A systematic approach, Nearest-neighbor collaborative filtering (CF), user-based and item-based CF, components of neighborhood methods (rating normalization, similarity weight computation, and neighborhood selection - Model based and pre-processing based approaches, Attacks on collaborative recommender systems							
Unit – 4	ATTACK-RESISTANT AND KNOWLEDGE BASED RECOMMENDER SYSTEMS					C04	9
Introduction – Types of Attacks – Detecting attacks on recommender systems – Individual attack – Group attack – Strategies for robust recommender design - Robust recommendation algorithms. Knowledge based recommendation: Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders.							
Unit – 5	EVALUATING RECOMMENDER SYSTEMS					C05	9
Evaluating Paradigms – User Studies – Online and Offline evaluation – Goals of evaluation design – Design Issues – Accuracy metrics - Evaluation on historical datasets, Error metrics, Decision-Support metrics, User-Centred metrics –Interactive and User-Centric Evaluation-Business-Oriented Metrics-Contextual and Adaptive Evaluation- Limitations of Evaluation measures							
Total Hours						45	
Textbooks:							
1	Francesco Ricci, Lior Rokach, Bracha Shapira, Recommender Systems Handbook, Springer,3rd Edition,2022.						
2	P. Pavan Kumar et al., Recommender Systems: Algorithms and Applications, CRC Press, 2021.						
Reference Books:							
1	Recommender Systems: The Textbook by Charu C. Aggarwal for comprehensive theory,						

	and Recommender Systems Handbook (3rd Edition, 2022)
2	Recommender Systems Handbook (Ricci, Rokach, Shapira, 3rd Ed. 2022): A definitive collection of chapters by experts covering algorithms, evaluation, and specialized applications.
Web References:	
1	https://onlinecourses.nptel.ac.in/noc24_ge35/preview
2	https://en.wikipedia.org/wiki/Recommender_system

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						
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/ 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	PSO2
C511.1	3	3	3	2	1	-	-	-	-	-	-	3	-
C511.2	3	3	2	2	1	-	-	-	-	-	-	3	-
C511.3	3	2	3	2	1	-	-	-	-	-	-	3	-
C511.4	3	2	3	2	1	-	-	-	-	-	-	3	-
C511.5	3	3	2	2	1	-	-	-	-	-	-	3	-

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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24AM512	KNOWLEDGE ENGINEERING	PE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
24	THEORY	-				
Pre-requisite Course(s)		Co-requisite Course(s)				
Data Structures and Algorithms		-				
Course Objectives						
1	To understand the basics of Knowledge Engineering.					
2	To discuss methodologies and modeling for Agent Design and Development.					
3	To design and develop ontologies.					
4	To apply reasoning with ontologies and rules.					
5	To understand learning and rule learning					
Course Outcomes						
Upon completion of the course, students will be able to						
C512.1	Understand the basics of Knowledge Engineering.					[U]
C512.2	Apply methodologies and modelling for Agent Design and Development.					[AP]
C512.3	Design and develop ontologies					[AP]
C512.4	Apply reasoning with ontologies and rule					[AP]
C512.5	Understand learning and rule learning.					[U]
Course Contents						
Unit – 1	REASONING UNDER UNCERTAINTY					C01 9 Hrs
Introduction – Abductive reasoning – Probabilistic reasoning: Enumerative Probabilities – Subjective Bayesian view – Belief Functions – Baconian Probability – Fuzzy Probability – Uncertainty methods - Evidence-based reasoning – Intelligent Agent – Mixed-Initiative Reasoning – Knowledge Engineering						
Unit – 2	METHODOLOGY AND MODELING					C02 9 Hrs
Conventional Design and Development – Development tools and Reusable Ontologies – Agent Design and Development using Learning Technology – Problem Solving through Analysis and Synthesis – Inquiry-driven Analysis and Synthesis – Evidence-based Assessment – Believability Assessment – Drill-Down Analysis, Assumption-based Reasoning, and What-If Scenarios						
Unit – 3	ONTOLOGIES – DESIGN AND DEVELOPMENT					C03 9 Hrs
Concepts and Instances – Generalization Hierarchies – Object Features – Defining Features – Representation – Transitivity – Inheritance – Concepts as Feature Values – Ontology Matching. Design and Development Methodologies – Steps in Ontology Development – Domain Understanding and Concept Elicitation – Modelling-based Ontology Specification.						
Unit – 4	REASONING WITH ONTOLOGIES AND RULES					C04 9 Hrs
Production System Architecture – Complex Ontology-based Concepts – Reduction and Synthesis rules and the Inference Engine – Evidence-based hypothesis analysis – Rule and Ontology Matching – Partially Learned Knowledge – Reasoning with Partially Learned Knowledge						
Unit – 5	LEARNING AND RULE LEARNING					C05 9 Hrs
Machine Learning – Concepts – Generalization and Specialization Rules – Types – Formal definition of Generalization. Modelling, Learning and Problem Solving – Rule learning and Refinement – Overview – Rule Generation and Analysis – Hypothesis Learning						
Total Hours						45
Textbooks:						
1	Artificial Intelligence: A Modern Approach, Stuart Russell, Peter Norvig, Pearson, Fourth Edition, 2020.					
2	Knowledge Graphs, Aidan Hogan, et al., Morgan & Claypool Publishers, First Edition, 2022.					
Reference Books:						
1	Semantic Web for the Working Ontologist, Dean Allemang, James Hendler, Association for Computing Machinery, Third Edition, 2020.					
2	Ela Kumar, Knowledge Engineering, I K International Publisher House, 2018.					
3	John F. Sowa: Knowledge Representation: Logical, Philosophical, and Computational Foundations, Brooks/Cole, Thomson Learning, 2000.					
Web References:						

1	https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_expert_systems.htm
2	https://www.w3.org/standards/semanticweb/ontology

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	60		40			
Apply	40	100	60			
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/ POs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
C512.1	3	2	-	-	-	-	-	-	-	-	-	2	-
C512.2	2	3	3	2	3	-	-	-	-	-	-	3	2
C512.3	2	3	3	2	3	-	-	-	-	-	-	3	2
C512.4	2	3	2	3	2	-	-	-	-	-	-	3	2
C512.5	2	2	-	2	2	-	-	-	-	-	-	2	2

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

OPEN ELECTIVES

Open Elective Courses offered by AI&DS to other Departments

S No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	Credits	Cat.
1.	24OE601	Text Analytics	3/0/0	3	3	OE
2.	24OE602	Introduction to Artificial Intelligence	3/0/0	3	3	OE
3.	24OE603	Health Informatics	3/0/0	3	3	OE
4.	24OE604	Management Analytics	3/0/0	3	3	OE
5.	24OE605	Data Science Essentials	3/0/0	3	3	OE

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE601	TEXT ANALYTICS	OE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	OPEN ELECTIVE	-	-			
Pre-requisite Course(s)		Co-requisite Course(s)				
-		-				
Course Objectives						
1	To understand the methods for keyword extraction from documents.					
2	To learn clustering methods for grouping of documents.					
3	To explore the methods for classification of documents and E-mails.					
4	To explore text visualization techniques and anomaly detection.					
5	To learn about Events and trends in text streams					
Course Outcomes						
Upon completion of the course, students will be able to						
C601.1	Design text extraction techniques.					[U]
C601.2	Devise clustering techniques for text mining					[AP]
C601.3	Design classification techniques for text mining					[AP]
C601.4	Apply visualization techniques and perform anomaly & trend detection					[AP]
C601.5	Perform Event operations in Text streams					[AP]
Course Contents						
Unit – 1	TEXT EXTRACTION					9
Introduction- Rapid automatic keyword extraction: candidate keywords, keyword scores, adjoining keywords, extracted keywords-Benchmark evaluation: precision and recall, efficiency, stoplist generation, Evaluation on new articles.						
Unit – 2	DOCUMENT CLUSTERING					9
Multilingual document clustering: Multilingual LSA, Tucker1 method, PARAFAC2 method, LSA with term alignments, LMSA, LMSA with term alignments; Constrained clustering with k-means type algorithms						
Unit – 3	CONTENT BASED CLASSIFICATION					9
Classification algorithms for Document Classification, Content-based spam email classification, Utilizing nonnegative matrix factorization for email classification problems.						
Unit – 4	ANOMALY AND TREND DETECTION					9
Text visualization techniques: Visualization in text analysis, Tag clouds, tag clouds, authorship and change tracking, Data Exploration and the search for novel patterns, sentiment tracking, visual analytics and Future Lens, scenario discovery. Adaptive threshold setting for novelty mining: Introduction, adaptive threshold for anomaly detection, Experimental study.						
Unit – 5	TEXT STREAMS					9
Events and trends in text streams: Introduction, Text streams, Feature extraction and data reduction, Event detection, Trend detection, Event and trend descriptions. Embedding semantics in LDA topic models: Introduction, vector space modeling, latent semantic analysis, probabilistic latent semantic analysis, Latent Dirichlet allocation, embedding external semantics from Wikipedia, data-driven semantic embedding.						
Total Hours						45
Reference Books:						
1	Michael W. Berry & Jacob Kogan,"Text Mining Applications and Theory", Wiley publications, 2010					
2	Aggarwal, Charu C., and ChengXiangZhai, eds., "Mining text data", Springer Science & Business Media, 2012.					
3	Miner, Gary, et al., "Practical text mining and statistical analysis for non-structured text data applications", Academic Press, 2012.					
4	Srivastava, Ashok N., and MehranSahami, "Text mining: Classification, clustering, and applications", Chapman and Hall/CRC, 2009.					

5	Buitelaar, Paul, Philipp Cimiano, and Bernardo Magnini, eds., "Ontology learning from text: methods, evaluation and applications", Vol. 123. IOS press, 2005.
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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				100%	100%	100%
Understand	80%		20%			
Apply	20%	100%	80%			
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/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO3
C601.1	3	3	3	3	2	-	-	-	-	-	3	3	3	-
C601.2	3	3	3	3	2	-	-	-	-	-	3	3	3	-
C601.3	3	3	3	3	2	-	-	-	-	-	3	3	3	-
C601.4	3	3	3	3	2	-	-	-	-	-	3	3	3	-
C601.5	3	3	3	3	2	-	-	-	-	-	3	3	3	-

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE602	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	OE	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 learn what Artificial Intelligence is, its history, and how intelligent agents work.					
2	To understand how AI solves problems using different search methods.					
3	To study various search algorithms like breadth-first, depth-first, and others.					
4	To learn how AI plays games and how it uses knowledge to make decisions.					
5	To understand how AI represents knowledge and reasons using logic and categories.					
Course Outcomes						
Upon completion of the course, students will be able to						
CO602.1	Enumerate the history and foundations of Artificial Intelligence.					[U]
CO602.2	Apply the basic principles of AI in problem solving. (Apply-L3).					[AP]
CO602.3	Illustrate the different searching algorithms to find and optimize the solution for the given problem.					[AP]
CO602.4	Illustrate the different gaming algorithms and identify the importance of knowledge representation in Artificial Intelligence.					[AP]
CO602.5	Describe the use of predicate logic to represent the knowledge in the AI domain.					[U]
Course Contents						
Unit – I	INTRODUCTION					9
What is AI?, The Foundations of Artificial Intelligence, The History of Artificial Intelligence, The State of the Art, Agents and Environments, Good Behaviour: The Concept of Rationality, The Nature of Environments, The Structure of Agents.						
Unit – II	PROBLEM SOLVING AND SEARCH ALGORITHMS					9
Problem-Solving Agents, Example Problems, searching for Solutions, search algorithms terminologies, properties of search algorithms, types of search algorithms. Informed and Uninformed Search Strategies, Informed (Heuristic) Search Algorithms : Best first search, A* Algorithm, AO* Algorithm, and Local Search Algorithms. Searching with Non-deterministic Actions.						
Unit – III	SEARCH ALGORITHMS: UNIFORMED / BLIND SEARCH ALGORITHMS					9
Breadth-first Search, Depth-first Search, Depth-limited Search, Iterative deepening depth-first search, Uniform cost search, Bidirectional Search.						
Unit – IV	GAME PLAYING AND KNOWLEDGE-BASED AGENT					9
Adversarial Search/ Game Playing: Introduction, Minimax algorithm, Alpha-Beta pruning. Knowledge-Based Agent: Architecture, Knowledge base Levels, Types, Knowledge Representation mappings, forward and backward chaining/Reasoning techniques of inference engine, Approaches of knowledge representation, issues in knowledge representation.						
Unit – V	KNOWLEDGE REPRESENTATION TECHNIQUES					9
Propositional Logic: A Very Simple Logic, Ontological Engineering, Categories and Objects, Events, Mental Events and Mental Objects, What is Reasoning? Types of Reasoning and Reasoning Systems for Categories, The Internet Shopping World.						
Total Hours						45
Textbooks:						
1	Stuart Russell, Peter Norvig, “Artificial Intelligence: A Modern Approach”, 3rd edition, Prentice Hall, 2009.Canalsouse 2 nd Ed., Pearson Education International,2003.					
2	Saroj Kaushik, “Artificial Intelligence”, Cengage Learning India,2011					
3	Rich & Knight, Artificial Intelligence, second edition,Tata Mc GrawHill.					
Reference Books:						

1	Nils Nilsson, "Artificial Intelligence: A New Synthesis", Morgan Kaufmann, 1998
2	David Poole, Alan Mackworth, "Artificial Intelligence: Foundations for Computational Agents", Cambridge Univ. Press, 2010.
3	Ronald Brachman, "Knowledge Representation and Reasoning", Morgan Kaufmann, 2004.
4	Frank van Harmelen, Vladimir Lifschitz, Bruce Porter (Eds), "Handbook of Knowledge representation", Elsevier, 2008.
5	Ivan Bratko, "Prolog Programming for Artificial Intelligence", 4thEd., Addison-Wesley, 2011.
Web References:	
1	https://onlinecourses.nptel.ac.in/noc24_cs08/preview
2	https://nptel.ac.in/domains/discipline/106?course=106_0

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				100%	100%	100%
Understand	50%		40%			
Apply	50%	100%	60%			
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/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
C602.1	3	1	1	1	1	1	1	1	1	1	1	3	1	1
C602.2	3	3	2	2	1	1	1	1	1	1	1	3	1	2
C602.3	3	3	2	2	1	1	1	1	1	1	1	3	1	2
C602.4	3	2	1	1	1	1	1	1	1	1	1	3	1	1
C602.5	3	2	1	1	1	1	1	1	1	1	1	1	1	2

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE603	HEALTH INFORMATICS	OE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	THEORY	-	-----			
Pre-requisite Course(s)		Co-requisite Course(s)				
ARTIFICIAL INTELLIGENCE, PYTHON PROGRAMMING, MACHINE LEARNING,DEEP LEARNING		-				
Course Objectives						
1	To understand the health data formats, health care policy and standards.					
2	To understand the significance and need of data analysis and data visualization.					
3	To understand the health data management frameworks.					
4	To apply the machine learning and deep learning algorithms in healthcare.					
5	To apply healthcare analytics for critical care applications.					
Course Outcomes						
Upon completion of the course, students will be able to						
C603.1	Understand the basics of health data analysis.					[U]
C603.2	Apply the Machine Learning techniques for analysis.					[AP]
C603.3	Apply various evaluation metrics on healthcare data.					[AP]
C603.4	Implement python frameworks on healthcare data.					[AP]
C603.5	Implement various healthcare management techniques.					[AP]
Course Contents						
Unit – I	INTRODUCTION TO HEALTHCARE ANALYSIS					9
Overview - History of Healthcare Analysis Parameters on medical care systems- Health care policy- Standardized code sets – Data Formats.						
Unit – II	ANALYTICS ON MACHINE LEARNING					9
Machine Learning Foundations: Tree Like reasoning , Probabilistic reasoning and Bayes Theorem, Weighted sum approach - Machine Learning Pipeline – Pre-processing –Visualization – Feature Selection – Training model parameter.						
Unit – III	EVALUATION METRICS					9
Evaluation model: Sensitivity, Specificity, PPV, NPV, FPR, Accuracy, ROC, Precision Recall Curves, Valued target variables – Python: Variables and types, Data Structures and containers.						
Unit – IV	PYTHON IN HEALTHCARE					9
Pandas Data Frame: Operations – Scikit –Learn: Pre-processing, Feature Selection - IOT- Smart Sensors – Migration of Healthcare Relational database to NoSQL Cloud Database.						
Unit – V	HEALTHCARE MANAGEMENT					9
Decision Support System – Matrix block Cipher System – Semantic Framework Analysis – Histogram bin Shifting and Rc6 Encryption – Clinical Prediction Models – Visual Analytics for Healthcare.						
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.					
Reference Books:						
1	Vikas Kumar, “Health Care Analysis Made Simple”, Packt Publishing, 2018.					

2	Nilanjan Dey, Amira Ashour , Simon James Fong, Chintan Bhatl, “Health Care Data Analysis and Management, First Edition, Academic Press, 2018.
3	Kulkarni , Siarry, Singh ,Abraham, Zhang, Zomaya , Baki, “Big Data Analytics in HealthCare”, Springer, 2020.
4	Deep Learning- Ian Goodfellow, Yoshua Benjio, Aaron Courville, The MIT Press.
Web References:	
1	https://onlinecourses.nptel.ac.in/noc22_hs40/preview .

