Kathir College of Engineering

[Autonomous]

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

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

CURRICULUM AND SYLLABUS

B.E - ELECTRICAL AND ELECTRONICS ENGINEERING

REGULATION 2024

CHOICE BASED CREDIT SYSTEM

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 ELECTRICAL AND ELECTRONICS ENGINEERING

VISION

To provide academic excellence meeting the demands of growing industries and bringing out globally competent electrical and electronics engineers through research oriented, ethical, social, innovative and industrially collaborating approach.

MISSION

M1: To provide quality technical & value based education using modern tools in the field of Electrical & Electronics Engineering.

M2: To bridge the gap between industry and academia by solving complex technological problems based on industrial and societal needs.

M3: To create a cadre of professionals who are well trained to promote collaborative and multidisciplinary activities.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

PEO1: Graduates will have a successful career by demonstrating their knowledge and skill to design, analyze and optimize the solutions for industrial challenges.

PEO2: Graduates will work in multi-disciplinary environments and teams by exhibiting technical and intellectual competencies, discharging their professional and social responsibilities.

PEO3: Graduates will engage in lifelong learning that contributes to personal & professional growth.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Ability to integrate the fundamental knowledge of mathematics, science, electrical engineering to solve complex problems in electrical, electronics and interdisciplinary areas.

PSO2: Ability to design and meet the demands of industry using the state of the art components and software tools.

PROGRAM OUTCOMES (POs)	
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. (WK1 to WK4)
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. (WK5)
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. (WK8).
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. (WK2 and WK6)
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. (WK1, WK5, and WK7).
7.Ethics:	Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
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 Critical thinking in the broadest context of technological change. (WK8)

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.E ELECTRICAL AND ELECTRONICS ENGINEERING

REGULATION 2024

CURRICULUM

CHOICE BASED CREDIT SYSTEM

SEMESTER – I

S.No	Course Code	Course	L	T	P	Contact hrs/ Week	Credits	Ext/ Int	Cat
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.	24BP213	Physics for Electronic Sciences	3	0	2	5	4	40/60	BS
4.	24HS114	Technical English	2	0	2	4	3	40/60	HS
Practical									
5.	24EP315	Engineering Practices Laboratory	0	0	4	4	2	40/60	ES
6.	24CS316	Programming in C Laboratory	0	0	4	4	2	40/60	ES
7.	24MC901	Mandatory Course I Induction program	3 Weeks Program				0	0	MC
		Total	**11**	**1**	**12**	**24**	**18**	**600**	

SEMESTER – II

S.No	Course Code	Course	L	T	P	Contact hrs/ Week	Credits	Ext/ Int	Cat.
Theory									
1.	24MA221	Differential Equations and Complex Functions	3	1	0	4	4	60/40	BS
2.	24EE422	Electric Circuit Analysis	3	0	0	3	3	60/40	PC
3.	24ME323	Basic Civil and Mechanical Engineering	3	0	0	3	3	60/40	ES
Theory Cum Practical									
4.	24HS124	Professional English	2	0	2	4	3	40/60	HS
5.	24EG315	Engineering Graphics	1	0	4	5	3	40/60	ES
6.	24BC226	Chemistry for Electronic Sciences	3	0	2	5	4	40/60	BS
Practical									
7.	24EE427	Electric Circuit Analysis Laboratory	0	0	4	4	2	40/60	PC
Mandatory									
8.	24MC902	Mandatory Course II / Heritage of Tamils	2	0	0	2	0	0/100	MC
		Total	**17**	**1**	**12**	**30**	**22**	**800**	

SEMESTER – III

S.No	Course Code	Course	L	T	P	Contact hrs/ Week	Credits	Ext/ Int	Cat
Theory									
1.	24MA232	Transforms and Partial Differential Equations	3	1	0	4	4	60/40	BS
2.	24EE432	Electromagnetic Fields	3	1	0	4	4	60/40	PC
3.	24EC333	Digital Logic Circuits	3	0	0	3	3	60/40	ES
4.	24EE434	DC Machines and Transformers	3	0	0	3	3	60/40	PC
Theory Cum Practical									
5.	24EE435	Electronic Devices and Circuits	3	0	2	5	4	40/60	PC
6.	24CS336	Problem Solving and Python Programming	3	0	2	5	4	40/60	ES
Practical									
7.	24EE437	DC Machines and Transformers Laboratory	0	0	4	4	2	40/60	PC
Mandatory									
8.	24MC903	Mandatory Course III Environmental Science and Sustainability	2	0	0	2	0	0/100	MC
		Total	**20**	**2**	**8**	**30**	**24**	**800**	

SEMESTER – IV

S.No	Course Code	Course	L	T	P	Contact hrs/ Week	Credits	Ext/Int	Cat
Theory									
1.	24MA244	Statistics and Numerical Methods	3	1	0	4	4	60/40	BS
2.	24EE442	Generation, Transmission and Distribution	3	0	0	3	3	60/40	PC
3.	24EE443	Measurements and Instrumentation	3	0	0	3	3	60/40	PC
4.	24EE444	Synchronous and Induction Machines	3	0	0	3	3	60/40	PC
5.	24EE445	Linear Integrated Circuits	3	0	0	3	3	60/40	PC
Theory cum Practical									
6.	24CS346	Data Structures and Algorithms	3	0	2	5	4	40/60	ES
Practical									
7.	24EE447	Synchronous and Induction Machines Laboratory	0	0	4	4	2	40/60	PC
8.	24EE448	Digital and Linear Integrated Circuits Laboratory	0	0	4	4	2	40/60	PC

Mandatory									
9.	24MC904	Mandatory Course IV Introduction to Women and Gender Studies	2	0	0	2	0	0/100	MC
		Total	**20**	**1**	**10**	**31**	**24**	**900**	

SEMESTER – V

S.No	Course Code	Course	L	T	P	Contact hrs/ Week	Credits	Ext/ Int	Cat
Theory									
1.	24MB151	Principles of Management	3	0	0	3	3	60/40	HS
2.	24EE452	Power Electronics	3	0	0	3	3	60/40	PC
3.	24EE5XX	Professional Elective I	3	0	0	3	3	60/40	PE
4.	24OE6XX	Open Elective I	3	0	0	3	3	60/40	OE
5.	24OE6XX	Open Elective II	3	0	0	3	3	60/40	OE
Theory Cum Practical									
6.	24EE456	Power System Analysis	3	0	2	5	4	40/60	PC
7.	24EE457	Control Systems	3	0	2	5	4	40/60	PC
Practical									
8.	24EE458	Power Electronics Laboratory	0	0	4	4	2	40/60	PC
		Total	**21**	**0**	**8**	**29**	**25**	**800**	

SEMESTER – VI

S.No	Course Code	Course	L	T	P	Contact hrs/ Week	Credits	Ext/ Int	Cat
Theory									
1.	24EE461	Power System Protection and Switchgear	3	0	0	3	3	60/40	PC
2.	24EC362	Digital Signal Processing	3	1	0	4	4	60/40	ES
3.	24EE5XX	Professional Elective II	3	0	0	3	3	60/40	PE
4.	24EE5XX	Professional Elective III	3	0	0	3	3	60/40	PE
5.	24OE6XX	Open Elective III	3	0	0	3	3	60/40	OE
Theory Cum Practical									
6.	24EE466	Electrical Drives	3	0	2	5	4	40/60	PC
7.	24EC367	Microcontroller and its applications	3	0	2	5	4	40/60	ES
		Total	**21**	**1**	**4**	**26**	**24**	**700**	

SEMESTER – VII

S.No	Course Code	Course	L	T	P	Contact hrs/ Week	Credits	Ext/ Int	Cat
Theory									
1.	24HS171	Human Values and Ethics	2	0	0	2	2	60/40	HS
2.	24EE5XX	Professional Elective IV	3	0	0	3	3	60/40	PE
3.	24EE5XX	Professional Elective V	3	0	0	3	3	60/40	PE
4.	24EE5XX	Professional Elective VI	3	0	0	3	3	60/40	PE
5.	24OE6XX	Open Elective IV	3	0	0	3	3	60/40	OE
6.	24OE6XX	Open Elective V	3	0	0	3	3	60/40	OE
Internship and Project									
7.	24EE871	Industrial Practices	0	0	0	0	2	0/100	IP
8.	24EE771	Project Work Phase I	0	0	4	4	2	40/60	PW
		Total	**17**	**0**	**4**	**21**	**21**	**800**	