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				100%	100%	100%
Understand	40%	-	20%			
Apply	60%	100%	80%			
Analyze						
Evaluate						
Create						
Total (100 Marks)				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/ 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
C603.1	3	2	2	1	1	-	-	-	-	-	-	3	-	2
C603.2	3	3	2	2	2	-	-	-	-	-	-	3	-	2
C603.3	3	3	2	2	2	-	-	-	-	-	-	3	-	2
C603.4	3	2	2	1	1	-	-	-	-	-	-	3	-	1
C603.5	3	2	3	1	1	-	-	-	-	-	-	3	-	2

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE604	MANAGEMENT ANALYTICS	HS	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 explain the relationship between BA and organizational decision-making.					
2	To analyze organizational structures for effective Business Analytics.					
3	To apply the appropriate analytics and generate solutions.					
4	To model and analyse the business situation using analytics.					
5	To recognize the concepts and techniques of prescriptive analytics					
Course Outcomes						
Upon completion of the course, students will be able to						
C604.1	Understand the fundamental concepts, terminologies, processes, and importance of Business Analytics in decision making.					[U]
C604.2	Demonstrate the management of BA personnel, data, and technology.					[AP]
C604.3	Apply descriptive analytics techniques to visualize, explore, and summarize the data.					[AP]
C604.4	Apply the principles of predictive analytics, including logic-driven and data-driven models.					[AP]
C604.5	Implement the application of prescriptive analytics in demonstrating business performance improvement.					[AP]
Course Contents						
Unit – 1	INTRODUCTION TO BUSINESS ANALYTICS (BA)					9
Business Analytics –Terminologies-Process-Importance-Relationship with Organisational Decision Making-Analytics in Decision Making-BA for Competitive Advantage.						
Unit – 2	MANAGEING RESOURCES FOR BUSINESS ANALYTICS					9
Managing BA Personnel-Data and Technology - Organisational Structures aligning BA-Managing Information policy-data quality and change in BA.						
Unit – 3	DESCRIPTIVE ANALYTICS					9
Introduction to Descriptive analytics – Visualising and Exploring Data – Descriptive Statistics - Sampling and Estimation - Probability Distribution for Descriptive Analytics -Analysis of Descriptive analytics.						
Unit – 4	PREDICTIVE ANALYTICS					9
Introduction to Predictive analytics - Logic and Data Driven Models - Predictive Analysis -Modeling and procedure - Data Mining for Predictive analytics. Analysis of Predictive analytics.						
Unit – 5	PRESCRITIVE ANALYTICS					9
Introduction to Prescriptive analytics - Prescriptive Modeling - Non Linear Optimisation - Demonstrating Business Performance Improvement.						
Total Hours						45
Textbooks:						
1	Marc J. Schniederjans, Dara G. Schniederjans and Christopher M. Starkey, "Business Analytics Principles, Concepts, and Applications - What, Why, and How" ,Pearson Ed, 2014					
2	Christian Albright S and Wayne L. Winston, "Business Analytics - Data Analysis and Decision Making", Fifth edition, Cengage Learning, 2015.					
Reference Books:						

1	James R. Evans, "Business Analytics - Methods, Models and Decisions", Pearson Ed, 2012.
Web References:	
1	https://www.coursera.org/learn/introduction-to-business-analytics
2	https://onlinecourses.swayam2.ac.in/imb20_mg19/preview
3	https://cce.iisc.ac.in/cce-proficiency/prescriptive-analytics-jm-2025/

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				100%	100%	100%
Understand	80%		20%			
Apply	20%	100%	80%			
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/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO3
C604.1	2	1	-	-	-	-	-	-	-	2	1	2	2	1
C604.2	2	2	2	2	-	-	-	-	2	1	3	2	1	1
C604.3	3	3	2	2	3	-	-	-	-	1	-	3	2	3
C604.4	3	3	3	3	-	-	-	-	-	1	-	3	3	2
C604.5	3	3	3	2	2	-	-	-	-	1	2	3	3	2

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE605	DATA SCIENCE ESSENTIALS	OE	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 Data Science steps to solve basic data-driven problems.					
2	To manipulate data using NumPy, Pandas and identify optimization bottlenecks.					
3	To apply machine learning algorithms for classification and regression tasks.					
4	To create visualizations using Matplotlib and Seaborn for complex datasets.					
5	To handle large datasets using efficient tools and programming techniques.					
Course Outcomes						
Upon completion of the course, students shall have ability to						
C605.1	Understand the steps of the Data Science process, including defining research goals, retrieving data, and preparing data, to solve basic data-driven problems.					[U]
C605.2	Implement data manipulation methods in NumPy and Pandas, identifying potential bottlenecks and areas for optimization.					[AP]
C605.3	Apply machine learning algorithms to solve classification and regression problems, using appropriate tools and techniques.					[AP]
C605.4	Apply various data visualization techniques using Matplotlib and Seaborn to create and customize visual representations of complex datasets					[AP]
C605.5	Apply techniques and programming strategies to handle large volumes of data effectively by leveraging appropriate tools and methods					[AP]
Course Contents						
Unit – I	INTRODUCTION					6
Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – retrieving data – data preparation - Exploratory Data analysis – build the model – presenting findings and building applications - Data Mining - Data Warehousing – Basic statistical descriptions of Data.						
Unit – II	DATA MANIPULATION					12
Python Shell - Jupyter Notebook - IPython Magic Commands - NumPy Arrays-Universal Functions – Aggregations – Computation on Arrays – Fancy Indexing – Sorting arrays – Structured data – Data manipulation with Pandas – Data Indexing and Selection – Handling missing data – Hierarchical indexing – Combining datasets – Aggregation and Grouping – String operations – Working with time series – High performance						
Unit – III	MACHINE LEARNING					9
The modeling process - Types of machine learning - Supervised learning - Unsupervised learning - Semi-supervised learning- Classification, regression - Clustering – Outliers and Outlier Analysis.						
Unit – IV	DATA VISUALIZATION					9
Importing Matplotlib – Simple line plots – Simple scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three-dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn.						
Unit – V	HANDLING LARGE DATA					9
Problems - techniques for handling large volumes of data - programming tips for dealing with large data sets- Case studies: Predicting malicious URLs, building a recommender system - Tools and techniques needed - Research question - Data preparation - Model building – Presentation and automation.						
Total Hours						45
Textbooks:						
1	David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016.					

2	Jake VanderPlas, "Python Data Science Handbook", O'Reilly, 2016.
Reference Books:	
1	Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017
2	Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press, 2014.
Web References:	
1	https://onlinecourses.nptel.ac.in/noc24_cs68/preview
2	https://archive.nptel.ac.in/courses/106/106/106106139/

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				100%	100%	100%
Understand	50%		20%			
Apply	50%	100%	80%			
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/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO3
C605.1	3	3	2	2	3	1	1	1	1	2	1	3	2	3
C605.2	3	3	3	2	3	1	1	1	1	1	2	3	3	3
C605.3	3	3	3	3	3	1	1	1	2	2	2	3	3	3
C605.4	2	2	3	2	3	1	1	1	2	3	2	2	3	2
C605.5	3	3	3	3	3	2	1	1	2	2	3	3	3	3

Open Elective courses offered to AI&DS by other Departments

S No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	Credits	Cat.
1.	24OE606	Fundamentals of Computer vision	3/0/0	3	3	OE
2.	24OE607	Machine Learning and its applications	3/0/0	3	3	OE
3.	24OE608	Deep Learning Techniques	3/0/0	3	3	OE
4.	24OE609	Language Engineering	3/0/0	3	3	OE
5.	24OE610	Neural Networks	3/0/0	3	3	OE
6.	24OE611	Database Fundamentals	3/0/0	3	3	OE
7.	24OE612	Basics of Image Processing	3/0/0	3	3	OE
8.	24OE613	Agile Methodologies	3/0/0	3	3	OE
9.	24OE614	Web Technology Fundamentals	3/0/0	3	3	OE
10.	24OE615	App Development Fundamentals	3/0/0	3	3	OE
11.	24OE616	Introduction to Augmented Reality/Virtual Reality	3/0/0	3	3	OE
12.	24OE617	Software Engineering	3/0/0	3	3	OE
13.	24OE618	Foundation of Cloud Computing	3/0/0	3	3	OE
14.	24OE619	Java Programming	3/0/0	3	3	OE
15.	24OE620	Blockchain Technology	3/0/0	3	3	OE
16.	24OE621	Introduction to VLSI design	3/0/0	3	3	OE
17.	24OE622	Communication Engineering	3/0/0	3	3	OE
18.	24OE623	Sensors and Actuators	3/0/0	3	3	OE
19.	24OE624	Embedded System	3/0/0	3	3	OE
20.	24OE625	Introduction to Internet of Things	3/0/0	3	3	OE
21.	24OE626	Industrial Automation with PLC and SCADA	3/0/0	3	3	OE
22.	24OE627	Electric Vehicle Technology	3/0/0	3	3	OE
23.	24OE628	Energy Technology	3/0/0	3	3	OE
24.	24OE629	Battery Management Systems	3/0/0	3	3	OE
25.	24OE630	Power Converters for Electrical Appliances	3/0/0	3	3	OE
26.	24OE631	Foundation of Robotics	3/0/0	3	3	OE

27.	24OE632	Basics of Drone Technology	3/0/0	3	3	OE
28	24OE633	Industrial Management	3/0/0	3	3	OE
29.	24OE634	Additive Manufacturing	3/0/0	3	3	OE
30.	24OE635	Introduction to Non- Destructive Testing	3/0/0	3	3	OE
31.	24OE636	Fundamentals of Operations Research	3/0/0	3	3	OE
32.	24OE637	Organizational Behaviour	3/0/0	3	3	OE
33.	24OE638	Total Quality Management	3/0/0	3	3	OE
34.	24OE639	Intellectual Property Rights	3/0/0	3	3	OE
35.	24OE640	Emotional Intelligence	3/0/0	3	3	OE
36.	24OE641	Algebra and Number Theory	3/0/0	3	3	OE
37.	24OE642	Linear Algebra	3/0/0	3	3	OE
38	24OE643	Advanced Engineering Chemistry	3/0/0	3	3	OE
39.	24OE644	Nanotechnology and NLO Materials	3/0/0	3	3	OE
40.	24OE645	English for Competitive Examinations	3/0/0	3	3	OE

Course Code	Course Name	Category	Hours/Week			C	
			L	T	P		
24OE606	FUNDAMENTALS OF COMPUTER VISION	OE	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 in C, Probability and Statistics		-					
Course Objectives							
1	To understand the fundamental concepts related to Image formation and processing.						
2	To learn feature detection, matching and detection						
3	To become familiar with feature-based alignment and motion estimation						
4	To develop skills on 3D reconstruction						
5	To understand image-based rendering and recognition						
Course Outcomes							
Upon completion of the course, students will be able to							
C606.1	To understand basic knowledge, theories and methods in image processing and computer vision.					[U]	
C606.2	To implement basic and some advanced image processing techniques in OpenCV.					[AP]	
C606.3	To apply 2D feature- based image alignment, segmentation and motion estimations.					[AP]	
C606.4	To apply 3D image reconstruction techniques					[AP]	
C606.5	To design and develop innovative image processing and computer vision applications.					[AP]	
Course Contents							
Unit – 1	INTRODUCTION TO IMAGE FORMATION AND PROCESSING					C01	9 Hrs
Computer Vision - Geometric primitives and transformations - Photometric image formation - The digital camera - Point operators - Linear filtering - More neighborhood operators - Fourier transforms - Pyramids and wavelets - Geometric transformations - Global optimization.							
Unit – 2	FEATURE DETECTION, MATCHING AND SEGMENTATION					C02	9 Hrs
Points and patches - Edges - Lines - Segmentation - Active contours - Split and merge - Mean shift and mode finding - Normalized cuts - Graph cuts and energy-based methods.							
Unit – 3	FEATURE-BASED ALIGNMENT & MOTION ESTIMATION					C03	9 Hrs
2D and 3D feature-based alignment - Pose estimation - Geometric intrinsic calibration - Triangulation - Two-frame structure from motion - Factorization - Bundle adjustment - Constrained structure and motion - Translational alignment - Parametric motion - Spline-based motion - Optical flow - Layered motion.							
Unit – 4	3D RECONSTRUCTION					C04	9 Hrs
Shape from X - Active range finding - Surface representations - Point-based representations - Volumetric representations - Model-based reconstruction - Recovering texture maps and albedosos.							
Unit – 5	IMAGE-BASED RENDERING AND RECOGNITION					C05	9 Hrs
View interpolation Layered depth images - Light fields and Lumigraphs - Environment mattes - Video-based rendering-Object detection - Face recognition - Instance recognition - Category recognition - Context and scene understanding- Recognition databases and test sets.							
Total Hours						45	
Textbooks:							
1	D. A. Forsyth, J. Ponce, <i>Computer Vision: A Modern Approach</i> , 2nd Edition, Pearson India, Latest Reprint 2025.						
2	Richard Szeliski, <i>Computer Vision: Algorithms and Applications</i> , 2nd Edition, Springer, 2022.						
Reference Books:							
1	Richard Hartley and Andrew Zisserman, <i>Multiple View Geometry in Computer Vision</i> , Second Edition, Cambridge University Press, March 2004						
2	Christopher M. Bishop; <i>Pattern Recognition and Machine Learning</i> , Springer, 2006						
Web References:							

1	https://archive.nptel.ac.in/courses/106/105/106105216/
2	https://opencv.org/opencv-free-course/

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	
Understand	20	20	20			
Apply	80	80	80			
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/ 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
C606.1	3	2	-	-	2	-	-	-	-	-	2	2	-
C606.2	3	3	2	2	3	-	-	-	-	-	2	3	2
C606.3	3	2	2	2	3	-	-	-	-	-	2	3	2
C606.4	3	3	3	3	2	-	-	-	-	-	2	3	2
C606.5	3	3	2	3	3	2	2	2	2	-	3	3	2

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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE607	Machine Learning and its Applications	OE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	THEORY		-----			
Pre-requisite Course(s)		Co-requisite Course(s)				
Nil		-				
Course Objectives						
1	To understand the basic concepts of machine learning.					
2	To understand and build supervised learning models.					
3	To understand and build unsupervised learning models.					
4	To design the algorithms based on corresponding metrics identified.					
5	To make use of classification algorithms, build the machine learning experiments.					
Course Outcomes						
Upon completion of the course, students shall have ability to						
C607.1	Understand the fundamental concepts and applications of machine learning.					U
C607.2	Apply preprocessing techniques and appropriate machine learning algorithms to real-world problems.					AP
C607.3	Apply supervised learning algorithms and evaluate model performance.					AP
C607.4	Implement ensemble and unsupervised learning techniques.					AP
C607.5	Design, evaluate, and compare machine learning experiments using appropriate statistical tools.					AP
Course Contents						
Unit – 1	INTRODUCTION TO MACHINE LEARNING					9
Introduction to Machine Learning and its importance, Types of Machine Learning: Supervised, Unsupervised, and Reinforcement Learning, Basic concepts: features, labels, training data, etc., Popular Machine Learning algorithms: Linear Regression, Logistic Regression, Decision Trees, kNearest Neighbors, etc., Evaluation metrics for Machine Learning models: accuracy, precision, recall, F1-score, etc.						
Unit – 2	MACHINE LEARNING TECHNIQUES					9
Machine Learning Techniques Data preprocessing techniques: handling missing data, feature scaling, feature encoding, etc., Model selection and hyperparameter tuning, Cross-validation techniques, Ensemble methods: Bagging, Boosting, Random Forests, etc., Introduction to deep learning and neural networks						
Unit – 3	SUPERVISED LEARNING					9
Linear Regression Models: Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function – Perceptron algorithm, Probabilistic discriminative model - Logistic regression, Probabilistic generative model – Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree, Random Forests.						
Unit – 4	APPLICATIONS OF MACHINE LEARNING					9
Ensemble learning applications, Voting technique, Bagging method, Boosting method, Stacking approach, Recommendation systems, K-means clustering for segmentation, KNN for classification, Anomaly detection.						
Unit – 5	MACHINE LEARNING PROJECT DESIGN AND ANALYSIS					9
Problem definition, Data collection, Data preprocessing, Model training (classification), Model training (regression), Model evaluation metrics, Model comparison, Model deployment basics, Ethical issues and challenges in real-world machine learning applications.						
Total Hours						45
Text books:						
1	EthemAlpaydin, “Introduction to Machine Learning”, MIT Press, Fourth Edition, 2020.					

2	Stephen Marsland, “Machine Learning: An Algorithmic Perspective, “Second Edition”, CRC Press, 2022.
Reference Books:	
1	Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
2	Tom Mitchell, “Machine Learning”, McGraw Hill, 3rd Edition, 1997.
3	MehryarMohri, Afshin Rostamizadeh, Ameet Talwalkar, “Foundations of Machine Learning”, Second Edition, MIT Press, 2018.
4	Ian Goodfellow, YoshuaBengio, Aaron Courville, “Deep Learning”, MIT Press, 2016
5	SebastainRaschka, Vahid Mirjalili , “Python Machine Learning”, Packt publishing 3rd Edition, 2019.
Web References:	
1	https://www.coursera.org/lecture/python-machine-learning/introduction-4f2So2
2	https://nptel.ac.in/courses/106/106/106106139/

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)			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand	80%	20%	20%			
Apply	20%	80%	80%			
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/ POs	P O1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2
C607.1	3	2	-	-	2	-	-	-	-	-	1	-	3
C607.2	3	3	2	2	3	-	-	-	-	-	2	-	3
C607.3	3	3	3	2	3	-	-	-	-	-	2	-	3
C607.4	3	3	3	3	3	-	-	-	-	-	2	-	3
C607.5	3	3	3	3	3	-	-	-	-	-	3	-	3

3 - Strong 2 - Moderate 1 - Weak - - no correlation

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
240E608	Deep Learning Techniques	OE	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)				
Fundamentals of Machine Learning		Artificial Intelligence				
Course Objectives						
1	To understand principles of deep neural networks.					
2	To understand CNN architectures of deep neural networks.					
3	To understand RNN architectures of deep neural networks.					
4	To comprehend advanced deep learning models.					
5	To learn the evaluation metrics for deep learning models.					
Course Outcomes						
Upon completion of the course, students will be able to						
C608.1	Understand the basics in deep neural networks.					U
C608.2	Apply Convolution Neural Network for image processing.					AP
C608.3	Apply Recurrent Neural Network and its variants for text analysis.					AP
C608.4	Demonstrate the model evaluation for various applications.					AP
C608.5	Apply autoencoders and generative models for suitable applications.					AP
Course Contents						
Unit – 1	DEEP NETWORKS BASICS				C01	10
Linear Algebra: Scalars -- Vectors -- Matrices and tensors; Probability Distributions -- Gradient-based Optimization -- Machine Learning Basics: Capacity -- Overfitting and underfitting --Hyperparameters and validation sets -- Estimators -- Bias and variance -- Stochastic gradient descent -- Deep Networks: Deep feedforward networks; Regularization -- Optimization.						
Unit – 2	CONVOLUTIONAL NEURAL NETWORKS				C02	10
Convolution Operation -- Sparse Interactions -- Parameter Sharing -- Equivariance -- Pooling -- Convolution Variants: Strided -- Tiled -- Transposed and dilated convolutions; CNN Learning: Nonlinearity Functions -- Loss Functions -- Regularization -- Optimizers --Gradient Computation.						
Unit – 3	RECURRENT NEURAL NETWORKS				C03	9
Unfolding Graphs -- RNN Design Patterns: Acceptor -- Encoder --Transducer; Gradient Computation -- Sequence Modeling Conditioned on Contexts -- Bidirectional RNN -- Sequence to Sequence RNN -- Deep Recurrent Networks -- Recursive Neural Networks -- Long Term Dependencies; Leaky Units: Skip connections and dropouts; Gated Architecture: LSTM.						
Unit – 4	MODEL EVALUATION				C04	8
Performance metrics -- Baseline Models -- Hyperparameters: Manual Hyperparameter -- Automatic Hyperparameter -- Grid search -- Random search -- Debugging strategies.						
Unit – 5	AUTOENCODERS AND GENERATIVE MODELS				C05	8
Autoencoders: Undercomplete autoencoders -- Regularized autoencoders -- Stochastic encoders and decoders -- Learning with autoencoders; Deep Generative Models: Variational autoencoders -- Generative adversarial networks - DALL-E, DALL-E 2 and IMAGEN						
Total Hours						45
Textbooks:						
1	Ian Goodfellow, Yoshua Bengio, Aaron Courville, ``Deep Learning'', MIT Press, 2018.					
2	Andrew Glassner, "Deep Learning: A Visual Approach". No Starch Press. 2021.					

3	Salman Khan, Hossein Rahmani, Syed Afaq Ali Shah, Mohammed Bennamoun, "A Guide to Convolutional Neural Networks for Computer Vision", Synthesis Lectures on Computer Vision, Morgan & Claypool publishers, 2018.
Reference Books:	
1	Francois Chollet, "Deep Learning with Python", Manning Publications Co, 2018.
2	Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer International Publishing, 2018.
3	Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2021.
4	Yoav Goldberg, "Neural Network Methods for Natural Language Processing", Synthesis Lectures on Human Language Technologies, Morgan & Claypool publishers, 2020.
Web References:	
1	https://nptel.ac.in/courses/
2	https://aikosh.indiaai.gov.in/static/Deep+Learning+Ian+Goodfellow.pdf

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						
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/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS 01	PS 02
C608.1	3	2	1	-	1	-	-	-	-	-	-	2	1
C608.2	3	3	2	2	3	-	-	-	-	-	1	3	2
C608.3	2	3	3	2	3	-	-	-	1	-	1	3	3
C608.4	2	3	2	3	2	-	-	-	-	-	1	2	2
C608.5	1	2	3	2	3	-	-	-	1	1	1	3	3

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

Course Code	Course Name	Category	Hours/ Week	C		
			L	T	P	
24OE609	Language engineering	OE	3	0	2	4
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	Theory	4	-----			
Pre-requisite Course(s)		Co-requisite Course(s)				
Nil		Natural Language processing				
Course Objectives						
1	To understand the fundamentals of natural language processing					
2	To construct the word level analysis methods					
3	To identify word class methods and models					
4	To construct Context Free Grammar in syntactic analysis					
5	To develop parsing concepts in syntactic analysis					
Course Outcomes						
Upon completion of the course, students shall have ability to						
C609.1	Understand basic language features for the given text.					U
C609.2	Build a rule based system to tackle morphology/syntax of a language					AP
C609.3	Build a rule based tagging and models for word level applications.					AP
C609.4	Apply different statistical approaches for CFG applications.					AP
C609.5	Build innovative parsing concepts to process natural language.					AP
Course Contents						
Unit – 1	INTRODUCTION					9
Origins and challenges of NLP – Language Modeling: Grammar-based LM, Statistical LM - Regular Expressions, Finite-State Automata – English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance.						
Unit – 2	WORD LEVEL ANALYSIS					9
Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging.						
Unit – 3	WORD LEVEL MODELS					9
Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models.						
Unit – 4	SYNTACTIC ANALYSIS -Context-Free Grammars					9

Context-Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar.		
Unit – 5	SYNTACTIC ANALYSIS -Parsing concepts	9
Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs - Feature structures, Unification of feature structures.		
Total Hours		45
Textbooks:		
1	Daniel Jurafsky, James H. Martin—Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication, 2014.	
2	Steven Bird, Ewan Klein and Edward Loper, —Natural Language Processing with Python, First Edition, O'Reilly Media, 2009.	
Reference Books:		
1	Breck Baldwin, —Language Processing with Java and LingPipe Cookbook, Atlantic Publisher, 2015.	
2	Richard M Reese, —Natural Language Processing with Java, O'Reilly Media, 2015.	
4	Tanveer Siddiqui, U.S. Tiwary, “Natural Language Processing and Information Retrieval”, Oxford University Press, 2008.	
Web References:		
1	https://onlinecourses.nptel.ac.in/noc23_cs45/preview	

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)			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand	80%	20%	20%			
Apply	20%	80%	80%			
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/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
C609.1	3	2	1	2	1	-	-	-	-	1	-	-	-	2
C609.2	3	3	2	2	-	-	-	-	-	2	-	-	-	2
C609.3	3	3	2	3	-	-	-	-	-	2	-	-	-	2
C609.4	3	3	2	2	-	-	-	-	-	1	-	-	-	2
C609.5	3	3	3	3	-	-	-	-	-	2	-	-	-	2

3 - Strong 2 - Moderate 1 - Weak - - no correlation

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE610	Neural Networks	OE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
24	THEORY	VI				
Pre-requisite Course(s)		Co-requisite Course(s)				
Programming Fundamentals		Artificial Intelligence				
Course Objectives						
1	Introduce the basic concepts of biological neurons and artificial neural networks .					
2	Explain different neural network architectures and learning algorithms .					
3	Provide knowledge of fuzzy sets, fuzzy logic, and fuzzy reasoning systems .					
4	Understand fuzzy inference systems and fuzzy controllers used in industrial applications .					
5	Explain the principles and applications of genetic algorithms for optimization problems .					
Course Outcomes						
Upon completion of the course, students will be able to						
C610.1	Explain the structure and working of biological and artificial neural networks.					[U]
C610.2	Apply perceptron learning and back propagation algorithms to neural network models.					[AP]
C610.3	Understand fuzzy sets, fuzzy relations and operations in fuzzy logic.					[U]
C610.4	Design fuzzy inference systems and fuzzy controllers for real-world applications.					[AP]
C610.5	Apply genetic algorithms for optimization and problem solving					[AP]
Course Contents						
Unit – 1	Introduction & Architecture					C01 9 Hrs
Neuron, nerve structure and synapse. Artificial neuron and its model. Activation functions. Neural network architecture: single layer feed forward networks, multilayer feed forward networks, recurrent networks. Various learning techniques: perceptron learning rule, convergence rule. Auto-associative memory and hetero-associative memory.						
Unit – 2	Back Propagation Networks					C02 10 Hrs
Architecture of neural networks. Perceptron model and solution. Single layer artificial neural network. Multilayer perceptron model. Back propagation learning methods. Effect of learning rule coefficient. Back propagation algorithm. Factors affecting back propagation training. Applications of back propagation networks.						
Unit – 3	Fuzzy Logic – I (Introduction)					C03 8 Hrs
Basic concepts of fuzzy logic. Fuzzy sets and crisp sets. Fuzzy set theory and operations. Properties of fuzzy sets. Fuzzy relations and crisp relations. Fuzzy to crisp conversion.						
Unit – 4	Fuzzy Logic – II (Membership Functions and Rules)					C04 9 Hrs
Membership functions. Inference in fuzzy logic. Fuzzy IF-THEN rules. Fuzzy implications and fuzzy algorithms. Fuzzification and defuzzification. Fuzzy controller. Industrial applications of fuzzy logic.						
Unit – 5	Genetic Algorithms (GA)					C05 9 Hrs
Basic concepts of genetic algorithms. Working principle of GA. Procedure of GA. Flow chart of GA. Genetic representation (encoding). Initialization and selection. Genetic operators. Mutation. Generational cycle. Applications of genetic algorithms.						
Total Hours						45
Textbooks:						
1	Soft Computing and Machine Learning: A Fuzzy and Neutrosophic View of Reality, Mohd Anas Wajid, Aasim Zafar, Mohammad Saif Wajid, Akib Mohi Ud Din Khanday, Pronaya Bhattacharya, CRC Press, First Edition, 2025.					
2	Artificial Neural Networks and Type-2 Fuzzy Set, Snehashish Chakraverty, Arup Kumar Sahoo, Dhabaleswar Mohapatra, Elsevier, First Edition, 2025.					
Reference Books:						
1	New Horizons for Fuzzy Logic Neural Networks and Metaheuristics, Oscar Castillo, Patricia Melin,					

	Springer, First Edition, 2024.
2	Soft Computing in Interdisciplinary Sciences, S. Chakraverty, Springer, First Edition, 2022.
Web References:	
1	NPTEL Course – Fuzzy Logic and Neural Networks https://nptel.ac.in
2	Stanford Online – Machine Learning Resources https://online.stanford.edu

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	60	40	40			
Apply	40	60	60			
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/ POs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PS01	PS02
C610.1	3	2	2	1	1	1	0	0	0	0	2	2	1
C610.2	3	3	3	2	2	1	2	2	1	0	3	3	2
C610.3	2	2	2	1	1	1	0	0	0	0	2	2	1
C610.4	3	3	3	2	2	2	2	2	1	1	3	3	2
C610.5	3	3	3	3	3	2	2	2	2	1	3	3	3

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

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.
Web References:	
1.	https://nptel.ac.in/courses/106104135
2.	https://onlinecourses.nptel.ac.in/noc22_cs91/preview

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

- 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
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

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.
Web References:	
1.	https://onlinecourses.nptel.ac.in/noc22_ee116/preview
2.	https://onlinecourses.nptel.ac.in/noc26_ee31/preview

Assessment based on Continuous and End Semester Examination						
Bloom's Level	Continuous Assessment			Assignment (10 Marks)	Attendance (10 Marks)	End Semester Examination (60 Marks)
	CIA1 (6 Marks)	CIA2 (6 Marks)	Model Exam (8 Marks)			
Remember				10	10	60
Understand	100	60	80			
Apply		40	20			
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/ 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

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					C01	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					C02	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					C03	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					C04	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					C05	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 Appications– 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.	https://nptel.ac.in/courses/106105160						

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

- 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
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

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.						
Reference Books:							

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
Web References:	
1.	https://onlinecourses.swayam2.ac.in/e-learning/preview/nou24_cs09
2.	https://onlinecourses.swayam2.ac.in/e-learning/preview/nou23_cs03

Assessment based on Continuous and End Semester Examination						
Bloom's Level	Continuous Assessment			Assignment (10 Marks)	Attendance (10 Marks)	End Semester Examination (60 Marks)
	CIA1 (6 Marks)	CIA2 (6 Marks)	Model Exam (8 Marks)			
Remember				10	10	60
Understand	80	100	20			
Apply	20		80			
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/ 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

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).					
Reference Books:						
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.
Web References:	
1.	https://onlinecourses.swayam2.ac.in/e-learning/preview/nou22_ge25
2.	https://onlinecourses.nptel.ac.in/noc20_cs52/preview

Assessment based on Continuous and End Semester Examination						
Bloom's Level	Continuous Assessment			Assignment (10 Marks)	Attendance (10 Marks)	End Semester Examination (60 Marks)
	CIA1 (6 Marks)	CIA2 (6 Marks)	Model Exam (8 Marks)			
Remember				10	10	60
Understand	80	100	20			
Apply	20		80			
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/ 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
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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE616	Introduction to Augmented Reality / Virtual Reality	OE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	THEORY	4	-----			
Pre-requisite Course(s)		Co-requisite Course(s)				
-		-				
Course Objectives						
1	To impart the fundamental aspects and principles of AR/VR technologies.					
2	To know the internals of the hardware and software components involved in the development of AR enabled applications.					
3	To learn about the graphical processing units and their architectures.					
4	To gain knowledge about AR/VR application development.					
5	To know the technologies involved in the development of AR/VR based applications.					
Course Outcomes						
Upon completion of the course, students shall have ability to						
C616.1	Understand the basic concepts of AR and VR.					U
C616.2	Understand the hardware tools and technologies related to AR/VR.					U
C616.3	Apply the working principle of AR/VR software components related to Sensor devices.					AP
C616.4	Design various models using modeling techniques.					AP
C616.5	Develop AR/VR applications in different domains.					AP
Course Contents						
Unit – 1	Introduction					9
Introduction to Virtual Reality and Augmented Reality – Definition – Introduction to Trajectories and Hybrid Space-Three I's of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR-AR Technologies-Input Devices – 3D Position Trackers – Types of Trackers – Navigation and Manipulation Interfaces – 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 – 2	VR MODELING					9
Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants –Object Hierarchies – Viewing the 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing and Mapping – Behavior Modeling – Model Management.						
Unit – 3	VR PROGRAMMING					9
VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D.						
Unit – 4	APPLICATIONS					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					9

Introduction to Augmented Reality-Computer vision for AR-Interaction-Modelling and AnnotationNavigation-Wearable devices .	
Total Hours 45	
Text books:	
1	Charles Palmer, John Williamson, "Virtual Reality Blueprints: Create compelling VR experiences for mobile", Packt Publisher, 2018.
2	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
Web References:	
1	https://en.wikipedia.org/wiki/Augmented_reality
2	https://developers.google.com/ar
3	https://unity.com/unity/features/arfoundation

Assessment based on Continuous and End Semester Examination						
Bloom'sLevel	Continuous Assessment			Assign ment	Attend ance	End SemesterExa mination
	CIA1 (6 Marks)	CIA2 (6 Marks)	Model Exam (8 Marks)			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand	100	20%	40%			
Apply		80%	60%			
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/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
C616.1	3	2	2	-	3	-	-	-	2	2	1	2	2	1
C616.2	3	2	2	1	3	-	-	-	3	2	2	3	3	1
C616.3	3	3	2	2	3	-	-	-	3	2	1	2	3	2
C616.4	3	3	3	2	3	-	-	-	3	2	2	3	3	2
C616.5	3	3	3	3	3	-	-	-	3	3	3	3	3	3

3 - High 2 - Medium 1 - Low -- no correlation

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE617	Software Engineering	OE	3	0	0	3
Regulation	Nature of Course	Semester	Data Book/Codes/Standards			
R24	Theory	4	-----			
Pre-requisite Course(s)		Co-requisite Course(s)				
-		-				
Course Objectives						
1	To understand Software Engineering Lifecycle Models					
2	To Perform software requirements analysis					
3	To gain knowledge of the System Analysis and Design concepts using UML.					
4	To understand software testing and maintenance approaches					
5	To work on project management scheduling using DevOps					
Course Outcomes						
Upon completion of the course, students shall have ability to						
C617.1	Describe and explain various Software Development Life Cycle (SDLC) models and their differences.					U
C617.2	Explain project management approaches as well as cost and schedule estimation strategies.					U
C617.3	Develop formal analysis models based on software specifications.					AP
C617.4	Apply UML diagrams for analysis and design.					AP
C617.5	Design architectural style, design patterns, and test the system					AP
Course Contents						
Unit-1	SOFTWARE PROCESS AND AGILE DEVELOPMENT					9
Introduction to Software Engineering, Software Process, Perspective and Specialized Process Models – Introduction to Agility-Agile process-Extreme programming-XP Process-Case Study.						
Unit – 2	REQUIREMENTS ANALYSIS AND SPECIFICATION					9
Requirement analysis and specification – Requirements gathering and analysis – Software Requirement Specification – Formal system specification – Finite State Machines – Petrinets – Object modelling using UML – Use case Model – Class diagrams – Interaction diagrams – Activity diagrams – State chart diagrams – Functional modelling – Data Flow Diagram- CASE TOOLS.						
Unit – 3	SOFTWARE DESIGN					9
Software design – Design process – Design concepts – Coupling – Cohesion – Functional independence – Design patterns – Model-view-controller – Publish-subscribe – Adapter – Command – Strategy – Observer – Proxy – Facade – Architectural styles – Layered - Client Server - Tiered - Pipe and filter- User interface design-Case Study.						
Unit – 4	SOFTWARE TESTING AND MAINTENANCE					9
Testing – Unit testing – Black box testing– White box testing – Integration and System testing– Regression testing – Debugging - Program analysis – Symbolic execution – Model Checking-Case Study						
Unit – 5	PROJECT MANAGEMENT					9
Software Project Management- Software Configuration Management - Project Scheduling- DevOps: Motivation-Cloud as a platform-Operations- Deployment Pipeline:Overall Architecture Building and Testing-Deployment-Tools- Case Study						
Total Hours						45
Textbooks:						
1	Bernd Bruegge and Allen H. Dutoit, “Object-Oriented Software Engineering: Using UML, Patterns and Java”, Third Edition, Pearson Education, 2009.					