SEMESTER – VIII

S.No	Course Code	Course	L	T	P	Contact hrs/ Week	Credits	Ext/ Int	Cat
1.	24EE781	Project Work Phase II	0	0	24	24	12	40/60	PW
		Total	**0**	**0**	**24**	**24**	**12**	**100**	

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	3	2

BASIC SCIENCE COURSES (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.	24BP213	Physics for Electronic Sciences	3/0/2	5	4
3.	24MA221	Differential Equations and Complex Functions	3/1/0	4	4
4.	24BC226	Chemistry for Electronic Sciences	3/0/2	5	4
5.	24MA232	Transforms and Partial Differential Equations	3/1/0	4	4
6.	24MA244	Statistics and Numerical Methods	3/1/0	4	4

ENGINEERING SCIENCES COURSES (32 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.	24EP315	Engineering Practices Laboratory	0/0/4	4	2
3.	24CS316	Programming in C Laboratory	0/0/4	4	2
4.	24ME323	Basic Civil and Mechanical Engineering	3/0/0	3	3
5.	24EG315	Engineering Graphics	1/0/4	5	3
6.	24EC333	Digital Logic Circuits	3/0/0	3	3
7.	24CS336	Problem Solving and Python Programming	3/0/2	5	4
8.	24CS346	Data Structures and Algorithms	3/0/2	5	4
9.	24EC362	Digital Signal Processing	3/1/0	4	4
10.	24EC367	Microcontroller and its applications	3/0/2	5	4

PROFESSIONAL CORE COURSES (54 credits)

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits
1.	24EE422	Electric Circuit Analysis	3/0/0	3	3
2.	24EE427	Electric Circuit Analysis Laboratory	0/0/4	4	2
3.	24EE432	Electromagnetic Fields	3/1/0	4	4
4.	24EE434	DC Machines and Transformers	3/0/0	3	3
5.	24EE435	Electronic Devices and Circuits	3/0/2	5	4

6.	24EE437	DC Machines and Transformers Laboratory	0/0/4	4	2
7.	24EE442	Generation Transmission and Distribution	3/0/0	3	3
8.	24EE443	Measurements and Instrumentation	3/0/0	3	3
9.	24EE444	Synchronous and Induction Machines	3/0/0	3	3
10.	24EE445	Linear Integrated Circuits	3/0/0	3	3
11.	24EE447	Synchronous and Induction Machines Laboratory	0/0/4	4	2
12.	24EE448	Digital and Linear Integrated Circuits Laboratory	0/0/4	4	2
13.	24EE452	Power Electronics	3/0/0	3	3
14.	24EE456	Power System Analysis	3/0/2	5	4
15.	24EE457	Control Systems	3/0/2	5	4
16.	24EE458	Power Electronics Laboratory	0/0/4	4	2
17.	24EE461	Power System Protection and Switchgear	3/0/0	3	3
18.	24EE466	Electrical Drives	3/0/2	5	4

PROFESSIONAL ELECTIVE COURSES (18 Credits)

POWER SYSTEMS

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits
1.	24EE501	Utilization and Conservation of Electrical Energy	3/0/0	3	3
2.	24EE502	Renewable Energy Systems	3/0/0	3	3
3.	24EE503	High Voltage Engineering	3/0/0	3	3
4.	24EE504	Energy Management and Auditing	3/0/0	3	3
5.	24EE505	Power Quality	3/0/0	3	3
6.	24EE506	Power System Operation and Control	3/0/0	3	3

POWER ELECTRONICS AND DRIVES

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits
7.	24EE507	Power Electronics for Renewable Energy Systems	3/0/0	3	3
8.	24EE508	Advanced Power Semiconductor Devices	3/0/0	3	3
9.	24EE509	Embedded control of Electrical Drives	3/0/0	3	3
10.	24EE510	Analysis of Power Converters	3/0/0	3	3
11.	24EE511	SMPS and UPS	3/0/0	3	3
12.	24EE512	Industrial Drives	3/0/0	3	3

ELECTRICAL MACHINES

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits
13.	24EE513	Special Electrical Machines	3/0/0	3	3
14.	24EE514	Design of Electrical Machines	3/0/0	3	3
15.	24EE515	Modeling and Analysis of Electrical Machines	3/0/0	3	3
16.	24EE516	Machine Monitoring System	3/0/0	3	3
17.	24EE517	Computer Aided Design of Electrical Apparatus	3/0/0	3	3
18.	24EE518	Wind Energy Conversion Systems	3/0/0	3	3

ELECTRIC VEHICLE TECHNOLOGY					
S. No	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**
19.	24EE519	Electric Vehicle Architecture	3/0/0	3	3
20.	24EE520	Design of Motor and Power Converters for Electric Vehicles	3/0/0	3	3
21.	24EE521	Electric Vehicle Design Mechanics and Control	3/0/0	3	3
22.	24EE522	Design of Electric Vehicle Charging System	3/0/0	3	3
23.	24EE523	Grid Integration of Electric Vehicles	3/0/0	3	3
24.	24EE524	Intelligent control of Electric Vehicles	3/0/0	3	3
EMBEDDED SYSTEMS					
S. No	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**
25.	24EE525	Embedded System Design	3/0/0	3	3
26.	24EE526	Embedded C Programming	3/0/0	3	3
27.	24EE527	Smart System Automation	3/0/0	3	3
28.	24EE528	Embedded System for Automotive Applications	3/0/0	3	3
29.	24EE529	Introduction to VLSI Design	3/0/0	3	3
30.	24EE530	MEMS and NEMS	3/0/0	3	3

MANDATORY COURSES (Non Credit)

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

OPEN ELECTIVES OFFERED TO OTHER DEPARTMENTS

S. No	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits
1.	24OE626	Industrial Automation with PLC and SCADA	3/0/0	3	3
2.	24OE627	Electric Vehicle Technology	3/0/0	3	3
3.	24OE628	Energy Technology	3/0/0	3	3
4.	24OE629	Battery Management Systems	3/0/0	3	3
5.	24OE630	Power Converters for Electrical Appliances	3/0/0	3	3

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
6.	24OE606	Fundamentals of Computer vision	3/0/0	3	3
7.	24OE607	Machine Learning and its applications	3/0/0	3	3
8.	24OE608	Deep Learning Techniques	3/0/0	3	3
9.	24OE609	Language Engineering	3/0/0	3	3
10.	24OE610	Neural Networks	3/0/0	3	3
11.	24OE611	Database Fundamentals	3/0/0	3	3
12.	24OE612	Basics of Image Processing	3/0/0	3	3
13.	24OE613	Vehicular ADHOC Networks	3/0/0	3	3
14.	24OE614	Web Technology Fundamentals	3/0/0	3	3
15.	24OE615	App development Fundamentals	3/0/0	3	3
16.	24OE616	Introduction to Augmented Reality/Virtual Reality	3/0/0	3	3
17.	24OE617	Software Engineering	3/0/0	3	3
18.	24OE618	Foundation of Cloud Computing	3/0/0	3	3
19.	24OE619	Java Programming	3/0/0	3	3
20.	24OE620	Block Chain Technology	3/0/0	3	3
21.	24OE621	Introduction to VLSI design	3/0/0	3	3
22.	24OE622	Communication Engineering	3/0/0	3	3
23.	24OE623	Sensors and Actuators	3/0/0	3	3
24.	24OE624	Basics of Hardware Description Languages	3/0/0	3	3
25.	24OE625	Introduction to Internet of Things	3/0/0	3	3
26.	24OE626	Industrial Automation with PLC and SCADA	3/0/0	3	3
27.	24OE627	Electric Vehicle Technology	3/0/0	3	3
28.	24OE628	Energy Technology	3/0/0	3	3
29.	24OE629	Battery Management Systems	3/0/0	3	3
30.	24OE630	Power Converters for Electrical Appliances	3/0/0	3	3
31.	24OE631	Foundation of Robotics	3/0/0	3	3
32.	24OE632	Basics of Drone Technology	3/0/0	3	3
33.	24OE633	3D Printing	3/0/0	3	3
34.	24OE634	Digital Manufacturing	3/0/0	3	3
35.	24OE635	Composite Materials	3/0/0	3	3
36.	24OE636	Fundamentals of Operations Research	3/0/0	3	3
37.	24OE637	Organizational Behaviour	3/0/0	3	3
38.	24OE638	Total Quality Management	3/0/0	3	3
39.	24OE639	Intellectual Property Rights	3/0/0	3	3
40.	24OE640	Emotional Intelligence	3/0/0	3	3
41.	24OE641	Algebra and Number Theory	3/0/0	3	3
42.	24OE642	Linear Algebra	3/0/0	3	3
43.	24OE643	Advanced Engineering Chemistry	3/0/0	3	3
44.	24OE644	Nanotechnology and NLO Materials	3/0/0	3	3
45.	24OE645	English for Competitive Examinations	3/0/0	3	3