2	Roger S. Pressman, Object-Oriented Software Engineering: An Agile Unified Methodology, First Edition, Mc Graw-Hill International Edition, 2014.
Reference Books:	
1	Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, Fundamentals of Software Engineering, 2nd edition, PHI Learning Pvt. Ltd., 2010.
2	Len Bass, Ingo Weber and Liming Zhu, “DevOps: A Software Architect’s Perspective”, Pearson Education, 2016
3	Stephen Schach, Object-Oriented and Classical Software Engineering, 8th ed, McGraw-Hill, 2010.
Web References:	
1	Onlinecourses.nptel.ac.in

Assessment based on Continuous and End Semester Examination						
Bloom’sLevel	ContinuousAssessment			Assignmen t	Atten danc e	End SemesterExaminati on
	CIA1 (6Marks)	CIA2 (6Marks)	Model Exam (8Marks)			
Remember				(10 Marks)	(10 Mark s)	(60Marks)
Understand	100%	20%	40%			
Apply		80%	60%			
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/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO12	PSO1	PSO2
C617.1	3	3	3	3	2	-	-	-	2	2	2	2	2	2
C617.2	3	3	3	3	3	-	-	-	2	2	2	2	2	2
C617.3	3	3	3	3	3	-	-	-	2	2	2	2	2	2
C617.4	3	3	3	3	3	-	-	-	2	2	2	2	2	2
C617.5	3	3	3	3	3	-	-	-	2	2	2	2	2	2

3 - Strong 2 - Moderate 1 - Weak - - no correlation

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE618	Foundation of cloud computing	OE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	THEORY	4	-----			
Pre-requisite Course(s)		Co-requisite Course(s)				
-		-				
Course Objectives						
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.					
Course Outcomes						
Upon completion of the course, students shall have ability to						
C618.1	Understand the design challenges in the cloud					U
C618.2	Apply the concept of virtualization and its types					AP
C618.3	Demonstrate virtualization of hardware resources and Docker.					AP
C618.4	Develop and deploy services on the cloud and set up a cloud environment.					AP
C618.5	Analyze the security challenges in the cloud environment.					AP
Course Contents						
Unit-1	CLOUD ARCHITECTURE MODELS AND INFRASTRUCTURE					9
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						
Unit – 2	VIRTUALIZATION BASICS					9
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.						
Unit – 3	VIRTUALIZATION INFRASTRUCTURE AND DOCKER					9
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						
Unit – 4	CLOUD DEPLOYMENT ENVIRONMENT					9
Google App Engine – Amazon AWS – Microsoft Azure; Cloud Software Environments – Eucalyptus – OpenStack						
Unit – 5	CLOUD SECURITY					9
Virtualization System-Specific Attacks: Guest hopping – VM migration attack – hyperjacking. Data Security and Storage; Identity and Access Management (IAM) - IAM Challenges - IAM Architecture and Practice.						
Total Hours						45
Textbooks:						
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.					
3	Krutz, R. L., Vines, R. D, “Cloud security. A Comprehensive Guide to Secure Cloud					

	Computing”, Wiley Publishing, 2010.(check edition)
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	https://medium.com/beyond-the-build/foundations-of-cloud-computing-saas-paas-iaas-for-product-managers-and-non-tech-professionals-63acf8c1a2bc
2	https://onlinelibrary.wiley.com/

Assessment based on Continuous and End Semester Examination						
Bloom’sLevel	ContinuousAssessment			Assign ment	Attend ance	End SemesterExa mination
	CIA1 (6Marks)	CIA2 (6Marks)	Model Exam (8Marks)			
Remember				(10 Marks)	(10 Marks)	(60Marks)
Understand	80%	20%	20%			
Apply	20%	80%	80%			
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/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C618.1	3	3	3	3	3	-	-	-	3	3	3	3	3	3
C618.2	3	3	3	3	3	-	-	-	3	3	3	3	3	3
C618.3	3	3	3	3	3	-	-	-	3	3	3	3	3	3
C618.4	3	3	3	3	3	-	-	-	3	3	3	3	3	3
C618.5	3	3	3	3	3	-	-	-	3	3	3	3	3	3

3 - Strong

2 - Moderate

1 - Weak

- - no correlation

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE619	JAVA PROGRAMMING	OE	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.	Learn fundamental features of object oriented language and JAVA.					
2.	Set up a Java JDK environment to create, debug and run simple Java programs.					
3.	Learn object oriented concepts using programming examples.					
4.	Study the concepts of importing packages and exception handling mechanisms.					
5.	Discuss the String Handling examples with Object Oriented concepts.					
Course Outcomes						
Upon completion of the course, students shall have ability to						
C619.1	Write simple programs in JAVA					AP
C619.2	Implement JAVA program using operators and statements					AP
C619.3	Demonstrate JAVA with classes and objects					AP
C619.4	Implement JAVA in creating packages and Exception handling					AP
C619.5	Demonstrate JAVA program in String Handling and File Handling					AP
Course Contents						
Unit – I	INTRODUCTION					9
An Overview of Java: Object-Oriented Programming, A First Simple Program, A Second Short Program, Two Control Statements, Using Blocks of Code, Lexical Issues, The Java Class Libraries, Data Types, Variables, and Arrays: The Primitive Data Types, Variables, Type Conversion and Casting, Arrays.						
Unit – II	JAVA OPERATORS AND STATEMENTS					9
Operators: Arithmetic Operators, The Bitwise Operators, Relational Operators, Boolean Logical Operators, The Assignment Operator, The Ternary Operator, Operator Precedence, Using Parentheses, Control Statements: Java’s Selection Statements, Iteration Statements, Jump Statements.						
Unit – III	CLASSES AND OBJECTS					9
Introducing Classes: Class Fundamentals, Constructors, the "this" Keyword, Methods and Classes: Overloading Methods, Recursion, Access Control, Inheritance: Inheritance, Using super, Multilevel Hierarchy, Method Overriding, Dynamic Method Dispatch, Using Abstract Classes, Using final with Inheritance, The Object Class.						
Unit – IV	PACKAGES AND EXCEPTION HANDLING					9
Packages and Interfaces: Packages, Access Protection, Importing Packages, Interfaces, Exception Handling: Exception-Handling Fundamentals, Exception Types, Uncaught Exceptions, Using try and catch, Multiple catch Clauses, Nested try Statements, throw, throws, finally, Java’s Built-in Exceptions, User Defined Exception Subclasses.						
Unit – V	I/O STREAM AND STRING CLASS					9
I/O Basics, Reading Console Input, Writing Console Output, The PrintWriter Class, Reading and Writing Files. String Handling: The String Constructors, String Length, Special String Operations, Character Extraction, String Comparison, Searching Strings, Modifying a String, Additional String Methods, StringBuffer, StringBuilder.						
Total Hours						45
Textbooks:						
1.	Herbert Schildt, Java The Complete Reference, 13th Edition, McGraw Hill, 2024.					
Reference Books:						

1.	E Balagurusamy, Programming with Java A primer, Tata McGraw Hill companies, 7th Edition, 2023.
2.	Kathy Sierra, Bert Bates, Trisha Gee, Head First Java: A Brain-Friendly Guide, Third Edition, 2022.
Web References:	
1.	https://onlinecourses.nptel.ac.in/noc25_cs57/preview

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)			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand	20%	20%	20%			
Apply	80%	80%	80%			
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/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS 01	PS 02
C619.1	3	3	-	-	-	-	-	-	-	-	-	2	-	-
C619.2	3	3	-	-	-	-	-	-	-	-	-	2	-	-
C619.3	3	3	3	2	-	-	-	-	-	-	-	3	-	-
C619.4	3	3	3	2	-	-	-	-	-	-	-	3	-	-
C619.5	3	3	3	2	-	-	-	-	-	-	-	3	-	-

3 - Strong 2 - Moderate 1 - Weak '-' - no correlation

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
240E620	BLOCKCHAIN TECHNOLOGY	OE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	Theory	4	-----			
Pre-requisite Course(s)		Co-requisite Course(s)				
Data Structures and Algorithms, Programming in C and Java		Operating Systems				
Course Objectives						
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 understand Smart contracts and Ethereum 101					
5	To understand blockchain alternatives and its applications					
Course Outcomes						
Upon completion of the course, students shall have ability to						
C620.1	Understand emerging abstract models of blockchain technology					U
C620.2	Explain major research challenges and technical gaps existing between theory and practice in the crypto currency domain					U
C620.3	Illustrate the Bitcoin features and its alternative options.					U
C620.4	Describe and deploy the smart contracts and Ethereum platform					U
C620.5	Apply the blockchain features outside of currencies.					AP
Course Contents						
Unit – 1	INTRODUCTION TO BLOCKCHAIN					9
Blockchain- Public Ledgers, Blockchain as Public Ledgers - Block in a Blockchain, Transactions- The Chain and the Longest Chain - Permissioned Model of Blockchain, Cryptographic –Hash Function, Properties of a hash function-Hash pointer and Merkle tree						
Unit – 2	BITCOIN AND CRYPTOCURRENCY					9
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						
Unit – 3	BITCOIN CONSENSUS					9
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.						
Unit – 4	SMART CONTRACTS AND ETHEREUM 101					9
Smart Contracts: Definition, Ricardian contracts. Ethereum 101: Introduction, Ethereum blockchain, Elements of the Ethereum blockchain, Precompiled contracts.						
Unit – 5	BLOCKCHAIN ALTERNATIVES & ITS APPLICATIONS					9
Blockchain-Outside of Currencies: Internet of Things, Government, Health, Finance, Media. Blockchain Applications in Supply Chain Management, Logistics, Smart Cities, Banking, Insurance, etc- Case Study.						
Total Hours						45
Textbooks:						
1	Andreas Antonopoulos, “Mastering Bitcoin: Unlocking Digital Cryptocurrencies”, O’Reilly, 2014.					
2	Bashir and Imran, Mastering Blockchain: Deeper insights into decentralization, cryptography, Bitcoin, and popular Blockchain frameworks, 2017					
3	Mastering Blockchain - Distributed ledgers, decentralization and smart contracts explained, Author- Imran Bashir, Packt Publishing Ltd, Second Edition, ISBN 978-1- 78712-544-5, 2017					
Reference Books:						
1	Bitcoin and Cryptocurrency Technologies, Author- Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, Princeton University, 2016					

2	Daniel Drescher, "Blockchain Basics", First Edition, Apress, 2017.
3	Blockchain Basics: A Non-Technical Introduction in 25 Steps, Author- Daniel Drescher, Apress, First Edition, 2017
4	Mastering Bitcoin: Unlocking Digital Cryptocurrencies, Andreas M. Antonopoulos, O'Reilly Media, First Edition, 2014
5	Handbook of Research on Blockchain Technology, published by Elsevier Inc. ISBN: 9780128198162, 2020.
Web References:	
1	https://blockchain-society.science/
2	https://www.coursera.org/learn/blockchain-basics

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)			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand	100%	80%	80%			
Apply		20%	20%			
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/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
C620.1	3	-	-	-	-	-	-	-	-	-	-	-	3	3
C620.2	3	2	2	2	3	2	2	2	-	-	-	-	3	3
C620.3	3	2	2	2	3	2	2	2	-	-	-	-	3	3
C620.4	3	2	2	2	3	2	2	2	-	-	-	-	3	3
C620.5	3	2	2	2	3	2	2	2	-	-	-	-	3	3

3 - Strong

2 - Moderate

1 - Weak

- - no correlation

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE621	Introduction to VLSI design	OE	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 learn the fundamentals of VLSI design					
2	To understand the IC Manufacturing Process					
3	To familiarize with VLSI combinational logic circuits design					
4	To familiarize with VLSI sequential logic circuits design					
5	To familiarize with the different FPGA architectures					
Course Outcomes						
Upon completion of the course, students shall have ability to						
C621.1	Ability to comprehend and appreciate the significance and role of this course in the present contemporary world					U
C621.2	At the end of the course students will be in a position to understand the basics of VLSI design					U
C621.3	At the end of the course students will be in a position to understand the basics of testing					U
C621.4	At the end of the course students will be in a position to understand the basics of different FPGA architectures.					U
Course Contents						
Unit – 1	MOS TRANSISTOR PRINCIPLES					9
MOS Technology and VLSI, Pass transistors, NMOS, CMOS Fabrication process and Electrical properties of CMOS circuits. Characteristics of CMOS inverter, Scaling principles and fundamental limits. Propagation Delays, CMOS inverter scaling, Stick diagram, Layout diagrams, Elmore’s constant, Logical Effort.						
Unit – 2	COMBINATIONAL LOGIC CIRCUITS					9
Static CMOS logic Design, Design techniques to improve the speed, power dissipation of CMOS logic, low power circuit techniques, Ratioed logic .Pass transistor Logic, Dynamic CMOS logic, Domino logic, Dual Rail logic, NP CMOS logic and NOR array logic.						
Unit – 3	SEQUENTIAL LOGIC CIRCUITS					9
Static and Dynamic Latches and Registers, Timing Issues, Pipelines, Clocking strategies, Memory Architectures, and Memory control circuits.						
Unit – 4	DESIGNING ARITHMETIC BUILDING BLOCKS & TESTING					9
Data path circuits, Architectures for Adders, Accumulators, Multipliers, Barrel Shifters, Need for testing- Manufacturing test principles- Design for testability.						
Unit – 5	IMPLEMENTATION STRATEGIES					9
Full Custom and Semicustom Design, Standard Cell design and cell libraries, FPGA building block architectures, FPGA interconnect routing procedures. Demo: Complete ASIC flow using Backend tool and fabrication flow Overall case study: Development of IC in commercial aspects (design, testing and fab cost)						
Total Hours						45
Textbooks:						
1	Jan Rabaey, AnanthaChandrakasan, B.Nikolic, “Digital Integrated circuits: A design perspective”. Second Edition, Prentice Hall of India, 2003.					
ReferenceBooks:						
1	N.Weste, K.Eshraghian, “Principles of CMOS VLSI DESIGN”, A system Perspective, second edition, Addison Wesley 2004					
2	A.Pucknell, Kamran Eshraghian, “BASIC VLSI DESIGN”, Third edition, Prentice Hall of India, 2007.					
3	M.J. Smith, “Application specific integrated circuits”, Addison Wesley, 1997					
4	R.Jacob Baker, Harry W.LI., David E.Boyee, “CMOS Circuit Design, Layout and Simulation”, 2005 Prentice Hall of India					

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)			
Remember	12%	12%	6%	(10 Marks)	(10 Marks)	(60 Marks)
Understand	58%	58%	58%			
Apply	30%	30%	36%			
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/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO 9	PO 10	PO11	PSO 1	PSO 2	PSO 3
C621.1	3	3	3	3		3				3	3			
C621.2	3	3	3	3		3				3	3			
C621.3	3	3	3	3		3				3	3			
C621.4	3	3	3	3		3				3	3			

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE622	Communication Engineering	OE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	Theory	-	-----			
Pre-requisite Course(s)		Co-requisite Course(s)				
Linear Integrated Circuits		-				
Course Out comes:						
Upon completion of the course, students shall have ability to						
C622.1	Gain insight into communication systems with signal processing, modulation, channel characteristics, and multiple access techniques					[U]
C622.2	Infer the principles of AM generation, demodulation, system comparisons, transmitter and receiver design of FM systems					[U]
C622.3	Understand the generation, detection, and performance analysis of digital modulation schemes, including ASK, FSK, BPSK, QPSK, and QAM					[U]
C622.4	Interpret information theory fundamentals, channel capacity, Shannon's theorems, source coding techniques, and error control coding for efficient and reliable communication					[U]
C622.5	Comprehend advanced wireless communication technologies and their associated standards					[U]
Course Contents						
Unit – 1	PRINCIPLES OF COMMUNICATION					9
Communication Systems Overview - Types of Communication Channels - Basic Signal Processing Operations in Communication systems - Baseband and Passband Modeling - Signal-to-Noise Ratio, Channel Bandwidth, Modulation, Spectral density - Multiplexing, Multiple Access						
Unit – 2	ANALOG COMMUNICATION SYSTEMS					9
Generation and demodulation of AM - DSB-SC, SSB-SC, VSB Amplitude Modulated Signals - Comparison of AM system - AM transmitters, AM receivers - Angle modulation: Phase Modulation, Frequency Modulation - Narrowband and wideband FM - Non-linear effects in FM systems - FM receivers						
Unit – 3	DIGITAL COMMUNICATION SYSTEMS					9
Generation and detection of Amplitude Shift Keying (ASK) Modulation - Generation and detection of Frequency Shift Keying (FSK) Modulation - Generation and detection of Binary Phase Shift Keying (BPSK) Modulation - Generation and detection of Quaternary Phase Shift Keying (QPSK) - QAM - Bit Error Rate Performance of BPSK, QPSK and QAM in AWGN channel						
Unit – 4	INFORMATION THEORY					9
Measure of information - Channel capacity and Shannons theorems - Source coding techniques: Prefix code, Huffman Coding, Shannon Fano Coding, Arithmetic Coding, Run length code - Channel coding theorem, Information capacity theorem - Error Control Coding						
Unit – 5	ADVANCED COMMUNICATION SYSTEMS					9
Spread Spectrum, OFDM, GSM architecture, General Packet Radio Service (GPRS), Enhanced Data Rate for Global Evolution (EDGE), Ultra wideband systems (UWB), Push-To-Talk (PTT) technology, Mobile IP, Bluetooth Technology, IEEE Standards for Wired and Wireless Communications						
Total Hours						45
Textbooks:						
1	Simon Haykin, Communication Systems, John Wiley & sons, NY, 5th Edition, 2016					
2	Michael P. Fitz, Fundamentals of Communication Systems, Tata McGraw-Hill, 2nd Edition-2013.					
ReferenceBooks:						
1	Taub and Schilling, Principles of communication systems, TMH, New Delhi, 4th Edition, 2017					
2	Theodore S. Rappaport: Wireless communication principles and practice, 2/e, Pearson Education					

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)			
Remember	20%	20%	20%	(10 Marks)	(10 Marks)	(60 Marks)
Understand	80%	80%	80%			
Apply						
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/ POs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
C622.1	2	2	1								1
C622.2	2	2	1								1
C622.3	2	2	1								1
C622.4	2	2	1								1
C622.5	2	2	1								1

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE623	SENSORS AND ACTUATORS	OE	3	0	0	3
Course Outcomes (s)						
Upon completion of the course, students shall have ability to						RBT
C623.1	List common types of sensor and actuators used in vehicles					U
C623.2	Design measuring equipment's for the measurement of pressure force, temperature and flow					AP
C623.3	Generate new ideas in designing the sensors and actuators for automotive application					AP
C624.4	Understand the operation of the sensors, actuators and electronic control.					U
C624.5	Design temperature control actuators for vehicles.					AP

Course Content		
Unit – I	INTRODUCTION TO MEASUREMENTS AND SENSORS	9
Sensors: Functions- Classifications- Main technical requirement and trends Units and standards Calibration methods- Classification of errors- Error analysis- Limiting error- Probable error Propagation of error- Odds and uncertainty-principle of transduction-Classification. Static characteristics- mathematical model of transducers- Zero, First and Second order transducers Dynamic characteristics of first and second order transducers for standard test inputs.		
Unit – II	VARIABLE RESISTANCE AND INDUCTANCE SENSORS	9
Principle of operation- Construction details- Characteristics and applications of resistive potentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer- Variable reluctance transducers:- EI pick up and LVDT		
Unit – III	VARIABLE AND OTHER SPECIAL SENSORS	9
Variable air gap type, variable area type and variable permittivity type- capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers-Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.		
Unit – IV	AUTOMOTIVE ACTUATORS	9
Electromechanical actuators- Fluid-mechanical actuators- Electrical machines- Direct-current machines- Three-phase machines- Single-phase alternating-current Machines - Duty-type ratings 318 for electrical machines. Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.		
Unit – V	AUTOMATIC TEMPERATURE CONTROL ACTUATORS	9
Different types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.		
		TOTAL: 45 Hours
Learning Resources		
Text Books		
1	Doebelin's Measurement Systems: 7th Edition (SIE),Ernest O. DoebelinDhaneshN.Manik,McGraw Hill Publishers, 2019.	
2	Robert Brandy, “ Automotive Electronics and Computer System”, Prentice Hall,2001	
3	William Kimberley,” Bosch Automotive Handbook”, 6th Edition, Robert Bosch GmbH, 2004.	
4	Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007, ISBN No: 978-3-658-01783-5.	
Reference Books		
1	James D Halderman, “ Automotive Electrical and Electronics” , Prentice Hall, USA, 2013	
2	Tom Denton, “Automotive Electrical and Electronics Systems,” Third Edition, 2004, SAE International.	
3	Patranabis.D, “ Sensors and Transducers”, 2nd Edition, Prentice Hall India Ltd,2003	
4	William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective," 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.	

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)			
Remember			10%	(10 Marks)	(10 Marks)	(60 Marks)
Understand	60%	40%	40%			
Apply	40%	60%	50%			
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/ POs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
C622.1.	2	2	1								1
C622.2	3	3	2								1
C622.3	3	3	2								1
C666.4	2	2	1								1
C666.5	3	3	2								1

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE624	Basics of Hardware Description Languages	OE	3	0	0	3
Pre-requisite Course(s)		Co-requisite Course(s)				
Digital Electronics		-----				
Course Outcome						
Upon completion of the course, students shall have ability to						
C624.1	Apply digital logic concepts to build circuits					[AP]
C624.2	Build Programmable devices and learn VLSI with FPGA.					[AP]
C624.3	Construct modules using basic HDL concepts.					[AP]
C624.4	Construct modules using advanced HDL concepts.					[AP]
C624.5	Build various digital circuits using Verilog.					[AP]
CourseContents						
Unit – 1	DIGITAL LOGIC					9
Number system, Boolean theorem - logic gates, Simplification of logic function- Combinational circuits-Adder, subtractor, Encoder, decoder, multiplexer, demultiplexer. Sequential circuits- latch, flip-flop, counter.						
Unit – 2	PROGRAMMABLE DIGITAL ICS					9
Introduction to VLSI - Evolution of VLSI Systems - Applications of VLSI Systems – Programmable Logic Devices - ROM, PAL, PLA - CPLD- Introduction to FPGA - Digital IC design flow						
Unit – 3	VERILOG HDL					9
Introduction to HDL - Lexical Conventions - Ports and Modules - Data Types - Data Flow Modeling -Operators - Gate Level Modeling						
Unit – 4	ADVANCED VERILOG HDL					9
Behavioral level Modelling - Synthesis of Finite State Machines- Switch Level Modelling- System Tasks & Compiler Directives - Test benches						
Unit – 5	SYSTEM DESIGN USING VERILOG HDL					9
Design of Combinational circuits -Multiplexers / Demultiplexers, Magnitude comparators, Adders -Multiplier-Divider. Design of Sequential circuits - Flip flops, Registers / Shift registers, counters – Statemachines -Pattern sequence detector design.						
Total Hours						45
Textbooks:						
1	M.Morris Mano, Michael D Ciletti, Digital Design, 4th edition Pearson, 2011					
2	Samir Palnitkar, Verilog HDL, Pearson Education, 2nd Edition, 2004.					
ReferenceBooks:						
1	Stephen Brown and Zvonko Vranesic,Fundamentals of Digital Logic with Verilog Design, 3rd Edition, Tata McGraw Hill, 2014					
2	Bob Zeidman, Designing with FPGAs and CPLDs, Elsevier, CMP Books, 2002					
3	Ion Grout, Digital Systems Design with FPGAs and CPLDs, Elsevier, 2008					

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)			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand	20%	20%	20%			
Apply	80%	80%	80%			
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/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
C624.1	3	3	2								
C624.2	3	3	2								
C624.3	3	3	2		3						2
C624.4	3	3	2								2
C624.5	3	3	2								2

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE625	Introduction to Internet of Things	OE	3	0	0	3
Course Objectives						RBT
C625.1	Explain the concept of IoT					U
C625.2	Understand the communication models and various protocols for IoT					U
C625.3	Design portable IoT using Arduino/Raspberry Pi /open platform					AP
C625.4	Apply data analytics and use cloud offerings related to IoT					AP
C625.5	Analyze applications of IoT in real time scenario					AN

Course Content		
Unit – I	INTRODUCTION TO INTERNET OF THINGS	9
Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT Models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT		
Unit – II	COMPONENTS IN INTERNET OF THINGS	9
Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee,Wifi, GPS, GSM Modules)		
Unit – III	PROTOCOLS AND TECHNOLOGIES BEHIND IOT	9
IOT Protocols - IPv6, 6LoWPAN, MQTT, CoAP - RFID, Wireless Sensor Networks, BigData Analytics, Cloud Computing, Embedded Systems.		
Unit – IV	OPEN PLATFORMS AND PROGRAMMING	9
IOT deployment for Raspberry Pi /Arduino platform-Architecture –Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud.		
Unit – V	IOT APPLICATIONS	9
Business models for the internet of things, Smart city, Smart mobility and transport, Industrial IoT, Smart health, Environment monitoring and surveillance – Home Automation – Smart Agriculture		
		TOTAL: 45 Hours
Learning Resources		
Text Books		
1	Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, CISCO Press, 2017	
2	Samuel Greengard, The Internet of Things, The MIT Press, 2015	
Reference Books		
1	Perry Lea, “Internet of things for architects”, Packt, 2018	
2	Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applications and Protocols”, Wiley, 2012	
3	IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT Kindle Edition.	
4	Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.	
5	ArshdeepBahga, Vijay Madiseti, “Internet of Things – A hands-on approach”, Universities Press, 2015	
Web References		
1	https://www.arduino.cc/	
2	https://www.ibm.com/smarterplanet/us/en/?ca=v_smarterplanet	

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)			
Remember	20%			(10 Marks)	(10 Marks)	(60 Marks)
Understand	80%	20%	40%			
Apply		80%	60%			
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/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
C625.1	2	2	1								
C625.2	2	2	1								1
C625.3	3	3	2								1
C625.4	3	3	2								1
C625.5	3	3	2								1

OPEN ELECTIVES OFFERED BY EEE

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE626	Industrial Automation With PLC and SCADA	OE	3	0	0	3
Course Outcomes (s)						
Upon completion of the course, students shall have ability to						RBT
C626.1	Understand the integrated industrial automation system.					U
C626.2	Identify the PLC hardware and programming languages for various applications.					U
C626.3	Develop PLC ladder logic programming for industrial problems.					AP
C626.4	Impart the knowledge about SCADA and understand the components of SCADA.					U
C626.5	Apply PLC and SCADA in real time applications to meet industrial automation.					AP
Course Content						
Unit-I	INTRODUCTION					9
Architecture of the basic three level Integrated Industrial Automation Systems – Field level for sensors actuators and smart devices, Control level for process and motion control functions, Distributed control system - Supervisory level for Data logging and Acquisition systems – DAS and SCADA for Management functions - Integrated automation through bus structure at the different levels.						
Unit - II	INTRODUCTION TO PROGRAMMABLE LOGIC CONTROLLER					9
Overview of Programmable Logic Controller – Architecture – Principle of operation – I/O Modules: Discrete, Analog, Special – I/O Specifications – CPU – Memory design and types – Programming devices – Recording and Retrieving data – PLC programming languages. Introduction to Human Machine Interfaces (HMI).						
Unit-III	BASIC PLC PROGRAMMING					9
Fundamentals of Logic – Program Scan – Relay-Type Instructions – Instruction addressing – Branch and Internal relay instructions – Entering the Ladder diagram – Electromagnetic Control relays – Contactors – Motor Starters – Manual operated switches and Mechanically operated switches.						
Unit-IV	SCADA					9
Introduction to SCADA – A brief history of SCADA – Real-time systems – Remote control – Communications: communication system components – protocol-modems – Remote terminal units (RTUs) – Master terminal units (MTUs).						
Unit-V	APPLICATIONS OF SCADA					9
Applications: Real time Revisited – Accounting and grade of data – Scanning and communications – Automatic control. Applications SCADA for Power Utility Network.						
Total Hours						45
Learning Resources						
Text books						
1	Krishnaswamy K, “Process Control”, 2nd Edition, New Age International(P) Ltd, NewDelhi, 2015.					
2	Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, Tata McGraw-Hill , New Delhi, 2019.					
3	Stuart A. Boyer, “SCADA: Supervisory Control and Data Acquisition”, 4th Edition, ISA Press, USA, 2009.					
Reference Books						
1	Webb John W & Reis Ronald A, "Programmable Logic Controllers - Principles and Applications", 5th Edition, PHI Learning Private Limited, New Delhi, 2002.					
2	Bolton W, “Programmable Logic Controllers”, 5th Edition, Elsevie , New York, 2009.					
Web References						
1	https://www.nielit.gov.in/calicut/content/online-course-industrial-automation-plc-scada					
2	https://www.nielit.gov.in/calicut/content/iad102					

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
240E627	Electric Vehicle Technology	OE	3	0	0	3
Course Outcomes (s)						
Upon completion of the course, students shall have ability to						RBT
C627.1	Summarize about the sustainable transportation through electric vehicle systems					U
C627.2	Design and select EV drive for the desirable performance and control					U
C627.3	Explain the architecture of various types of hybrid Vehicles.					U
C627.4	Apply the various control strategies of series & Parallel HEVs using DC and AC Motor drives.					AP
C62.75	Examine about the battery technologies for Electric vehicle charging schemes.					AP

Course Content		
Unit-I	INTRODUCTION TO ELECTRIC VEHICLES	9
Sustainable Transportation – EV System – EV Advantages – Vehicle Mechanics – Performance of EVs – Electric Vehicle drive train – EV Transmission Configurations and components -Tractive Effort in Normal Driving – Energy Consumption – EV Market – Types of Electric Vehicle in Use Today – Electric Vehicles for the Future		
Unit – II	ELECTRIC VEHICLE DESIGN CONSIDERATIONS	9
General Description of Vehicle Movement - Vehicle Resistance – Dynamic Equation - Power Train Tractive Effort and Vehicle Speed - Vehicle Power Plant and Transmission Characteristics - Vehicle Performance - Brake Performance - EV configurations – General and Typical EV configurations - EV parameters		
Unit-III	HYBRID TRACTION	9
Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies-power flow controls in hybrid drive-train topologies - Basic concept of electric traction- Introduction to various electric drive-train topologies- fuel efficiency analysis.		
Unit-IV	HYBRID VEHICLE CONTROL STRATEGY	9
Vehicle Supervisory Controller- Mode Selection Strategy -Mechanical Power-Split Hybrid Modes - Series-Parallel Hybrid Modes - Modal Control Strategies - Introduction to Electric Components & Drives used in Hybrid and Electric vehicles, Configuration and control of DC Motor drives – configuration and control of AC Motor drives, Configuration and control of Switch Reluctance Motor drive.		
Unit-V	BATTERY TECHNOLOGIES FOR ELECTRIC VEHICLE	9
Introduction - Power and Energy of Electric Propulsion - Basic Terms of Battery Performance and Characterization - Battery Charging Methods and EV Charging Schemes: Charging Methods - EV Charging Schemes - Basic Operation of a Rechargeable Battery - Battery Modeling - Current Status of Battery in Automobile Applications.		
Total Hours		45
Learning Resources		
Text books		
1	Mehrdad Ehsani, Yimin Gao and Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", 2nd Edition, CRC press, Florida, United States, 2010.	
2	Sira -Ramirez, Silva.R Ortigoza, "Control Design Techniques in Power Electronics Devices", 1st Edition, Springer, New York, 2006.	
Reference Books		
1	Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals", 2nd Edition, CRC press, Taylor&Francis Group, Florida, United States, 2011.	
2	Chan C. C. and Chau K. T., "Modern electric vehicle technology", 1st Edition, Oxford University Press, New York, 2001.	
Web References		
1	https://onlinecourses.nptel.ac.in/noc20_ee18/preview	
2	https://www.coursera.org/learn/electric-vehicles-mobility	

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE628	Energy Technology	OE	3	0	0	3
Course Outcomes (s)						
Upon completion of the course, students shall have ability to						RBT
C628.1	Describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.					U
C628.2	Excel as professionals in the various fields of energy engineering					U
C628.3	Compare different renewable energy technologies and choose the most appropriate based on local conditions.					U
C628.4	Explain the technological basis for harnessing renewable energy sources.					U
C628.5	Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level.					U

Course Content		
Unit-I	INTRODUCTION	8
Units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, Renewable and non-renewable energy sources and their availability. Prospects of Renewable energy sources		
Unit – II	CONVENTIONAL ENERGY	8
Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.		
Unit-III	NON-CONVENTIONAL ENERGY	10
Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.		
Unit-IV	BIOMASS ENERGY	10
Biomass energy resources, thermo-chemical and biochemical methods of biomass conversion, combustion, gasification, Pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte fuel cell, magneto hydrodynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage and electrical storage.		
Unit-V	ENERGY CONSERVATION	9
Energy conservation in chemical process plants, energy audit, energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation.		
Total Hours		45
Learning Resources		
Textbooks		
1	Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.	
2	Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 1984.	
Reference Books		
1	Bansal, N.K., Kleeman, M. and Meliss, M., Renewable Energy Sources and Conversion Technology, Tata McGraw Hill, 1990.	
2	El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 2002.	
3	Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 2008.	
Web References		
1	https://onlinecourses.nptel.ac.in/noc24_ge51/preview	
2	https://onlinecourses.nptel.ac.in/noc20_ch37/preview	

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE629	Battery Management Systems	OE	3	0	0	3
Course Outcomes (s)						
Upon completion of the course, students shall have ability to						RBT
C629.1	Acquire knowledge of different Li-ion Batteries performance.					U
C629.2	Design a Battery Pack and make related calculations.					U
C629.3	Demonstrate a Battery Model or Simulation.					U
C629.4	Estimate State-of-Charges in a Battery Pack.					U
C629.5	Approach different BMS architectures during real world usage.					U

Course Content		
Unit-I	ADVANCED BATTERIES	9
Li-ion Batteries-different formats, chemistry, safe operating area, efficiency, aging. Characteristics-SOC,DOD, SOH. Balancing-Passive Balancing Vs Active Balancing. Other Batteries-NCM and NCA Batteries. NCR18650B specifications.		
Unit – II	BATTERY PACK	9
Battery Pack- design, sizing, calculations, flow chart, real and simulation Model. Peak power – definition, testing methods-relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging.		
Unit-III	BATTERY MODELLING	9
Battery Modeling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models- Introduction. Battery Modelling software/simulation frameworks.		
Unit-IV	BATTERY STATE ESTIMATION	9
SOC Estimation- Definition, importance, single cell Vs series batteries SOC. Estimation Methods- Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method, Kalman filter. Estimation Algorithms.		
Unit-V	BMS ARCHITECTURE AND REAL TIME COMPONENTS	9
Battery Management System- needs, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray- CANedge1 package. ARBIN Battery Tester. BMS Development with Modeling software and Model Based Design.		
Total Hours		45
Learning Resources		
Text books		
1	Jiuchun Jiang and Caiping Zhang, “Fundamentals and applications of Lithium-Ion batteries in Electric Drive Vehicles”, Wiley, 2015.	
2	Davide Andrea ,“Battery Management Systems for Large Lithium-Ion Battery Packs” ARTECH House, 2010.	
Reference Books		
1	Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper	
Web References		
1	https://nptel.ac.in/courses/113105102	
2	https://archive.nptel.ac.in/courses/113/105/113105102/	

Course Code	Course Name	Category	Hours / Week			C
			L	T	P	
240E630	Power Converters For Electrical Appliances	OE	3	0	0	3
Course Outcome (s)						
Upon completion of the course students shall have ability to						RBT
C630.1	Understand how different power electronic devices like diodes, SCRs, BJTs, MOSFETs, and IGBTs work.					U
C630.2	Learn how rectifiers convert AC to DC and how to reduce ripples using filters.					U
C630.3	Know how inverters convert DC to AC and where they are used, like in UPS and solar systems.					U
C630.4	Understand how DC-DC converters (like buck, boost, and buck-boost) work and where to use them.					U
C630.5	Learn how power converters are used in smart systems like smart homes, electric vehicles, and solar energy.					U