COURSE DISTRIBUTION

Stream	No. of Courses								Total No. of courses
	I	II	III	IV	V	VI	VII	VIII	
Humanities (HS)	1	1			1		1		4
Basic Sciences(BS)	2	2	1	1					6
Engineering Sciences(ES)	3	2	2	1		2			10
Program Core(PC)		2	4	6	4	2			18
Program Electives(PE)					1	2	3		6
Open Electives(OE)					2	1	2		5
Project Work(PW)							1	1	2
Industry Practices (IP)						1			1
Mandatory Course (MC)	1	1	1	1					4
Total	**7**	**8**	**8**	**9**	**8**	**8**	**7**	**1**	**56**

CREDIT DISTRIBUTION

Stream	Credits/Semester								Total Credits
	I	II	III	IV	V	VI	VII	VIII	
Humanities (HS)	3	3			3		2		11
Basic Sciences(BS)	8	8	4	4					24
Engineering Sciences(ES)	7	6	7	4		8			32
Program Core(PC)		5	13	16	13	7			54
Professional Electives(PE)					3	6	9		18
Open Electives(OE)					6	3	6		15
Project Work(PW)							2	12	14
Industry Practices (IP)							2		2
Mandatory Course (MC)	0	0	0	0					0
Total	**18**	**22**	**24**	**24**	**25**	**24**	**21**	**12**	**170**

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24MA211	Matrices And Calculus	BS	01	3	1	0	4

Course Outcomes (s)
Upon completion of the course, students shall have ability to

C211.1	Utilize matrix algebra techniques effectively to solve practical engineering problems.	AP
C211.2	Apply differential calculus tools to solve a wide range of engineering application problems, effectively utilizing concepts such as derivatives and differential equations to model and analyze real-world phenomena.	AP
C211.3	Apply differential calculus concepts to functions of several variables, enabling them to examine complex relationships and phenomena encountered in engineering contexts.	AP
C211.4	Employ a variety of integration methods, empowering them to solve practical engineering problems efficiently and accurately.	AP
C211.5	Apply the principles of multiple integrals to address a variety of practical engineering challenges, effectively solving problems related to areas, volumes, and other pertinent applications.	AP

Course Content

Unit – 1	**MATRICES**	12

Eigen values and Eigen vectors of a real matrix – Characteristic equation – Properties of Eigen values and Eigen vectors – Cayley - Hamilton theorem – Diagonalization of matrices by similarity transformation(concept only) and orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

Unit– 2	**DIFFERENTIAL CALCULUS**	12

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Maxima and Minima of functions of one variable.

Unit–3	**FUNCTIONS OF SEVERAL VARIABLES**	12

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

Unit-4	**INTEGRAL CALCULUS**	12

Definite and Indefinite integrals - Substitution rule - Techniques of Integration : Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.

Unit-5	**MULTIPLE INTEGRALS**	12

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.

TOTAL : 60 Hours

Textbooks

1	Kreyszig. E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2	Grewal.B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition , 2018.
3	James Stewart, " Calculus: Early Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015. [For Units II & IV - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].

Reference Books

1	Anton. H, Bivens. I and Davis. S, "Calculus", Wiley, 10th Edition, 2016.
2	Bali. N., Goyal. M. and Watkins. C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
3	Jain R.K. and Iyengar. S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 5th Edition, 2016.

4	Narayanan. S. and Manicavachagom Pillai. T. K., “Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5	Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6	Srimantha Pal and Bhunia. S.C, "Engineering Mathematics" Oxford University Press, 2015.
7	Thomas. G. B., Hass. J and Weir. M.D, “Thomas Calculus", 14th Edition, Pearson India, 2018.
Web References	
1	https://nptel.ac.in/courses/122104018 /
2	https://archive.nptel.ac.in/courses/111/104/111104092
3	https://onlinecourses.nptel.ac.in/noc20_ma27/preview
4	https://archive.nptel.ac.in/courses/111/105/111105122
5	https://nptel.ac.in/courses/111105122
6	https://www.coursera.org/learn/introduction-to-calculus/ https://www.coursera.org/learn/discrete-calculus/

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24CS312	PROGRAMMING IN C	ES	01	3	0	0	3

Course Outcomes (s)		
Upon completion of the course, students shall have ability to		RBT
C312.1	Understand programming using algorithms, flowcharts and pseudocode	U
C312.2	Develop a C program using datatypes, control flow and arrays	AP
C312.3	Implement decision-making using if-else, switch and control flow statements	AP
C312.4	Apply functions and recursion to solve problems systematically	AP
C312.5	Use pointers to implement the memory manipulation and allocation	AP
C312.6	Create, read, write, and append data to files in C	AP

Course Content		
Unit – I	**ALGORITHMIC THINKING & INTRODUCTION TO C LANGUAGE**	9
Algorithm -Definition, Characteristics of Algorithms. Constituents of algorithms: - Sequence, Selection and Repetition. Flowchart/Pseudocode with examples. Introduction To C Language: Structure of C Program, Data Types, Input and Output statements, Operators, Precedence and Associativity of operators, Evaluation of Expressions, Type Conversions in Expressions, Example programs for operator precedence and evaluating expressions..		
Unit – II	**CONTROL STRUCTURES AND ARRAYS**	9
Control structures: Decision statements; if and switch statement; Loop control statements: while, for and do while loops, Jump statements: break, continue, goto statements, Example programs using decision statements, looping statements and jump statements. Arrays: Concepts, One dimensional array, declaration and initialization of one dimensional arrays, two dimensional arrays, initialization and accessing, multi-dimensional arrays, programming examples using arrays.		
Unit – III	**FUNCTIONS AND POINTERS**	9
Functions: Function definition, Types of Functions: User defined and built-in Functions, Advantages of User Defined Functions. Parameter passing in functions: Call by value, Call by reference, passing arrays to functions, Recursion as a different way of solving problems, example programs to perform call by value and reference, nested functions, recursion. Pointers: Pointer basics, pointer arithmetic, pointers to pointers, generic pointers, array of pointers, Functions returning pointers, Dynamic memory allocation, Example program to perform types of pointers.		
Unit – IV	**STRINGS AND USER DEFINED DATA TYPES**	9
Strings: Array of characters, variable length character strings, input character strings, character library functions, String Handling Functions, Arrays of Strings, Example programs to perform string length, copy, concatenate and compare. Structures and Unions: Structure definition, initialization, accessing structures, nested structures, arrays of structures, Structures and functions, Self-referential structures, unions, typedef, enumerations, Difference between structure and union with examples.		
Unit – V	**FILE HANDLING**	9
File Handling: Command Line Arguments, File Modes, Basic File Operations Read, Write and Append, Example Programs. Random Access Using fseek, ftell and rewind Functions.		
	Total Hours	45

Learning Resources	
Textbooks	
1	Computer Science: A Structured Programming Approach Using C, B.A.Forouzan and R.F.Gilberg, Third Edition, 2006
2	ReemaThareja, "Programming in C", Oxford University Press, Second Edition, 2016
Reference Books	
1	The C Programming Language by Brian Kernighan and Dennis Ritchie 2nd edition.

2	Programming and Data Structures by E.Balagurusamy, Tata McGraw Hill, 2008.
3	Anita Goel and Ajay Mittal, “Computer Fundamentals and Programming in C”, 1st Edition, Pearson Education, 2013
Online Resources	
1	Introduction to programming in C - Course (nptel.ac.in)
2	https://www.udemy.com/topic/c-programming/

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24BP213	PHYSICS FOR ELECTRONIC SCIENCES	BS	01	3	0	2	4

Course Outcomes (s)		
Upon completion of the course, students shall have ability to		RBT
C213.1	Understand the basic concepts of elasticity, stress, strain and how forces cause deformation in materials.	[U]
C213.2	Understand the basic principles of optics, lasers and fiber optics.	[U]
C213.3	Understand basic principles of Quantum mechanics and tunneling microscope.	[U]
C213.4	Illustrate merits of electron theory of materials and principle, types, properties and application of semiconductors	[U]
C213.5	Understand the foundational knowledge of Nano electronic devices and advanced engineering materials.	[U]

Course Content		
Unit – I	**ELECTROMAGNETIC WAVES AND PROPERTIES OF MATTER**	**9**
Introduction-electromagnetic waves-the source of electromagnetic waves and Maxwell's equation. Elasticity-Stress-strain diagram and its uses-factors affecting elastic modulus and tensile strength. Torsional stress and deformations-twisting couple- torsion pendulum: theory and experiment-bending of beam-bending moment-cantilever: theory and experiment. Uniform and non-uniform bending: theory and experiment-I-shaped girders.		
Unit – II	**OPTICS, LASER AND FIBRE OPTICS**	**9**
Introduction-properties and propagation of light -Theory of air wedge-Air wedge experiment. Laser–characteristics–Spontaneous and Stimulated emission-population inversion – Einstein's A and B coefficients derivation-Semiconductor laser-Industrial and medical applications – Introduction to fibre optics-principle and propagation of light in optical fibres - Numerical aperture and Acceptance angle of the fibre.		
Unit – III	**BASIC QUANTUM MECHANICS**	**9**
Black body radiation-Planck's hypothesis, wave particle duality- de-Broglie concept of matter waves - Electron diffraction–meaning of wave function-The Schrodinger equation (Time dependent and time independent forms) - Normalization of wave function–particle in a infinite potential well: 1D Box-Quantum tunnelling (qualitative) and Scanning Tunnelling microscope.		
Unit – IV	**SEMICONDUCTING MATERIALS**	**9**
Introduction-Basic crystallography-linear density and planer density of the crystals -Introduction-Intrinsic semiconductor – carrier concentration derivation – Fermi level – Variation of Fermi level with temperature – band gap determination– compound semiconductors - direct and indirect band gap- derivation of carrier concentration in n-type and p-type semiconductor – variation of Fermi level with temperature and impurity concentration.		
Unit – V	**NANOELECTRONIC DEVICES**	**9**
Density of states for solids - Significance between Fermi energy and volume of the material – Quantum confinement – Quantum structures – Density of states for quantum wells, wires and dots – Band gap of nanomaterial's –Tunnelling – Single electron phenomena – Single electron Transistor. Carbon nanotubes: Properties and applications – quantum well laser.		
	Total Hours	**45**

Course Outcomes		
Upon completion of the course, students shall have ability to		
C213.6	Demonstrate the basic measurement techniques and the use of the basic concepts of properties of matter, lasers, fibre optics, basic quantum mechanics and	[AN]

	semiconductor physics.	

Lab Components	
1. Torsional pendulum - Determination of Rigidity modulus of wire and moment of inertia of regular object.	
2. Determination of Young's modulus of the cantilever by Simple Harmonic Oscillations.	
3. Uniform bending - Determination of Young's modulus of the beam.	
4. Non-uniform bending - Determination of Young's modulus of the beam.	
5. Determination of Band gap of a semiconductor.	
6. Laser- Determination of the wavelength of the laser source using grating.	
7. Optical fiber -Determination of Numerical Aperture and acceptance angle	
8. Determine the wave length of prominent lines of mercury by plane diffraction grating with the help of spectrometer.	
Total Hours	**30**

Learning Resources	
Textbooks	
1.	Gaur and Gupta, A Textbook of Engineering Physics, Dhanpat Rai Publishers, New Delhi,8th edition,2011.
2.	S.O.Pilai, Sivakami, Engineering Physics, VII Edition, New Age International Publishers, 2017.
3.	E.M.Purcell and D.J.Morin, Electricity and Magnetism,Cambridge Univ.Press, 2013.
4.	D.Kleppner and R.Kolenkow, An Introduction to Mechanics, McGraw Hill Education (Indian Edition), 2017.
5.	Arthur Beiser, Concepts of Modern Physics ,Shobhit Mahajan, S. Rai Choudhury, , McGraw-Hill (Indian Edition), 2017.
6.	Kakani S.L,Nanotechnology, New Age International (P) Ltd., Publishers, 2020.
Reference Books	
1.	David Halliday, Robert Resnick, Jearl Walker, Fundamentals of Physics,John Wiley & Sons Inc; 12th Edition,2021
2.	M A Wahab, Solid State Physics, 3rd Edition, Narosa Publishing House Pvt. Ltd., 2015.
3.	T. Pradeep,Nano: The Essentials: Understanding Nanoscience And Nanotechnology, McGraw Hill Education,1st edition,2017
4.	M.Vijaya,G.Rangarajan G, Materials Science, McGraw Hill Education,2004
Web References	
1	https://phet.colorado.edu/en/simulations
2	https://blossoms.mit.edu/resources/physics_resources
3	https://amrita.olabs.edu.in

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24HS114	TECHNICAL ENGLISH	HS	01	2	0	2	3

Course Outcomes (s)		
Upon completion of the course, students shall have ability to		
C114.1	Precisely explain products and write instructions.	AP
C114.2	Effectively express their ideas both in writing and non-verbal.	AP
C114.3	Compose emails, formal letters, and descriptions/narratives.	AP
C114.4	Gain knowledge in writing essays on various topics.	AP
C114.5	Develop the writing skills specific reference to technical writing.	AP

Course Content		
Unit – 1	**DESCRIPTION OF A PROCESS / PRODUCT**	**6**
Reading – Reading advertisements. Writing – instructions, Product /Process description. Grammar - Adjectives; Degrees of comparison; Present Tense.		
Unit – 2	**UNDERSTANDING AND IMPLEMENTING**	**6**
Reading - Reading biographies, newspaper reports .Writing - Transferring information from non verbal. Grammar - Past tense, Subject-Verb Agreement Prepositions. Phrasal verbs.		
Unit – 3	**BASICS OF COMMUNICATION**	**6**
Reading - Reading brochures. Writing - Writing emails / letters introducing oneself. Grammar - Question types: Wh/ Yes or No/ and Tags, One word substitution.		
Unit– 4	**EXPRESSION OF OPINION**	**6**
Reading – Reading editorials; and Opinion Blogs. Writing - Essay Writing. Grammar - Future Tenses, Punctuation; Negation (Statements & Questions)		
Unit – 5	**CLASSIFICATION AND RECOMMENDATIONS**	**6**
Reading – Newspaper articles; Journal reports. Writing - Note-making / Note-taking, Writing recommendations. Grammar - Articles; Pronouns - Possessive & Relative pronouns.		
	TOTAL	**30 Hours**

English Laboratory		
Upon completion of the course, students shall have ability to		
C114.6	Speak fluently and accurately in formal and informal communication	AP
1. Self introduction		
2. Introduating a friend and others.		
3. Narrating personal experiences.		
4. Giving instruction to use the product presenting a product.		
5. Talking about precautions in different situation.		
6. Talking about given topic.		
7.Making polite requests, making polite offers replying to polite requests		

Textbooks	
1	English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition).
2	English for Science & Technology Cambridge University Press, 2021.
3	Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.
Reference Books	
1	A Course Book On Technical English By Lakshminarayanan, Scitech Publications (India) Pvt.Ltd.
2	Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
Web References	
1	https://archive.nptel.ac.in/courses/109/106/109106094/

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EP315	Engineering Practices Laboratory	ES	01	0	0	4	2

Course Outcomes
Upon completion of the course, students shall have ability to

C315.1	Draw pipeline plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planning; making joints in wood materials used in common household woodwork.	AP
C315.2	Demonstrate various electrical wiring connections in common household.	AP
C315.3	Do various welding joints in steel plates using arc welding work; Machining simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipment's; Making a tray out of metal sheet using sheet metal work.	AP
C315.4	To Solder, test and Desolder simple electronic components on PCB.	AP
C315.5	To understand the working of basic household appliances and logic gates and basic laws.	U

List of Experiments:

GROUP A

CIVIL ENGINEERING PRACTICES

1	Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
2	Preparing plumbing line sketches
3	Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.
4	Sawing and Planning.
5	Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

MECHANICAL ENGINEERING PRACTICES

1	Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding
2	Practicing gas welding
3	Basic Machining work- turning, drilling and tapping
4	Making of a square tray
5	Demonstrating basic foundry operations.

GROUP B

ELECTRICAL ENGINEERING PRACTICE

1	Residential house wiring using switches, fuse, indicator, lamp and energy meter and fuse calculation.
2	Fluorescent Lamp wiring.
3	Two way switch connection.
4	Measurement of electrical quantities -Voltage, Current, Energy, Power& power factor in RLC circuit.
5	Measurement of resistance to earth of electrical equipment.

ELECTRONICS ENGINEERING PRACTICE

1	Study of Electronic components and equipment – Resistor, colour coding measurement
2	Investigate sinusoidal, square, and triangular waveforms signal parameter measurement (peak-peak, RMS period, frequency) using DSO.
3	Study of logic gates AND, OR, EX-OR and NOT.
4	Verification of Ohm's Law and Kirchhoff's Laws.
5	Soldering and De-soldering practice of electronic components using general purpose PCB.
6	Implementation of Regulated Power Supply (RPS).