Course Contents		
Unit-I	Introduction to Power Electronic Devices	9
Overview of Power Electronics – Definition, Need, and Applications Power Semiconductor Devices – Diodes, Thyristors (SCR), Power BJT, Power MOSFET, IGBT Switching Characteristics – Turn-on, Turn-off, Losses Basic Drive Circuits for Power Devices		
Unit-II	AC-DC Converters (Rectifiers)	9
Introduction to Rectifiers – Need and Types Single-Phase Rectifiers – Half-wave, Full-wave (Center-tap & Bridge)Ripple & Smoothing – Why capacitors are used (Like filtering noise in signals)Applications – Laptop adapters, USB chargers, PC power supplies, Applications – Battery Chargers, DC Power Supplies		
Unit-III	DC-AC Converters (Inverters)	9
Introduction to Inverters – Need and Types (Voltage Source & Current Source) Single-Phase Inverters – Half-bridge, Full-bridge (Square wave & PWM) Applications – UPS, Solar PV Systems, Motor Drives		
Unit-IV	DC-DC Converters (Choppers)	9
Introduction to DC-DC Converters – Need and Types Step-down (Buck) Converter – Operation and Waveforms Step-up (Boost) Converter – Operation and Waveforms Buck-Boost Converter – Operation and Applications – SMPS, Electric Vehicles, LED Drivers Applications –Smartphone fast charging, LED drivers, Laptop power management		
Unit-V	Power Converters in Smart Systems	9
Home Automation – How converters work in smart bulbs, Wi-Fi switches, Computer & IT Systems –SMPS (Switched Mode Power Supply) in PCs/Data center power backup systems Renewable Energy – Solar inverters, electric vehicle charging Future Trends – AI in power management, IoT-based energy saving		
Total Hours		45
Text books		
1	Power Electronics: Circuits, Devices and Applications, Muhammad H. Rashid, Pearson Education, 4th Edition, 2017	
2	Power Electronics, P.S. Bimbhra, Khanna Publishers,7th Edition, 2018	
Reference Books		
1	Power Electronics: Essentials and Applications L. Umanand Wiley India 1st Edition, 2009	
2	Power Electronics: Converters, Applications and Design, Ned Mohan, Tore M.Undeland, William P. Robbins, Wiley, 3rd Edition, 2002	
Web References		
1	https://nptel.ac.in/courses/108/105/108105066/	
2	https://www.allaboutcircuits.com/technical-articles/categories/power/	

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE631	FOUNDATION OF ROBOTICS	OE	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 study the kinematics, drive systems and programming of robots.					
2	To study the basics of robot laws and transmission systems.					
3	To familiarize students with the concepts and techniques of robot manipulator, its kinematics.					
4	To familiarize students with the various Programming and Machine Vision application in robots.					
5	To build confidence among students to evaluate, choose and incorporate robots in engineering systems.					
Course Outcomes						
Upon completion of the course, students shall have ability to						
C631.1	Interpret the features of robots and technology involved in the control.					[U]
C631.2	Apply basic engineering knowledge and relevant laws for the design of robotics.					[AP]
C631.3	Apply the concepts of various configurations, classifications, and parts of end effectors to compare different end effectors, grippers, tools, and sensors used in robots.					[AP]
C631.4	Apply the principles of kinematics, degeneracy, dexterity, and trajectory planning in robotics applications.					[AP]
C631.5	Apply image processing and image analysis techniques using a machine vision system.					[AP]
Course Contents						
Unit – 1	FUNDAMENTALS OF ROBOT					9
Robot Definition, Robot Anatomy Co-ordinate systems, Work Envelope, classification – Requirements- Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load - Need for Robots - Applications.						
Unit – 2	ROBOT KINEMATICS					9
Forward kinematics, inverse kinematics and the difference- two and three degrees of freedom (in 2 dimensional), four degrees of freedom (in 3 dimensional). Homogeneous transformation matrices, translation and rotation matrices.						
Unit – 3	ROBOT DRIVE SYSTEMS AND END EFFECTORS					9
Pneumatic Drives - Hydraulic Drives - Mechanical Drives - Electrical Drives: D.C. Servo Motors, Stepper Motor, A.C. Servo Motors - Applications and Comparison. End Effectors - Grippers : Mechanical , Pneumatic and Hydraulic, Magnetic , vacuum, internal and external grippers- selection and design considerations of a gripper.						
Unit – 4	SENSORS IN ROBOTICS					9
Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors for hazarded environment and compliance mechanism. Machine vision system , frame grabber, sensing and digitizing image data signal conversion, image storage, lighting techniques, image processing and analysis - data reduction, segmentation, feature extraction, object recognition and other algorithms. Applications, Inspection, safety considerations , visual serving and navigation.						
Unit – 5	PROGRAMMING AND APPLICATIONS OF ROBOT					9
Teach pendant programming, lead through programming, robot programming languages -commands for Motion, Sensors and End-Effector. Robot applications for inspection, assembly, material handling, underwater, space and medical fields.						
Total Hours						45
Textbooks:						
1	Ganesh.S.Hedge, "A textbook of Industrial Robotics", Lakshmi Publications, 2022.					

2	Mikell.P.Groover, "Industrial Robotics McGraw Hill 2ND edition 2012. Technology, Programming and applications"
3	
Reference Books:	
1	Fu K.S. Gonalz R.C. and ice C.S.G. "Robotics Control, Sensing, Vision and Intelligence". McGraw Hill book co. 2007
2	YoramKoren, "Robotics for Engineers", McGraw Hill Book, Co., 2002.
3	Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill 2005.
4	John. J.Craig, "Introduction to Robotics: Mechanics and Control" 2nd Edition, 2002.
5	Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer India reprint, 2010.
Web References:	
1	https://www.barnesandnoble.com/w/foundations-of-robotics-bruno-siciliano
2	https://www.foundations-of-robotics.org/?utm_source=chatgpt.com

Assessment based on Continuous and End Semester Examination						
Bloom's Level	Continuous Assessment			Assignm ent	Attenda nce	End Semester Examination
	CIA1 (6 Marks)	CIA2 (6 Marks)	Model Exam (8 Marks)			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand	4	2	2			
Apply	2	4	6			
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/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3
C631.1	√	√		√	√					√		√	√	√	
C631.2	√	√		√	√					√		√	√	√	
C631.3	√	√		√	√					√		√	√	√	
C631.4	√	√		√	√					√		√	√	√	
C631.5	√	√		√	√					√		√	√	√	

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE632	BASICS OF DRONE TECHNOLOGY	OE	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	THEORY		-----			
Pre-requisite Course(s)		Co-requisite Course(s)				
Nil		Nil				
Course Objectives						
1	To understand the basics of drone concepts					
2	To learn and understand the fundamentals of design, fabrication and programming of drone					
3	To impart the knowledge of an flying and operation of drone					
4	To know about the various applications of drone					
5	To understand the safety risks and guidelines of fly safely					
Course Outcomes						
Upon completion of the course, students shall have ability to						
C101.1	Know about a various type of drone technology, drone fabrication and programming.					[U]
C101.2	Execute the suitable operating procedures for functioning a drone					[U]
C101.3	Select appropriate sensors and actuators for Drones					[U]
C101.4	Develop a drone mechanism for specific applications					[U]
C101.5	Create the programs for various drones					[U]
Course Contents						
Unit – 1	INTRODUCTION TO DRONE TECHNOLOGY					9
Drone Concept - Terminology- History of drone - Overview of the main drone parts- Function of the component parts -Technical characteristics of the Types of current generation of drones based on their method of propulsion- Operation of drone. Classifications of the UAV.						
Unit – 2	DRONE DESIGN, FABRICATION AND PROGRAMMING					9
Assembling a drone - The energy sources- Types of autonomy - Drones configurations - methods of programming – programing, compiling and uploading - data collection - Wi-Fi connection.						
Unit – 3	DRONE OPERATION					9
Flight modes- Operation in a controlled environment- Drone controls- Multi rotor stabilization –management tools: Sensors, Onboard storage, control system-Removable storage devices – Linked devices and applications.						
Unit – 4	DRONE COMMERCIAL APPLICATIONS					9
Selection of a drone based on the application - Drones in the insurance sector- Drones in delivering parcels and other cargo - Drones in agriculture - Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing. Drones in military applications. Drone technology impact on the businesses- Drone business through entrepreneurship - Opportunities/applications for entrepreneurship and employability.						
Unit – 5	FUTURE DRONES AND SAFETY					9
The safety risks- Guidelines to fly safely - Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms.						
Textbooks:						
1	Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, 2021 John Wiley & Sons, Inc.					
2	Terry Kilby and Belinda Kilby, “Make:Getting Started with Drones “,Maker Media, Inc, 2016 .					
Reference Books:						
1	John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016.					
2	Zavrnsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018.					
Web References:						
1	https://dronelaunchacademy.com/					

2	https://www.air sight.com/knowledge-hub/drone-basics
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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)			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand	2	2	2			
Apply	4	4	6			
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/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3
C101.1	√	√				√	√	√				√			
C101.2	√	√	√	√								√			
C101.3	√	√				√	√	√				√			
C101.4	√	√	√	√								√			
C101.5	√	√	√	√	√	√						√			

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE633	3D PRINTING	PC	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24	Theory	OE	-----			
Pre-requisite Course(s)		Co-requisite Course(s)				
Computer Aided Design & Drafting		Engineering Materials				
Course Objectives						
1	To Know the importance of 3D printing in Manufacturing.					
2	To know the different 3D Printing Technologies.					
3	To select a suitable material for 3D Printing.					
4	To observe the different methods for Post-processing of 3D Printing parts.					
5	To Understand the applications of 3D Printing in Automobile, Aerospace, Bio-medical etc.					
Course Outcomes						
Upon completion of the course, students shall have ability to						
C101.1	Apply the features of robots and the technology involved in their control.					[AP]
C101.2	Apply basic engineering knowledge and relevant laws for the design of robotics.					[AP]
C101.3	Apply the concepts of various configurations, classifications, and parts of end effectors to compare different end effectors, grippers, tools, and sensors used in robots.					[AP]
C101.4	Apply the principles of kinematics, degeneracy, dexterity, and trajectory planning in robotics applications.					[AP]
C101.5	Apply image processing and image analysis techniques using a machine vision system.					[AP]
Course Contents						
Unit – 1	INTRODUCTION AND BASIC PRINCIPLES					9
introduction, Generic 3D Printing Process, Benefits, Distinction Between 3D Printing and CNC Machining, Other Related Technologies Development of 3D Printing Technology: Introduction, Computers, Computer-Aided Design Technology, Other Associated Technologies, The Use of Layers, Classification of 3D Printing Processes, Metal Systems, Hybrid Systems, Milestones in 3D Printing Development, 3D Printing around the World.						
Unit – 2	3D PRINTING PROCESS CHAIN & PHOTOPOLYMERIZATION PROCESSES					9
Eight Steps in Additive Manufacture, Variations from One 3D Printing Machine to Another, Metal Systems, Maintenance of Equipment, Materials Handling Issues, Design for 3D PRINTING. Introduction to Photopolymerization Processes: Photopolymerization Materials, Reaction Rates, Vector ScanSL, SL Resin Curing Process, SL Scan Patterns, Vector Scan Micro stereolithography, Mask Projection Photopolymerization Technologies and Processes, Two-Photon SL.						
Unit – 3	POWDER BED FUSION PROCESSES & EXTRUSION-BASED SYSTEMS					9
Powder Bed Fusion Processes: Introduction, SLS Process Description, Powder Handling, Approaches to Metal and Ceric Part Creation, Variants of Powder Bed Fusion Processes, Process Par3D Printingeters, Applied Energy Correlations and Scan Patterns, Typical Materials and Applications, Materials - Capabilities and Limitations. Extrusion-Based Systems: Introduction, Basic Principles, Plotting and Path Control, Materials, Limitations of FDM, Bioextrusion, Other Systems						
Unit – 4	DESIGN, GUIDELINES FOR PROCESS SELECTION & SOFTWARE ISSUES					9
Design for 3D Printing - Design for Manufacturing and Assembly, Core DFM for 3D Printing Concepts and Objectives, 3D Printing Unique Capabilities, Exploring Design Freedoms, Design Tools for 3D Printing.Guidelines for Process Selection - Selection Methods for a Part, Challenges of Selection, Preliminary Selection,Production Planning and Control.Software Issues for 3D Printing - Preparation of CAD Models – the STL File, Problems with STL Files, STL File Manipulation, Beyond the STL File, Additional Software to Assist 3D Printing.						
Unit – 5	MEDICAL APPLICATIONS & FUTURE DIRECTIONS FOR 3D PRINTING					9
Medical Applications for 3D Printing - Use of 3D Printing to Support Medical Applications, Software Support for Medical Applications, Limitations of 3D Printing for Medical Applications, Further Development of Medical 3D Printing Applications.Use of Multiple Materials in 3D Printing - Discrete Multiple Material Processes, Porous Multiple Material Processes, Blended Multiple Material Processes, Embedded Component 3D Printing, Commercial Applications Using Multiple Materials, Future Directions, Business Opportunities and Future Directions						

		Total Hours	45
Textbooks:			
1	Ian Gibson, David W Rosen, Brent Stucker., “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.		
2	Khanna Editorial, “3D Printing and Design”, Khanna Publishing House, Delhi.		
Reference Books:			
1	Chua Chee Kai, Leong Kah Fai, “Rapid Prototyping: Principles & Applications”, World Scientific,2003.		
2	Ali K. Kamrani, Emand Abouel Nasr, “Rapid Prototyping: Theory & Practice”, Springer, 2006.		
3	D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid prototyping and Rapid Tooling, Springer 2001.		

Assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			Assignm ent	Attenda nce	End Semester Examination
	CIA1 (6 Marks)	CIA2 (6 Marks)	Model Exam (8 Marks)			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand						
Apply						
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/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS 01	PS 02	PS 03
C101.1	√	√	√	√										√	
C101.2	√	√	√	√								√		√	
C101.3	√	√	√	√								√		√	
C101.4	√	√	√	√								√		√	
C101.5	√	√	√	√								√		√	

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Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE634	DIGITAL MANUFACTURING	OE	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 study the various aspects of digital manufacturing.					
2	To inculcate the importance of DM in Product Lifecycle Management and Supply					
3	Chain Management.					
4	To formulate of smart manufacturing systems in the digital work environment.					
5	To interpret IoT to support the digital manufacturing.					
Course Outcomes						
Upon completion of the course, students shall have ability to						
C101.1	Impart knowledge to use various elements in the digital manufacturing.					[U]
C101.2	Differentiate the concepts involved in digital product development life cycle process and supply chain management in digital environment.					[AP]
C101.3	Select the proper procedure of validating practical work through digital validation in Factories.					[AP]
C101.4	Implementation the concepts of IoT and its role in digital manufacturing.					[AP]
C101.5	Analyse and optimize various practical manufacturing process through digital twin					[AP]
Course Contents						
Unit – 1	INTRODUCTION					9
Introduction – Need – Overview of Digital Manufacturing and the Past – Aspects of Digital Manufacturing: Product life cycle, Smart factory, and value chain management – Practical Benefits of Digital Manufacturing – The Future of Digital Manufacturing.						
Unit – 2	DIGITAL LIFE CYCLE & SUPPLY CHAIN MANAGEMENT					9
Collaborative Product Development, Mapping Requirements to specifications – Part Numbering, Engineering Vaulting, and Product reuse – Engineering Change Management, Bill of Material and Process Consistency – Digital Mock up and Prototype development – Virtual testing and collateral. Overview of Digital Supply Chain - Scope& Challenges in Digital SC - Effective Digital Transformation - Future Practices in SCM						
Unit – 3	SMART FACTORY					9
Smart Factory – Levels of Smart Factories – Benefits – Technologies used in Smart Factory – Smart Factory in IoT- Key Principles of a Smart Factory – Creating a Smart Factory – Smart Factories and Cyber security						
Unit – 4	INDUSTRY 4.0					9
Introduction – Industry 4.0 –Internet of Things – Industrial Internet of Things – Framework: Connectivity devices and services – Intelligent networks of manufacturing – Cloud computing – Data analytics –Cyber physical systems – Machine to Machine communication – Case Studies.						
Unit – 5	STUDY OF DIGITAL TWIN					9
Basic Concepts – Features and Implementation – Digital Twin: Digital Thread and Digital Shadow- Building Blocks – Types – Characteristics of a Good Digital Twin Platform – Benefits, Impact & Challenges – Future of Digital Twins.						
					Total Hours	45
Textbooks:						
1	Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012.					
2	Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, A press, 2016.					
3						
Reference Books:						
1	Lihui Wang and Andrew YehChing Nee, Collaborative Design and Planning for Digital					

	Manufacturing, Springer-Verlag London Limited, 2009
2	Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science., United States, 2019
3	Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing, Switzerland, 2017
4	Ronald R. Yager and Jordan Pascual Espada, "New Advances in the Internet of Things", Springer., Switzerland, 2018.
Web References:	
1	https://link.springer.com
2	https://www.reddit.com
3	https://link.springer.com

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)			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand	4	2	2			
Apply	2	4	6			
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/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3
C101.1	√	√		√	√					√		√	√	√	
C101.2	√	√		√	√					√		√	√	√	
C101.3	√	√		√	√					√		√	√	√	
C101.4	√	√		√	√					√		√	√	√	
C101.5	√	√		√	√					√		√	√	√	

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Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE635	Composite Materials	PC	3	0	0	3
Regulation	Nature of the Course	Semester	Data Book/Codes/Standards			
R24A	THEORY		-----			
Pre-requisite Course(s)		Co-requisite Course(s)				
Course Objectives						
1	To introduce the fundamental concepts, classification, and applications of composite materials.					
2	To provide knowledge on different types of reinforcement and matrix materials used in composites.					
3	To impart understanding of various composite fabrication methods and processing techniques.					
4	To develop knowledge of mechanical behavior, testing methods, and failure mechanisms of composites.					
5	To explore advancements and emerging trends in composite materials.					
Course Outcomes						
Upon completion of the course, students shall have ability to						
C101.1	Explain the classification, characteristics, and applications of composite materials					[U]
C101.2	Identify and describe types of reinforcement and matrix materials used in composites					[U]
C101.3	Apply suitable composite manufacturing techniques for specific applications					[AP]
C101.4	Analyze the mechanical behavior and failure mechanisms in composite materials					[AP]
C101.5	Discuss recent trends and developments in advanced composites					[U]
Course Contents						
Unit – 1	Introduction:					9
Introduction and overview of composite materials and their need, Enhancement of properties, classification of composites, Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC), Application of composites.						
Unit – 2	Reinforcements Materials:					9
Metallic, Polymer, Ceramic and Composite fibres, Whiskers and Particulates, Nano-fillers used in polymer composites, Reinforcement fibres, Woven fabrics and Nonwoven random mats.						
Types of matrix: Commonly used Matrices (Metal matrix, Polymer matrix, Ceramic matrix, Intermetallic matrix, Carbon-Carbon composites), Basic Requirements in Selection of constituents.						
Unit – 3	Production techniques:					9
Processing of cast composites - XD process, Spray processes, In-situ Dispersion Processes, Liquidmetal impregnation technique .Hand lay-up processes – Spray up processes, Compression moulding, Reinforced reaction injection moulding, Resin transfer moulding, Pultrusion, Filament winding, Injection moulding.						
Unit – 4	Mechanics of Composite Materials:					9
Continuous fibres – iso-stress and iso-strain conditions, discontinuous fibres, Nature of stress vs. strain curves for different composite materials. Mechanical Properties: Mechanical testing of composites – tensile, flexure (3 point and 4 point bend tests), interfacial tests of laminates; Modes of fracture; Toughening mechanisms in composites.						
Unit – 5	Recent developments in Composites:					9
Self healing composites, Molecular composites, Micro and Nanocomposites, Biocomposites, Left handed composites, Stiffer than stiff composites, Carbon / carbon composites (Advantages and limitations of carbon matrix).						
Total Hours						45
Textbooks:						
1	K. K. Chawla, Composite Materials – Science and Engineering, Springer, 3rd Edition, 2012.					
2	Gibson, R. F., Principles of Composite Material Mechanics, CRC Press, 4th Edition, 2016.					
Reference Books:						
1	Mallick, P. K., Fiber-Reinforced Composites: Materials, Manufacturing, and Design, CRC Press, 3rd Edition, 2007.					
2	Mathews F.L., Rawlings R.D., Composite Materials: Engineering and Science, Woodhead Publishing,					

	1999.
3	Agarwal, B. D., Broutman, L. J., Analysis and Performance of Fiber Composites, Wiley, 3rd Edition, 2006
4	Sharma S.C., Composite materials, Narosa Publications, 2000.
5	Mallick, P.K, Composite Materials Technology: Process and Properties, Hanser, New York, 1990.

Assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			Assignm ent	Attenda nce	End Semester Examination
	CIA1 (6 Marks)	CIA2 (6 Marks)	Model Exam (8 Marks)			
Remember				(10 Marks)	(10 Marks)	(60 Marks)
Understand	20	20	20			
Apply	30	30	80			
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/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3
C101.1	√						√								
C101.2	√	√					√								
C101.3	√	√	√		√							√			
C101.4	√	√	√	√	√							√			
C101.5	√				√		√					√			

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE637	ORGANISATIONAL BEHAVIOUR	OE	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 help students to understand the concepts of organizational behavior and basics of personality					
2	To help them recognize the role of individual personality, perception and learning in organizational effectiveness					
3	To discuss the learning process and development of attitude					
4	To explain group dynamics and skills required for working in groups					
5	To examine organizational climate and culture					
Course Outcomes						
Upon completion of the course, students shall have ability to						
OE637.1	Comprehend the fundamental concepts in organizational behaviour					[U]
OE637.2	Explain the difference in the individual behaviour					[U]
OE637.3	Relate motivation, morale and attitude					[U]
OE637.4	Demonstrate the significance of working as a group and understand leadership					[U]
OE637.5	Outline the importance of organizational climate and culture					[U]
Course Contents						
Unit-1	INTRODUCTION TO MANAGEMENT					9
Organizational Behaviour: Definition- Importance and Scope of Organizational Behaviour, Factors influencing OB- Contributing disciplines to OB. Individual Differences - Intelligence tests - Measurement of Intelligence.						
Unit - 2	PERSONALTY, PERCEPTION AND LEARNING					9
Personality: Meaning, Types, Determinants of Personality, Personality Theory (Psycho analytic Theory), Perception – Meaning- Process- Factors affecting Perception. Learning – Meaning –Concepts – Factors affecting learning,						
Unit - 3						9
Motivation – Meaning- Theories (Maslow’s, Herzberg’s, Mc Gregors X and Y theory, Morale – meaning-Importance. Attitude: Meaning & Components, Work attitude,						
Unit – 4	GROUP DYNAMICS AND LEADERSHIP					9
Group dynamics: Group-Meaning-types, group cohesiveness –Group Norms-Group decision making. Team- Meaning, Types, Difference between group and team. Leadership- Meaning, Characteristics of a Successful Leader, Leadership Styles-Managerial Grid Theory						
Unit – 5	ORGANISATIONAL DYNAMICS					9
Organizational climate- meaning, components and factors affecting organizational climate. Organizational Culture - Types, creating and sustaining culture, managing cultural diversity.						
Total Hours						45
Textbooks:						
1	Prasad.L.M - “Organizational Behaviour, Sultan Chand & Son, New Delhi, 2024					
2	Stephen P. Robbins, Timothy A judge & Neharika Vohra- “Organizational Behaviour”, 8 th Edition, Pearson Education Ltd, 2022					
Reference Books:						
1	Aswathappa. K,“Organizational Behavior”, Himalaya Publishing House, 2024					

2	Fred Luthans, "Organisational Behaviour", McGraw Hill Book Co., 14 th edition, 2020
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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	100%	100%	100%			
Apply						
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/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
OE637.1	-	-	-	-	-	-	-	3	3	-	3	-	-	-
OE637.2	-	-	-	-	-	-	-	3	3	-	3	-	-	-
OE637.3	-	-	-	-	-	-	-	3	3	-	3	-	-	-
OE637.4	-	-	-	-	-	-	-	3	3	-	3	-	-	-
OE637.5	-	-	-	-	-	-	-	3	3	-	3	-	-	-

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE638	Total Quality Management	OE	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 introduce the fundamental concepts, principles, and evolution of Total Quality Management (TQM) and their significance in achieving organizational excellence.					
2	To develop an understanding of TQM principles such as leadership, employee involvement, continuous improvement, and supplier partnership for quality enhancement.					
3	To familiarize students with quality management tools and techniques used for problem-solving and process improvement in manufacturing and service sectors.					
4	To provide knowledge of advanced quality tools, process capability analysis, and quality improvement methodologies for organizational performance.					
5	To impart an understanding of quality management systems and international standards for implementing effective quality practices in organizations.					
Course Outcomes						
Upon completion of the course, students shall have ability to						
OE638.1	Explain the concepts, principles, frameworks, and importance of Total Quality Management, including customer focus and cost of quality.					[U]
OE638.2	Apply TQM principles such as leadership, employee involvement, continuous improvement, and supplier partnership to enhance organizational quality practices.					[AP]
OE638.3	Apply quality management tools and techniques, including the seven QC tools, Six Sigma, benchmarking, and FMEA, to solve quality-related problems.					[AP]
OE638.4	Apply control charts, process capability analysis, QFD, Taguchi methods, and TPM concepts to improve process performance and product quality.					[AP]
OE638.5	Explain the requirements and implementation of ISO 9000, ISO 9001, ISO 14000, quality auditing, and quality systems in manufacturing and service sectors.					[U]
Course Contents						
Unit-1	INTRODUCTION					9
Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, and Customer retention - Costs of quality.						
Unit - 2	TQM PRINCIPLES					9
Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.						
Unit - 3	TQM TOOLS & TECHNIQUES I					9
The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.						
Unit - 4	TQM TOOLS & TECHNIQUES II					9
Control Charts - Process Capability - Concepts of Six Sigma - Quality Function Development (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.						
Unit - 5	QUALITY SYSTEMS					9

Need for ISO 9000 - ISO 9001-2008 Quality System - Elements, Documentation, Quality Auditing - QS 9000 - ISO 14000 - Concepts, Requirements and Benefits – TQM Implementation in manufacturing and service sectors.

Total Hours **45**

Textbooks:

- 1 Dale H.Besterfield, Carol B.Michna, Glen H. Besterfield, Mary B.Sacre, Hemant Urdhwareshe and RashmiUrdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.
- 2 Joel.E. Ross, "Total Quality Management – Text and Cases", Routledge., 2017.

Reference Books:

- 1 Kiran. D.R, "Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
- 2 Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd.,2006.

Web References:

- 1 <https://www.youtube.com/playlist?list=PL2H1Li34F7gRnoyJer96C5R4dG48G6eO>
- 2 <https://www.youtube.com/watch?v=OSz7MykPhFI>
- 3 https://www.youtube.com/playlist?list=PL8fPvgxF8y0XY6AKVJMq9V_fbT0clL6N

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	80%		80%			
Apply	20%	100%	20%			
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/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PS01	PS02	PS03
OE638.1	-	2	2	-	-	-	3	-	2	-	-	-	-	-
OE638.2	-	-	2	1	-	2	2	-	2	-	-	-	-	-
OE638.3	-	3	1	1	2	-	-	-	3	-	-	-	-	2
OE638.4	-	-	1	1	-	2	-	-	1	-	-	-	-	2
OE638.5	-	-	2	-	2	-	-	-	-	-	-	1	-	-

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE639	Intellectual Property Rights		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 introduce the fundamental concepts, types, significance, and evolution of Intellectual Property Rights in India and globally.					
2	To familiarize students with the procedures and practical aspects involved in registering various forms of intellectual property in India and abroad.					
3	To provide knowledge of international treaties and national legislations governing Intellectual Property Rights.					
4	To develop an understanding of the protection of digital innovations and the relationship between IP laws, cyber laws, and unfair competition.					
5	To impart knowledge on infringement issues, enforcement mechanisms, and emerging challenges in Intellectual Property Rights.					
Course Outcomes						
Upon completion of the course, students shall have ability to						
OE639.1	Explain the fundamental concepts, types, significance, and need for Intellectual Property Rights, including patents, copyrights, geographical indications, TRIPS, and WIPO.					[U]
OE639.2	Describe the procedures and practical aspects involved in the registration of copyrights, trademarks, patents, geographical indications, trade secrets, and industrial designs in India and abroad.					[U]
OE639.3	Summarize the key provisions of international treaties and national legislations related to Intellectual Property Rights, including TRIPS, PCT, Patent Act, Design Act, Trademark Act, and Geographical Indication Act.					[U]
OE639.4	Apply Intellectual Property and cyber law principles to analyze the protection of digital innovations, digital content, and issues related to unfair competition through case studies.					[AP]
OE639.5	Apply appropriate legal provisions and enforcement measures to address Intellectual Property Rights infringement and emerging issues using relevant case studies.					[AP]
Course Contents						
Unit-1	INTRODUCTION TO IPR					9
Introduction to IPRs, Basic concepts and need for Intellectual Property – Patents, copyrights, geographical Indications. IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO – TRIPS, Nature of Intellectual Property, Industrial Property, technological research, inventions and innovations – Important examples of IPR.						
Unit – 2	REGISTRATION OF IPRs					9
Meaning and practical aspects of registration of copy rights, trademarks, patents, geographical indications, trade secrets and industrial design registration in India and abroad.						
Unit – 3	AGREEMENTS AND LEGISLATIONS					9
International treaties and conventions on IPRs, TRIPS agreement, PCT agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademarks Act, Geographical Indication Act.						
Unit – 4	DIGITAL PRODUCTS AND LAW					9

Digital innovations and developments as knowledge assets – IP laws, cyber law and digital content protection – unfair competition – meaning and relationship between unfair competition and IP laws – case studies.

Unit – 5 **ENFORCEMENT OF IPRS** **9**

Infringement of IPRs, enforcement measures, emerging issues – case studies.

Total Hours **45**

Textbooks:

1 Dr. G.B.Reddy, Intellectual Property Rights and The Law, Gogia Law Agency, 2020

2 B.L. Wadehra, Law Relating to Intellectual Property, Universal Law Publishing Co., 2011

Reference Books:

1 P. Narayanan, Intellectual Property Law, Eastern Law House, 2023

2 Dr.S.R. Myneni, Law of Intellectual Property, Asian Law House, 2012.

Web References:

1 <https://www.youtube.com/watch?v=IlXGjaCkM6Y>

2 <https://www.youtube.com/watch?v=pqRqJ3e4PUE>

3 https://www.youtube.com/watch?v=Oj_Vwml-Q18

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	100%	100%				
Apply			100%			
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/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PS01	PS02	PS03
OE639.1	-	-	-	-	-	-	3	3	-	-	3	-	-	-
OE639.2	-	-	-	-	-	-	3	3	-	-	3	-	-	-
OE639.3	-	-	-	-	-	-	3	3	-	-	3	-	-	-
OE639.4	-	-	-	-	-	-	3	3	-	-	3	-	-	-
OE639.5	-	-	-	-	-	-	3	3	-	-	3	-	-	-

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE640	EMOTIONAL INTELLIGENCE	OE	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 help students gain basic understanding of Emotions					
2	To provide them with knowledge regarding concepts and models of emotional Intelligence(EI)					
3	To enable them to recognize and regulate their emotions					
4	To help students manage relationship in a positive manner.					
5	To infer ways to measure and develop strategies for acquiring EQ					
Course Outcomes						
Upon completion of the course, students shall have ability to						
OE640.1	Comprehend the basic concepts of management and evolution in management.					[U]
OE640.2	Demonstrate the roles and skills in planning and decision making for the business.					[U]
OE640.3	Discover personal competencies and manage emotions					[U]
OE640.4	Gain insight into positive relationship through EI					[U]
OE640.5	Identify ways to improve emotional Intelligence					[AP]
Course Contents						
Unit-1	INTRODUCTION TO THE CONCEPT OF EMOTION					9
Emotion- Meaning, characteristics of emotion, components of emotion-cognitive component, physiological component, Behavioural component, Types of emotions,						
Unit – 2	FUNDAMENTALS OF EMOTIONAL INTELLIGENCE					9
Nature and Significance, Models of emotional intelligence: Ability, Trait and Mixed, Building blocks of emotional intelligence: self-awareness, self-management, social awareness, and relationship management						
Unit – 3	PERSONAL COMPETENCE					9
Self-Awareness: Observing and recognizing one's own feelings, Knowing one's strengths and areas of development. Self-Management: Managing emotions, anxiety, fear, and anger.						
Unit – 4	SOCIAL COMPETENCE					9
Social Awareness: Others' Perspectives, Empathy and Compassion, Relationship Management: Effective communication, Collaboration, Teamwork, and Conflict management						
Unit – 5	EMOTIONAL INTELLIGENCE: MEASUREMENT AND DEVELOPMENT					9
Measures of emotional intelligence, Strategies to enhance emotional intelligence						
Total Hours						45
Textbooks:						
1	Daniel Goleman, Emotional Intelligence: Why it Matters more than IQ, Bloomsbury India, 2021					
2	Travis Bradberry, Jean Greaves, Emotional Intelligence 2.0, Talentsmart, 2009					
Reference Books:						
1	Dr. Pratik P Surana, Mastering Emotional Intelligence : Making Emotions Work “For” you and not “Against” you, Notion Press, 2021					
2	Ryan James, Emotional Intelligence: The Definitive Guide to Understanding Your Emotions, How to Improve Your EQ and Your Relationships, Kindle Edition,2016					

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	100%	100%	80%			
Apply			20%			
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/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PS01	PS02	PS03
OE640.1	-	-	-	-	-	-	-	3	3	-	3	-	-	-
OE640.2	-	-	-	-	-	-	-	3	3	-	3	-	-	-
OE640.3	-	-	-	-	-	-	-	3	3	-	3	-	-	-
OE640.4	-	-	-	-	-	-	-	3	3	-	3	-	-	-
OE640.5	-	-	-	-	-	-	-	3	3	-	3	-	-	-

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
240E641	Algebra and Number Theory		OEC	3	0	0	3
Course Outcomes (s)							
Upon completion of the course, students shall have ability to							RBT
C01	Apply algebraic structures and mappings to solve problems related to groups and rings.						[AP]
C02	Utilize properties of finite fields to analyze and factor expressions within polynomial systems.						[AP]
C03	Implement number-theoretic techniques from divisibility and decomposition to perform structured arithmetic computations.						[AP]
C04	Solve modular equations and systems using methods from Diophantine analysis and congruences.						[AP]
C05	Apply classical results and arithmetic functions to evaluate and reason about numerical properties.						[AP]