Total Hours 60

Textbooks:

1	S Gowri & T Jeyapoovan, "Engineering Practices Lab Manual", Fifth Edition, Vikas Publishing

2	D. Citharthan. “ENGINEERING PRACTICES LABORATORY (GROUP B)” February 2020

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24CS316	PROGRAMMING IN C LABORATORY	ES	01	0	0	4	2

Course Outcomes (s)		
Upon completion of the course, students shall have ability to		
C316.1	Design an algorithm using pseudocode and flowchart.	AP
C316.2	Develop C programs for simple applications making use of basic constructs.	AP
C316.3	Develop C programs using arrays and strings.	AP
C316.4	Develop C programs involving functions, recursion.	AP
C316.5	Develop applications in C using pointers, and structures.	AP
C316.6	Design applications in C using sequential and random access file processing	AP

List of Experiments:	
Exp.No.	**Name of the Experiment**
1	Design an algorithm using pseudocode and flowchart
2	I/O statements, operators, expressions
3	Decision-making constructs: if-else, goto, switch-case
4	Loops: for, while, do-while
5	Arrays: 1D and 2D, multi-dimensional arrays
6	Functions: call, return, passing parameters by (value, reference), passing arrays to function.
7	Recursion
8	Pointers: Arrays, Pointers to Pointers, Array of Pointers
9	Strings: Operations
10	Structures: Nested Structures, Pointers to Structures, Arrays of Structures and Unions.
11	Files: reading and writing, File pointers, file operations, random access
	Total Hours **60**

Learning Resources	
Reference Books	
1	Computer Science: A Structured Programming Approach Using C, B.A.Forouzan and R.F.Gilberg, Third Edition, 2006.
2	ReemaThareja, “Programming in C”, Oxford University Press, Second Edition, 2016.
3	The C Programming Language by Brian Kernighan and Dennis Ritchie 2nd edition.
4	Computer Programming and Data Structures by E.Balagurusamy, Tata McGraw Hill, 2008.
5	Anita Goel and Ajay Mittal, “Computer Fundamentals and Programming in C”, 1st Edition, Pearson Education, 2013.
Online Resources	
1	Introduction to programming in C - Course (nptel.ac.in)
2	https://www.udemy.com/topic/c-programming/

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24MA221	Differential Equations and Complex Functions	BS	02	3	1	0	4

Course Outcomes (s)
Upon completion of the course, students shall have ability to

C221.1	Learn about differential equations, fundamental tools in engineering, used to describe various physical phenomena.	AP
C221.2	Understand how to solve the given standard partial differential equations.	AP
C221.3	Understand standard techniques in complex variable theory, focusing on analytic functions and their mapping properties.	AP
C221.4	Develop familiarity with complex integration and contour integration techniques for practical application in real-world integrals.	AP
C221.5	Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems	AP

Course Content

Unit – 1	**ORDINARY DIFFERENTIAL EQUATIONS**	**12**

Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients.

Unit– 2	**PARTIAL DIFFERENTIAL EQUATIONS**	**12**

Formation of partial differential equations - Singular integrals -- Solutions of standard types of first order partial differential equations - Lagrange's linear equation -- Linear partial differential equations of second and higher order with constant coefficients of homogeneous and non- homogeneous types.

Unit– 3	**ANALYTIC FUNCTIONS**	**12**

Functions of a complex variable – Analytic functions: Necessary conditions – Cauchy-Riemann equations and sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function – Harmonic conjugate – Construction of analytic functions – Conformal mapping: w = z+k, kz, 1/z, z^2, e^z and bilinear transformation.

Unit–4	**COMPLEX INTEGRATION**	**12**

Complex integration – Statement and applications of Cauchy's integral theorem and Cauchy's integral formula – Taylor's and Laurent's series expansions – Singular points – Residues – Cauchy's residue theorem – Evaluation of real definite integrals as contour integrals around unit circle and semi-circle (excluding poles on the real axis).

Unit-5	**TRANSFORMS AND DIFFERENCE EQUATIONS**	**12**

Z- transforms - Elementary properties - Inverse Z - transform (using partial fraction and residues) - Convolution theorem - Formation of difference equations - Solution of difference equations using Z - transform.

TOTAL : 60 Hours

Textbooks

1	Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2018.
2	Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2018.
3	Sastry, S.S, "Engineering Mathematics", Vol. I & II, PHI Learning Pvt. Ltd, 4th Edition, New Delhi, 2014.

Reference Books

1	Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.
2	Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10th Edition, Laxmi Publications Pvt. Ltd, 2021.
3	James. G., "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education, New Delhi, 2016.
4	Narayanan. S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
5	Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
6	Wylie. R.C. and Barrett. L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education

	Pvt. Ltd, 6th Edition, New Delhi, 2012
Web References	
1	https://archive.nptel.ac.in/courses/111/108/111108081 /
2	https://archive.nptel.ac.in/courses/111/101/111101153 /
3	https://archive.nptel.ac.in/courses/111/106/111106111/
4	https://nptel.ac.in/courses/111106084/
5	https://archive.nptel.ac.in/courses/111/103/111103070/
6	https://www.coursera.org/learn/differential-equations-engineers/

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24EE422	Electric Circuit Analysis	02	PC	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to		RBT
C422.1	Explain the fundamental concepts and laws used in DC and AC circuit analysis.	[U]
C422.2	Explain network reduction techniques and circuit theorems for DC and AC circuits.	[U]
C422.3	Explain the transient behavior of RL, RC, and RLC circuits using Laplace transforms.	[U]
C422.4	Apply resonance and coupling concepts to analyze RLC and coupled circuits.	[AP]
C422.5	Apply three-phase circuit analysis to evaluate balanced and unbalanced systems.	[AP]

Course Contents

Unit – I	BASIC CIRCUITS ANALYSIS	9

Fundamentals concepts of R, L and C elements-Energy Sources- Ohm's Law -Kirchhoff 's Laws – DC Circuits – Resistors in series and parallel circuits - A.C Circuits – Average and RMS Value – Complex Impedance – Phasor diagram - Real and Reactive Power, Power Factor, Energy -Mesh current and node voltage methods of analysis D.C and A.C Circuits.

Unit – II	NETWORK REDUCTION AND THEOREMS FOR DC AND AC CIRCUITS	9

Network reduction: voltage and current division, source transformation – star delta conversion- Theorems – Superposition, Thevenin's and Norton's Theorem – Maximum power transfer theorem –Reciprocity Theorem

Unit – III	TRANSIENT RESPONSE ANALYSIS	9

Introduction - Laplace transforms and inverse Laplace transforms - standard test signals –Transient response of RL, RC and RLC circuits using Laplace transform for Source free, Step input and Sinusoidal input.

Unit – IV	RESONANCE AND COUPLED CIRCUITS	9

Series and parallel resonance –frequency response – Quality factor and Bandwidth – Self and mutual inductance – Coefficient of coupling – Dot rule-Analysis of coupled circuits– Single Tuned circuits.

Unit – V	THREE PHASE CIRCUITS	9

Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced and unbalanced – phasor diagram of voltages and currents – power measurement in three phase circuits– Power Factor Calculations.

Total : 45 Hours

Learning Resources

Textbooks

1	William H. HaytJr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", McGraw Hill publishers, 9thedition, New Delhi, 2020.
2	Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", Second Edition, McGraw Hill, 2019.
3	Allan H. Robbins, Wilhelm C. Miller, "Circuit Analysis Theory and Practice", Cengage Learning India, 2013.
4	Sudhakar A and Shyam Mohan SP, "Circuits and Networks Analysis and Synthesis", McGraHill, 2015.
5	Richard C. Dorf and James A. Svoboda, "Introduction to Electric Circuits", 7th Edition, John Wiley Sons, Inc. 2018.

Reference Books

1	Chakrabarti A, "Circuits Theory (Analysis and synthesis), Dhanpat Rai& Sons, New Delhi, 2020.
2	Joseph A. Edminister, Mahmood Nahvi, "Electric circuits", Schaum's series, McGraw-Hill, First Edition, 2019
3	M E Van Valkenburg, "Network Analysis", Prentice-Hall of India Pvt Ltd, New Delhi, 2015.