Course Content		
Unit – I	GROUPS AND RINGS	09
Groups: Definition - Properties - Homomorphism - Isomorphism - Cyclic groups - Cosets - Lagrange's theorem. Rings: Definition - Sub rings - Integral domain - Field - Integer modulo n - Ring homomorphism.		
Unit – II	FINITE FIELDS AND POLYNOMIALS	09
Rings - Polynomial rings - Irreducible polynomials over finite fields - Factorization of polynomials over finite fields.		
Unit – III	DIVISIBILITY THEORY AND CANONICAL DECOMPOSITIONS	09
Division algorithm- Base-b representations – Number patterns – Prime and composite numbers – GCD – Euclidean algorithm – Fundamental theorem of arithmetic – LCM.		
Unit – IV	DIOPHANTINE EQUATIONS AND CONGRUENCES	09
Linear Diophantine equations – Congruence's – Linear Congruence's - Applications : Divisibility tests - Modular exponentiation - Chinese remainder theorem – 2x2 linear systems		
Unit – V	CLASSICAL THEOREMS AND MULTIPLICATIVE FUNCTIONS	09
Wilson's theorem – Fermat's Little theorem – Euler's theorem – Euler's Phi functions – Tau and Sigma functions.		
		TOTAL: 45 Hours
Learning Resources		
Textbooks		
1	R. P. Grimaldi and B. V. Ramana, <i>Discrete and Combinatorial Mathematics: An Applied Introduction</i> , 5th ed. New Delhi, India: Pearson Education, 2019.	
2	T. Koshy, <i>Elementary Number Theory with Applications</i> , 2nd ed. Burlington, MA, USA: Academic Press, 2007.	
Reference Books		
1	S. Ling and C. Xing, <i>Coding Theory: A First Course</i> , 1st ed. Cambridge, U.K.: Cambridge University Press, 2004.	
2	I. Niven, H. S. Zuckerman, and H. L. Montgomery, <i>An Introduction to the Theory of Numbers</i> , 5th ed. Singapore: John Wiley and Sons, 2004.	
3	R. Lidl and G. Pilz, <i>Applied Abstract Algebra</i> , 2nd ed. New Delhi, India: Springer-Verlag, 2006.	
Web References		
1	https://archive.nptel.ac.in/courses/111/106/111106113/	
2	https://nptel.ac.in/courses/106/106/106106094/	
3	https://nptel.ac.in/courses/106/106/106106183/	
4	https://nptel.ac.in/courses/106/104/106104137/	
5	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-042j-mathematics-for-computer-science-fall-2005/	

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24OE642	Linear Algebra		OEC	3	0	0	3
Course Outcomes (s)							
Upon completion of the course, students shall have ability to							RBT
C01	Test the consistency and solve system of linear equations.						[AP]
C02	Find the basis and dimension of vector space.						[AP]
C03	Obtain the matrix of linear transformation and its eigenvalues and eigen vectors						[AP]
C04	Find orthonormal basis of inner product space and find least square approximation.						[AP]
C05	Find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.						[AP]

Course Content		
Unit – I	MATRICES AND SYSTEM OF LINEAR EQUATIONS	09
Matrices - Row echelon form - Rank - System of linear equations - Consistency - Gauss elimination method - Gauss Jordan method.		
Unit – II	VECTOR SPACES	09
Vector spaces over Real and Complex fields - Subspace – Linear space - Linear independence and dependence - Basis and dimension.		
Unit – III	LINEAR TRANSFORMATION	09
Linear transformation - Rank space and null space - Rank and nullity - Dimension theorem– Matrix representation of linear transformation - Eigenvalues and eigenvectors of linear transformation – Diagonalization.		
Unit – IV	INNER PRODUCT SPACES	09
Inner product and norms - Properties - Orthogonal, Orthonormal vectors - Gram Schmidt orthonormalization process - Least square approximation.		
Unit – V	EIGEN VALUE PROBLEMS AND MATRIX DECOMPOSITION	09
Eigen value Problems: Power method, Jacobi rotation method - Singular value decomposition – QR decomposition.		
		TOTAL: 45 Hours
Learning Resources		
Textbooks		
1	J. D. Faires and R. L. Burden, <i>Numerical Methods</i> , 4th ed. Boston, MA, USA: Cengage Learning, 2012.	
2	S. H. Friedberg, A. J. Insel, and L. E. Spence, <i>Linear Algebra</i> , 5th ed. New Delhi, India: Pearson Education, 2019.	
Reference Books		
1	B. Kolman and D. R. Hill, <i>Introductory Linear Algebra</i> , 8th ed. New Delhi, India: Pearson Education, 2009.	
2	S. Kumaresan, <i>Linear Algebra: A Geometric Approach</i> , Reprint, New Delhi, India: Prentice Hall of India, 2010.	
3	R. Bronson, <i>Schaum's Outline of Matrix Operations</i> , 2nd ed. New York, NY, USA: McGraw-Hill, 2011.	
4	G. Strang, <i>Linear Algebra and Its Applications</i> , 5th ed. New Delhi, India: Pearson Education, 2023.	
5	V. Sundarapandian, <i>Numerical Linear Algebra</i> , New Delhi, India: PHI Learning Pvt. Ltd., 2023.	
Web References		
1	https://archive.nptel.ac.in/courses/111/106/111106051	
2	https://onlinecourses.nptel.ac.in/noc24_ee48/preview	
3	https://archive.nptel.ac.in/courses/111/107/111107106/	

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24OE643	Advanced Engineering Chemistry		OE	3	0	0	3
Course Outcomes (s)							
Upon completion of the course, students shall have ability to							RBT
C01	Understand the basic principles of semiconductors, including periodic trends, band gaps, conductivity, and their applications in various electronic and optoelectronic devices.						[U]
C02	Select appropriate modern engineering alloys based on their composition and properties for specific applications in electronics, telecommunications, and aerospace.						[AP]
C03	Classify different types of refractories and abrasives and describe their properties and manufacturing processes with respect to industrial usage.						[U]
C04	Describe the types and mechanisms of adsorption, interpret adsorption isotherms, and explain their significance in catalytic and surface chemistry applications.						[U]
C05	Apply suitable spectroscopic techniques such as UV-Visible, IR, XRD, and flame photometry for the qualitative and quantitative analysis of materials.						[AP]

Course Content		
Unit – I	Chemistry of Semiconductors	09
Semiconductors – Introduction – Periodic trends –Band gaps, conductivity and colours of semiconductors - compound semiconductors–Semiconductor Technology – An overview of Integrated circuit design and fabrication – uses in FET – BJT, JFET, MOSFET - Semiconductors in traffic lights and electronics, CD/DVD optical discs, microchips in computers and cell phones, solar cells- amorphous semiconductors – an overview		
Unit – II	Modern Engineering Materials	09
Metals and Metallic properties-Alloys and Need for Alloys - Modern Electronic grade alloys-Composition, Properties of Aluminium, Silicon, Nickel, Phosphorus and Copper alloys-Applications in electrical components, transducers, electromagnetic shielding of computers, telecommunications equipment and rocket motor casings.		
Unit – III	Refractories and Abrasives	09
Refractories – classification – acidic, basic and neutral refractories – properties (refractoriness, refractoriness under load, dimensional stability, porosity, thermal spalling) – manufacture of alumina, magnesite and zirconia bricks. Abrasives – natural and synthetic abrasives – quartz, corundum, emery, garnet, diamond, silicon carbide and boron carbide.		
Unit – IV	Surface Chemistry	09
Adsorption- Classification of adsorption-adsorption of gases on solids-adsorption of solutes from Solutions-Types of adsorption isotherms-Freundlich adsorption Isotherm-Langmuir's theory of adsorption- Applications of adsorption - Role of adsorbents in catalysis.		
Unit – V	Spectroscopic Techniques	09
Basic concepts of spectroscopy - Electromagnetic spectrum – Lambert and Beers law - Absorption and Emission spectroscopy – Different spectroscopic Techniques - UV- Visible – IR – Colorimetry - Flame photometry (Block Diagram) - XRD technique.		
		TOTAL: 45 Hours
Learning Resources		
Textbooks		
1	David W. Greve, "Semiconductor Devices and Technology", Squirrel Hill Publications, Pittsburg, USA, 14th Edition, 2011.	
2	Jain P. C. & Monica Jain., "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.	
3	Dara S.S., "A Text book of Engineering Chemistry", S.Chand Publications, 2004	
4	Shashi Chawla "A Text Book Of Engineering Chemistry" Dhanpat Rai & Co. (P) Limited, 2017	
Reference Books		

1	Joel Irwin Gersten and Frederick William Smith, "The Physics and Chemistry of Materials", Wiley Interscience, New Jersey, 12th Edition, 2012.
2	Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3	Friedrich Emich, "Engineering Chemistry", Medtech, 2014.
Web References	
1	https://learncheme.com/
2	https://www.coursera.org/browse/physical-science-and-engineering/chemistry
3	http://www.cheresources.com/

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24OE644	Nanotechnology And NLO Materials		OE	3	0	0	3
Course Outcomes (s)							
Upon completion of the course, students shall have ability to							RBT
C01	Understand the basic concepts of nanotechnology.						[U]
C02	Explained the method of synthesizing nanostructures with desired size, shape, and surface properties.						[AP]
C03	Apply characterization results to optimize the synthesis process and enhance the functionality of nanomaterials for targeted applications.						[AP]
C04	Utilize nanomaterials for the design of high-performance sensing devices.						[AP]
C05	Utilize nonlinear optical concepts to enhance and develop technologies in recent engineering.						[AP]

Course Content		
Unit – I	INTRODUCTION TO NANOMATERIALS	09
History of nanomaterial's, Classification of Nanomaterial's, Scientific Revolutions, Nanotechnology and Nano machines, The Periodic Table, Atomic Structure, Energy, Molecular and Atomic size, Surfaces and Dimensional Space.		
Unit – II	SYNTHESIS METHOD OF NANO MATERIALS	09
Top down and Bottom-up approach, Ball Milling, Electros pinning, Lithographic techniques, Mechanical milling Etching, Sputtering, Laser Ablation, Molecular beam epitaxy, CVD, Arc discharge, Flame synthesis, spray pyrolysis and solvated metal atom dispersion, Sol-Gel, Electro deposition.		
Unit – III	BASICS OF NANO MATERIALS CHARACTERIZATION TECHNIQUES	09
UV- Visible Spectroscopy, Fourier Transform infrared (FTIR) spectroscopy, Raman spectroscopy-X-ray Photoelectron Spectroscopy (XPS), Energy Dispersive X-ray analysis (EDAX), microscopy (SEM), Transmission electron microscopy (TEM), Atomic force microscopy (AFM), Scanning tunneling microscopy (STM). Resistivity by Four Point Probe method, Hall measurement.		
Unit – IV	NANO MATERIALS AND APPLICATIONS	09
Sensors, Nanotechnology Enabled Sensors, Sensor Characteristics and Terminology, Static Characteristics, Dynamic Characteristics, Resistive and Capacitive Gas Sensors, Potentiometric Sensors, Amperometric Sensors, Electro-Chemical Biosensors.		
Unit – V	NONLINEAR OPTICS AND APPLICATIONS	09
Nonlinear Optics: Nonlinear Susceptibility, 2nd order nonlinear effect- Optical Rectification, 2nd harmonic generation, , Nonlinear Maxwell's equation, Concept of phase matching Birefringence Phase Matching (BPM) , Kleinman symmetry, Index contraction, d-matrix ,Quasi Phase Matching (QPM), Optical Parametric Oscillator (OPO),Singly Resonant Oscillator (SRO),Doubly Resonant Oscillator.		
		TOTAL: 45 Hours
Learning Resources		
Textbooks		
1	A textbook of Nano science and Nanotechnology, Pradeep.T, Tata McGraw – Hill Education private Ltd, 2012.	
2	Nanostructured materials: Processing, Properties and Potential Applications, edited by C.C. Koch, Noyes Publications, 2002.	
3	Inorganic Materials Synthesis and Fabrication by J.N. Lalena, D.A. Cleary, E.E. Carpenter, N.F. Dean, John Wiley & Sons Inc,2008.	
4	Characterization of nanostructured materials by Z.L. Wang, Wiley India, 1999.	
5	Nanotechnology-Enabled Sensors, KouroshKalantar-zadeh, Springer publications, 2007.	
6	Chemical Sensors-An Introduction for Scientists and Engineers, Peter Grundler, Springer publications, 2006.	
7	Nonlinear Optics. Third Edition. Robert W. Boyd. The Institute of Optics. University of Rochester. Rochester, NY, United States, 2008.	
8	Introduction to nonlinear optics by Geoffrey New, Imperial College of Science, Technology and Medicine, London, 2011.	
Reference Books		
1	Nanotechnology: Principles and Practices – Sulabha K. Kulkarni – Capital Publishing Company, 2015.	

2	Design and Applications of Nanomaterials for Sensors by Jorge M. Seminario, Jerzy Leszczynski, Springer, Volume-16, 2014.
3	Fundamentals of nonlinear optics (2nd Ed.) by Peter E. Powers, Joseph W. Haus , CRC Press, 2017.
4	Nonlinear Optics: Principles and Applications by K Rottwitt, P Tidemand-Lichtenberg , CRC Press, 2014.
5	Introduction to Nano science, S.M. Lindsay, Oxford university Press, 2010.
6	Encyclopedia of Nano Technology by M. BalakrishnaRao and K. Krishna Reddy, Vol I to X, Cumpus Books International, 2006.
7	A practical approach to X-Ray diffraction analysis by C. Suryanarayana, Plenum Press, Newyork, 1998.
8	Atomic and Molecular Spectroscopy: Basic Aspects and Applications by S. Svanberg, Springer, 2001.
Web References	
1	https://archive.nptel.ac.in/courses/118/102/118102003/#
2	https://archive.nptel.ac.in/courses/115/105/115105105/
3	https://archive.nptel.ac.in/courses/115/101/115101008/#
4	https://ocw.mit.edu/courses/2-57-nano-to-macro-transport-processes-spring-2012/resources/lecture-1-intro-to-nanotechnology-nanoscale-transport-phenomena/

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
240E645	English for Competitive Examinations	HS	3	0	0	3
Course Outcomes (s)						
Upon completion of the course, students shall have ability						RBT
C114.1	Understanding of common English words and phrases, building their vocabulary to communicate.					AP
C114.2	Recognize different types of sentence structures.					AP
C114.3	Learn to write précis and notes with clarity.					AP
C114.4	Express ideas in a clear and concise manner.					AP
C114.5	Gain a clear understanding in the use of prepositions and eliminate common errors.					AP

Course Content		
Unit –1	INTRODUCTION TO BASICS OF ENGLISH	9
Different kinds of Tenses, Types of Sentences, Phrase, Adverb& Phrases and Idioms. Synonyms and Antonyms.		
Unit –2	TRANSFORMATION OF SENTENCE	9
Transformation of simple, Compound and complex sentences, Transformation of communication classification of sentences & Transformation of Degree. Synonyms And Antonyms.		
Unit –3	PRECIS AND NOTE WRITING	9
Precise writing, Note making, Paragraph Writing & Essay Writing. Synonyms And Antonyms.		
Unit –4	COMPREHENSION AND LETTER AND REPORT WRITING	9
Comprehension, Letter Writing &Report Writing. Synonyms And Antonyms.		
Unit –5	COMMON ERRORS AND USE OF PREPOSITIONS	9
Match Words With Their Meanings, Spotting Common Errors In English Grammar, Appropriate Use Of Prepositions. Synonyms And Antonyms.		
		TOTAL: 45Hours
Learning Resources		
Textbooks		
1	K. S. Sinha, <i>The King’s Grammar</i> . New Delhi, India: Blackie ELT Books, 2008.	
2	C. D. Sidhu, P. Nath, and K. Kapoor, <i>Comprehensive English Grammar and Composition</i> . New Delhi, India: Khosla Publishing House, 2004.	
3	P. C. Wren and H. Martin, <i>High School English Grammar & Composition</i> . New Delhi, India: S. Chand & Company, 2007.	
Reference Books		
1	C. Baldick, <i>The Oxford Dictionary of Literary Terms</i> . Oxford, U.K.: Oxford University Press, 2009.	
3	J. Mathew, <i>Fine Tune Your English</i> . New Delhi, India: Orient Blackswan Pvt. Ltd., 2010.	
Web References		
1	https://byjus.com/govt-exams/general-english-competitive-exams//	

APPENDIX

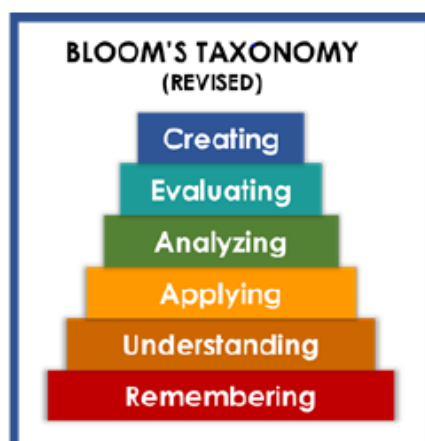
A. Knowledge and Attitude Profile (WK)

WK	Knowledge and Attitude Profile
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.

B. BLOOMS TAXONOMY

According to revised Blooms taxonomy the levels in the cognitive domain are as follows:

Level	Descriptor	Level of attainment
1	Remembering	Recalling from the memory of the previously learned material
2	Understanding	Explaining ideas or concepts
3	Applying	Using the information in another familiar situation
4	Analysing	Breaking information into the part to explore understanding and relationships
5	Evaluating	Justifying a decision or course of action
6	Creating	Generating new ideas, products or new ways of viewing things



Bloom's taxonomy is hierarchical, meaning that learning at the higher level requires that skills at a lower level are attained.

As per the Examination Reform Policy following are the Action Verbs for Assessment

Level	Question cues / Verbs for tests
1. Remember	list, define, tell, describe, recite, recall, identify, show, label, tabulate, quote, name, who, when, where
2. Understand	describe, explain, paraphrase, restate, associate, contrast, summarize, differentiate interpret, discuss
3. Apply	calculate, predict, apply, solve, illustrate, use, demonstrate, determine, model, experiment, show, examine, modify
4. Analyse	classify, outline, break down, categorize, analyze, diagram, illustrate, infer, select
5. Evaluate	assess, decide, choose, rank, grade, test, measure, defend, recommend, convince, select, judge, support, conclude, argue, justify, compare, summarize, evaluate
6. Create	design, formulate, build, invent, create, compose, generate, derive, modify, develop, integrate