Web references

1	https://onlinecourses.nptel.ac.in/noc20_ee64/preview
2	https://www.allaboutcircuits.com/textbook/

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24ME323	BASIC CIVIL AND MECHANICAL ENGINEERING	ES	02	3	0	0	3

Course Outcomes
Upon completion of the course, students shall have ability to

C323.1	Develop a comprehensive understanding of Civil and Mechanical Engineering principles.	[U]
C323.2	Master the integrated planning processes for buildings, infrastructure, and machinery operations.	[U]
C323.3	Translate acquired disciplinary knowledge into real-world applications, solving complex problems and driving innovation within the field."	[AP]
C323.4	Illustrate the practical applications of Civil and Mechanical Engineering concepts through innovative problem-solving and project implementation."	[AP]
C323.5	Effectively evaluate materials, structures, machines, and energy systems to optimize performance and sustainability."	[AP]

Course Contents

Unit – 1	**Overview of Civil Engineering and Overview of Mechanical Engineering**	**9**

Civil Engineering contributions to the welfare of Society – Specialized sub disciplines in Civil Engineering– Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering – National building code – terminologists: Plinth area, Carpet area, Floor area, Buildup area, Floor space index – Types of buildings: Residential buildings, Industrial buildings.
Overview of Mechanical Engineering – Mechanical Engineering Contributions to the welfare of Society – Specialized sub disciplines in Mechanical Engineering – Manufacturing, Automation, Automobile and Energy Engineering – Interdisciplinary concepts in Mechanical Engineering.

Unit – 2	**Surveying and Civil Engineering Materials**	**9**

Surveying: Objects – Classification – Principles – Measurements of Distances and angles – Leveling – Determination of areas– Contours.Civil Engineering Materials: Bricks – Stones – Sand – Cement – Concrete – Steel – Timber – Modern Materials, Thermal and Acoustic Insulating Materials, Decorative Panels, Water Proofing Materials. Modern uses of Gypsum, Pre-fabricated Building component (brief discussion only)

Unit – 3	**Building Components and Infrastructure**	**9**

Building plans – Setting out of a Building – Foundations: Types of foundations – Bearing capacity and settlement – Brick masonry – Stone Masonry – Beams – Columns – Lintels – Roofing – Flooring Plastering. Types of Bridges and Dams – Water Supply Network – Rain Water Harvesting – Solid Waste Management – Introduction to Highways and Railways – Introduction to Green Buildings.

Unit – 4	**Internal Combustion Engines and Power Plants**	**9**

Classification of Power Plants- Working principle of steam, Gas, Diesel, Hydro -electric and Nuclear Power plants- Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines. Working principle of Boilers-Turbines, Reciprocating Pumps (single acting and double acting) and Centrifugal Pumps, Concept of hybrid engines. Industrial safety practices and protective devices.

Unit – 5	**Refrigeration and Air Conditioning System**	**9**

Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system–Layout of typical domestic refrigerator–Window and Split type room Air conditioner. Properties of air – water mixture, concepts of psychometric and its process.

Total Hours	**45**

Textbooks:

1	G Shanmugam, M S Palanichamy, Basic Civil and Mechanical Engineering, McGraw Hill Education; First edition, 2018
2	Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018.

Reference Books:

1	Palanikumar, K. Basic Mechanical Engineering, ARS Publications, 2018.
2	Ramamrutham S., "Basic Civil Engineering", Dhanpat Rai Publishing Co.(P) Ltd, 2013. 3
3	Seetharaman S., "Basic Civil Engineering", Anuradha Agencies, 2005. 4. Shantha Kumar SRJ., "Basic Mechanical Engineering", Hi-tech Publications, Mayiladuthurai, 2000.

4	Shantha Kumar SRJ., “Basic Mechanical Engineering”, Hi-tech Publications, Mayiladuthurai, 2000

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24HS124	Professional English	HS	02	2	0	2	3

Course Outcomes (s)

Upon completion of the course, students shall have ability to		RBT
C124.1	Compose email effectively to convey ideas in appropriate tone.	AP
C124.2	Use the student's knowledge and experiences to comprehend Technical texts.	AP
C124.3	Understand governing the way in which words are put together to convey meaning in different contexts.	AP
C124.4	Write effective resumes and cover letter to the context of job search.	AP
C124.5	Write check lists to organize thoughts and communicate in with Written format.	AP

Course Content

Unit–I	**MAKING COMPARISONS**	**6**
Reading-Company profiles. Writing–Professional emails , Email etiquette- Compare and Contrast Essay. Grammar–Mixed Tenses, Prepositional phrases. Compound Nouns, Vocabulary.		
Unit–II	**PROBLEM SOLVING**	**6**
Reading–News paper articles. Writing–Recommendations, Accident Report and Survey Report. Grammar–Reported Speech, Modals, Conjunctions-use of prepositions		
Unit–III	**SPEAKING AND WRITING ABOUT CAUSAL COMMUNICATION**	**6**
Reading – Reading longer technical texts. Writing – Writing responses to complaints, transferring information from nonverbal. Grammar–Active voice and Passive Voice, Infinitive and Gerunds.		
Unit–IV	**THE ABILITY TO EXPRESS INFORMATION**	**6**
Reading-an excerpt of interview with professionals. Writing–Job / Internship application–Cover letter &Resume. Grammar–Numerical adjectives, Relative Clauses.		
Unit–V	**REPORTING AND RESEARCH**	**6**
Reading-news reports. Writing–Letter to the Editor, Checklists. Grammar–Error Correction, If conditional sentences.		

English Laboratory

Upon completion of the course, students shall have ability to		
C124.6	Speak effectively in various situation held informal /semi Formal conversation.	AP

1. Introduction to classmates.
2. Narrating personal experiences.
3. Discussing experiences in various situations.
4. Discussing locations in workplaces.
5. Group Discussion.
6. Discussing news stories.
7. Discussing imaginary scenarios.

TOTAL HOURS	**60**

Learning Resources

Text books

1	Technical Communication–Principles And Practices By Meenakshi Raman & Sangeeta Sharma,Oxford Univ.Press,2016,NewDelhi.
2	A Course Book on Technical English By Lakshmi Narayanan, Scitech Publications(India)Pvt.Ltd.

3	Authored by Dr.Veena Selvam, Dr.Sujatha Priyadarshini, Dr.Deepa Mary Francis,Dr.KN.Shoba,and Dr.Lourdes Joevani,Department of English,Anna University.
Reference Books	
1	Business Correspondence and Report Writing by Prof. R.C. Sharma&KrishnaMohan,TataMcGrawHill&Co.Ltd.,2001,NewDelhi.
2	Raman.Meenakshi,Sharma.Sangeeta(2019).Professional English. Oxford university press.New Delhi.
Web References	
1	https://onlinecourses.nptel.ac.in/noc22_hs77
2	https://onlinecourses.nptel.ac.in/noc22_hs05

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EG315	ENGINEERING GRAPHICS	ES	02	1	0	4	3

Course Outcomes		
Upon completion of the course, students shall have ability to		
C315.1	Interpret and apply the fundamental principles of engineering drawing, including BIS standards and dimensioning rules, to produce accurate technical drawings.	[AP]
C315.2	Construct orthographic projections of points, straight lines, planes, and solids by applying standard projection principles	[AP]
C315.3	Generate isometric and other pictorial views of simple engineering components by applying principles of pictorial representation.	[AP]
C315.4	Convert given pictorial or isometric views into corresponding orthographic views with proper representation and dimensioning.	[AP]
C315.5	Develop sectional views and lateral surface developments of regular and truncated solids by applying appropriate sectioning principles and development techniques.	[AP]
Course Contents		
ORTHOGRAPHIC AND PICTORIAL PROJECTION:		45
1	Introduction to Engineering Drawing. BIS. Principles of dimensioning.	
2	Principles of orthographic projection-projection of points, straight lines, planes and solids.	
3	Principles of pictorial views, isometric view of simple engineering components	
4	Orthographic views from given pictorial views	
SECTION OF SOLIDS:AND DEVELOPMENT OF SURFACES		45
1	Section of regular solids, types of sections, selection of section views	
2	Sectional views of simple engineering components	
3	Development of lateral surfaces of regular solids and truncated solid.	
	Total Hours	90

Textbooks:	
1	K. V. Natrajan, “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai (2006).
2	M.S. Kumar, “Engineering Graphics”, D.D. Publications, (2007).
Reference Books:	
1	K. R. Gopalakrishnana, “Engineering Drawing” (Vol.I&II), Subhas Publications (1998).
2	Dhananjay A.Jolhe, “Engineering Drawing with an introduction to AutoCAD” Tata
3	McGraw Hill Publishing Company Limited (2008).
4	Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill
5	Publishing Company Limited, New Delhi, (2008).
6	K. V. Natrajan, “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai (2006).

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24BC226	CHEMISTRY FOR ELECTRONIC SCIENCES	BS	02	3	0	2	4

Course Outcomes (s)

Upon completion of the course, students shall have ability to		RBT
C226.1	Infer the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.	U
C226.2	Recognize the importance of electrochemistry and principles behind electrochemical cell, reference electrodes and apply them for suitable applications.	AP
C226.3	Recognize different storage devices and apply them for suitable applications in energy sectors.	AP
C226.4	Understand and identify appropriate corrosion protection techniques for addressing practical problems.	U
C226.5	Understand different types of polymeric materials, their general preparation methods, and their applications to meet future material fabrication needs.	U

Course Content

Unit – I **WATER TECHNOLOGY** **9**

Water – sources and impurities – water quality parameters: colour, odour, pH, hardness, alkalinity, fluoride, TDS, COD, BOD and turbidity. Boiler feed water – requirement – troubles (scale & sludge, caustic embrittlement, boiler corrosion and priming & foaming. Internal conditioning – phosphate, calgon and carbonate treatment. External conditioning – demineralization and zeolite process. Municipal water treatment (screening, sedimentation, coagulation, filtration and disinfection-ozonation, UV treatment, chlorination), Desalination of brackish water: Reverse Osmosis.

Unit – II **ELECTRO CHEMISTRY** **9**

Electrochemical cells – reversible and irreversible cells – EMF – measurement of emf – Single electrode potential – Nernst equation (problem) – reference electrodes –Standard Hydrogen electrode -Calomel electrode – Ion selective electrode – glass electrode and measurement of pH – electrochemical series – significance – Potentiometer titrations (redox – Fe^{2+}vs dichromate and precipitation – Ag^{+}vs CI^{-} titrations) and Conductometric titrations (acid-base – HCI vs, NaOH) titrations.

Unit – III **ENERGY SOURCES** **9**

Introduction to energy sources - Batteries - Characteristics - types of batteries – primary battery (dry cell, Alkaline battery), secondary battery (lead acid, lithium-ion-battery) – Fuel cells (Types) – H2-O2 fuel cell – microbial fuel cell- Super capacitors- Types and Applications, Renewable Energy: Solar- solar cells(DSSC).

Unit – IV **CORROSION SCIENCE** **9**

Introduction to corrosion - chemical and electrochemical corrosions-mechanism of electrochemical and galvanic corrosions-concentration cell corrosion-passivity-soil, pitting, inter-granular, water line, stress and microbiological corrosions-galvanic series-factors influencing corrosion- measurement of corrosion rate. Corrosion control-material selection and design-electrochemical protection- sacrificial anodic protection and impressed current cathodic protection.

Protective coatings- organic coatings (paints). Paints: Constituents and functions. Metallic coatings – electroplating (Au) and electroless (Ni) plating.

Unit – V **POLYMER CHEMISTRY** **9**

Introduction: Functionality-degree of polymerization. Types of polymerization, Mechanism of free radical addition polymerization. Properties of polymers: Tg, tacticity, molecular weight-number average, weight average, viscosity average and polydispersity index (Problems). Techniques of polymerization: Bulk, emulsion, solution and suspension.

Engineering Plastics: PVC, Polyamides, Polycarbonates, Polyester and Polyurethanes. Compounding and Fabrication Techniques: Injection, Extrusion, Blow and Calendaring

Total Hours **45**

Course Outcomes
Upon completion of the course, students shall have ability to

CO6	Analyze and interpret experimental data from various chemical estimation methods, nanoparticle preparation techniques, and corrosion evaluation to address practical challenges in engineering and technology applications.	AN

LIST OF EXPERIMENT'S

(Any seven experiments to be conducted)

1. Determination of hardness of water by EDTA method.
2. Determination of alkalinity in water sample.
3. Determination of chloride content of water sample by Argentometric method.
4. Determination of strength of given hydrochloric acid using pH meter.
5. Preparation of nanoparticles (TiO2/ZnO/CuO) by Sol-Gel method.
6. Corrosion experiment-weight loss method.
7. Estimation of iron content of the given solution using potentiometer
8. Conductometric titration of strong acid against strong base (acid-base titration)
9. Conductometric titration of barium chloride against sodium sulphate (precipitation titration)
10. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.

Total Hours	**30**

Learning Resources

Textbooks

1	Jain P. C. & Monica Jain., "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
2	Dara S.S., "A Text book of Engineering Chemistry", Chand Publications, 2004
3	Shashi Chawla "A Text Book Of Engineering Chemistry" Dhanpat Rai & Co. (P) Limited, 2017

Reference Books

1	Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
2	Friedrich Emich, "Engineering Chemistry", Medtech, 2014.
3	Gowariker V.R., Viswanathan N.V. and Jayadev Sreedhar, "Polymer Science" New AGE International Publishers, 2009.

Web References

1	https://learncheme.com/
2	https://www.coursera.org/browse/physical-science-and-engineering/chemistry
3	http://www.cheresources.com/
4	https://www.vlab.co.in/broad-area-chemical-sciences
5	https://chemcollective.org/vlab
6	https://www.vlab.co.in/ba-nptel-labs-chemical-sciences

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE427	Electric Circuit Analysis Laboratory	PC	02	0	0	4	2

Course Outcomes

Upon completion of the course, students shall have ability to

C427.1	Use simulation and experimental methods to verify the fundamental electrical laws for the given DC/AC circuit	AP
C427.2	Use simulation and experimental methods to verify the various electrical theorems (Superposition, Thevenin , Norton and maximum power transfer) for the given DC/AC circuit	AP
C427.3	Analyze transient behavior of the given RL/RC/RLC circuit using simulation and experimental methods	AP
C427.4	Analyze frequency response of the given series and parallel RLC circuit using simulation and experimentation methods	AP
C427.5	Analyze the performance of the given three-phase circuit using simulation and experimental methods	AP

	List of Experiments:	**COs**	**RBT**
1.	Simulation and experimental verification of series and parallel electrical circuit using fundamental laws.	C427.1	AP
2.	Simulation and experimental verification of electrical circuit problems using Thevenin's theorem.	C427.2	AP
3.	Simulation and experimental verification of electrical circuit problems using Norton's theorem.	C427.2	AP
4.	Simulation and experimental verification of electrical circuit problems using Superposition theorem.	C427.2	AP
5.	Simulation and experimental verification of Maximum Power transfer theorem.	C427.2	AP
6.	Simulation and Experimental validation of R-C,R-L and RLC electric circuit transients	C427.3	AP
7.	Simulation and Experimental validation of frequency response of RLC electric circuit.	C427.4	AP
8.	Design and implementation of series resonance circuit.	C427.4	AP
9.	Design and implementation of Parallel resonance circuit.	C427.4	AP
10.	Simulation and experimental verification of three phase balanced and unbalanced star, delta networks circuit (Power and Power factor calculations).	C427.5	AP
		Total Hours	**60**

Textbooks:

1. William H. HaytJr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", McGraw Hill publishers, 9thedition, New Delhi, 2020.
2. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", Second Edition, McGraw Hill, 2019.
3. Allan H. Robbins, Wilhelm C. Miller, "Circuit Analysis Theory and Practice", Cengage Learning India, 2013.

Reference Books:

1. Chakrabarti A, "Circuits Theory (Analysis and synthesis), Dhanpat Rai& Sons, New Delhi, 2020.
2. Joseph A. Edminister, Mahmood Nahvi, "Electric circuits", Schaum's series, McGraw-Hill, First Edition, 2019
3. M E Van Valkenburg, "Network Analysis", Prentice-Hall of India Pvt Ltd, New Delhi, 2015.

Web References:

1. https://onlinecourses.nptel.ac.in/noc20_ee64/preview
2. https://www.allaboutcircuits.com/textbook/
3. http://www. circuitstoday.com

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24MA232	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	BS	03	3	1	0	4

Course Outcomes

Upon completion of the course, students shall have ability to

C232.1	Apply Fourier series techniques to represent periodic functions and compute harmonic components.	[AP]
C232.2	Apply the physical significance of Fourier series techniques in solving one- and two dimensional heat flow problems and one-dimensional wave equations.	[AP]
C232.3	Apply Fourier transform methods to convert functions between time and frequency domains.	[AP]
C232.4	Apply properties and theorems of Laplace transforms to simplify and solve Differential equations.	[AP]
C232.5	Applying the knowledge of various techniques and methods to solve various types of partial differential equations.	[AP]

Course Contents

Unit – 1	**FOURIER SERIES**	**12**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series and cosine series – Root mean square value – Parseval's identity – Harmonic analysis.

Unit – 2	**APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS**	**12**

Classification of PDE – Method of separation of variables - Fourier series solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two-dimensional equationof heat conduction (Cartesian coordinates only)

Unit – 3	**FOURIER TRANSFORMS**	**12**

Statement of Fourier integral theorem– Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

Unit – 4	**LAPLACE TRANSFORMS**	**12**

Laplace transform – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Transforms ofunit step function and impulse functions – Transform of periodic functions. Inverse Laplace transform – Statement of Convolution theorem (Statement Only) – Initial and final value theorems – Solution of linearODE of second order with constant coefficients using Laplace transformation techniques.

Unit – 5	**BOUNDARY VALUE PROBLEMS IN PARTIAL DIFFERENTIAL EQUATIONS**	**12**

Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit(Bender-Schmidt) and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.

Total Hours	**60**

Textbooks:

1	B. S. Grewal, Higher Engineering Mathematics, 45th ed. New Delhi, India: Khanna Publishers, 2020.
2	E. Kreyszig, Advanced Engineering Mathematics, 11th ed. Hoboken, NJ, USA: John Wiley & Sons, 2025.
3	Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.
4	Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015

Reference Books:

1	Narayanan. S., ManicavachagomPillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998
2	Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018

3	Wylie. R.C. and Barrett. L.C., “Advanced Engineering Mathematics “Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.
4	Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10th Edition, LaxmiPublications Pvt. Ltd, 2021.
5	James. G., "Advanced Modern Engineering Mathematics", 4thEdition, Pearson Education, New Delhi, 2016.
6	R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 5th ed. New Delhi, India: Narosa Publishing House, 2019.
Web References:	
1	https://onlinecourses.nptel.ac.in/noc20_ma06/preview
2	https://onlinecourses.nptel.ac.in/noc24_ma02/preview
3	https://onlinecourses.nptel.ac.in/noc21_ma51/preview

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24EE432	Electro Magnetic Fields	03	PC	3	1	0	4

Course Outcomes

Upon completion of the course, students shall have ability to

C432.1	Apply electrostatic laws and vector analysis to determine electric fields.	[AP]
C432.2	Apply electric potential and dielectric concepts to compute field parameters and capacitance.	[AP]
C432.3	Apply magneto static laws to evaluate magnetic fields, forces, and inductance.	[AP]
C432.4	Apply Maxwell's equations to analyze electromagnetic field behaviour.	[AP]
C432.5	Apply wave theory to evaluate electromagnetic wave propagation and characteristics.	[AP]

Course Contents

Unit – 1	**ELECTROSTATICS - I**	12

Sources and effects of electromagnetic fields – Coordinate Systems – Vector fields –Gradient, Divergence, Curl – theorems and applications - Coulomb's Law – Electric field intensity – Field due to discrete and continuous charges – Gauss's law and applications.

Unit – 2	**ELECTROSTATICS - II**	12

Electric potential – Electric field and equipotential plots, Uniform and Non-Uniform field, Utilization factor – Electric field in free space, conductors, dielectrics - Dielectric polarization –Dielectric strength - Electric field in multiple dielectrics –Poisson's and Laplace's equations, Capacitance, Energy density, Applications.

Unit – 3	**MAGNETOSTATICS**	12

Lorentz force, magnetic field intensity (H) – Biot–Savart's Law - Ampere's Circuit Law – H due to straight conductors, circular loop, infinite sheet of current, Magnetic flux density (B) – B in free space, conductor, magnetic materials – Magnetization–scalar and vector potential, Poisson's Equation, Magnetic force, Torque, Inductance, Energy density, Applications.

Unit – 4	**ELECTRODYNAMIC FIELDS**	12

Magnetic Circuits - Faraday's law – Transformer and motional EMF – Displacement current -Maxwell's equations (differential and integral form) – Relation between field theory and circuit theory – Applications.

Unit – 5	**ELECTROMAGNETIC WAVES**	12

Electromagnetic wave generation and equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossy and lossless dielectrics, conductors- skin depth - Poynting vector – Plane wave reflection and refraction.

Total Hours 60

Textbooks:

1	Mathew N. O. Sadiku, 'Principles of Electromagnetics', 6th Edition, Oxford University Press Inc. Asian edition, 2015.
2	William H. Hayt and John A. Buck, 'Engineering Electromagnetics', McGraw Hill Special Indian edition, 2014.
3	Kraus and Fleish, 'Electromagnetics with Applications', McGraw Hill International Editions, Fifth Edition, 2010.

Reference Books:

1	V.V.Sarwate, 'Electromagnetic fields and waves', Second Edition, Newage Publishers,2018.
2	J.P.Tewari, 'Engineering Electromagnetics - Theory, Problems and Applications', Second Edition, Khanna Publishers 2013.
3	Joseph. A.Edminister, 'Schaum's Outline of Electromagnetics, Fifth Edition (Schaum's Outline Series), McGraw Hill, 2018.
4	S.P.Ghosh, Lipika Datta, 'Electromagnetic Field Theory', First Edition, McGraw Hill Education (India) Private Limited, 2017.

Web References:

1	https://archive.nptel.ac.in/courses/108/106/108106073/
2	https://nptel.ac.in/courses/108106073

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24EC333	Digital Logic Circuits	03	ES	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to

C333.1	Understand Boolean algebra, logic operations, Boolean functions and their simplification	[U]
C333.2	Understand the design and working of combinational logic circuits	[U]
C333.3	Apply sequential logic design methods to implement circuits using Flip Flops	[AP]
C333.4	Apply counters and registers in designing sequential digital systems	[AP]
C333.5	Explain about logic families and programmable logic devices and its operation.	[U]

Course Contents

Unit – 1	**NUMBER SYSTEMS AND LOGIC REDUCTION**	**9**

Introduction to Digital Systems, Review of Number Systems, Representation of signed numbers, Binary Arithmetic using 1s and 2s Complements, Codes-weighted Binary codes-Non weighted binary codes-Error detection codes-Error Correction codes-Alphanumeric codes.

Logic gates, Basic Theorems and Properties of Boolean Algebra, Boolean Functions, AOI, NAND and NOR Implementation - Canonical and Standard Forms of representation, Karnaugh-Map Method (four variables).

Unit – 2	**COMBINATIONAL CIRCUITS**	**9**

Combinational logic – Binary adders –Subtractor - Decimal Adders - Binary multiplier - Magnitude comparator -Multiplexers and De multiplexers - Encoders and Decoders – Parity Generator and Checker-Code converters-BCD-to Binary code converter-Binary to Gray code converters-Gray to Binary code converters .

Unit – 3	**SEQUENTIAL LOGIC CIRCUITS**	**9**

Sequential logic- SR, JK, D and T flip flops - level triggering and edge triggering - Design of synchronous sequential circuits& asynchronous sequential circuits - Analysis of sequential logic circuits– Moore and Mealy models - state diagram - state reduction - state assignment.

Unit – 4	**COUNTERS AND REGISTERS**	**9**

Counters –Synchronous counters - Modulo counters –Ring counters- Johnsons counters- Registers - Shift registers-Universal shift register.

Unit – 5	**LOGIC FAMILIES AND PLDS**	**9**

Digital Logic Families –Introduction to RTL, DTL, TTL, ECL and MOSL families – wired and operation, characteristics of digital logic family – Comparison of different logic families-Introduction to Programmability Logic Devices: PROM – PLA –PAL, CPLD-FPGA.

Total Hours	**45**

Text books:

1	Morris Mano.M, 'Digital Logic and Computer Design', Prentice Hall of India, 4th Edition, 2015.
2	Donald D.Givone, 'Digital Principles and Design', Tata McGraw Hill,1st Edition, 2003
3	Thomas L Floyd, 'Digital fundamentals', Pearson Education Limited, 11th Edition, 2018

Reference Books:

1	Tocci R.J., Neal S. Widmer, 'Digital Systems: Principles and Applications', Pearson Education Asia, 12th Edition, 2017.
2	Donald P Leach, Albert Paul Malvino, GoutamSha, 'Digital Principles and Applications', Tata McGraw Hill, 7th Edition, 2010.

Course Code	Course Name	Semester	Category	Hours / Week			C
				L	T	P	
24EE434	DC Machines and Transformers	03	PC	3	0	0	3

Course Outcomes

Upon completion of the course students shall have ability to		RBT
C434.1	Apply the laws governing the electromechanical energy conversion for singly and multiple excited systems.	[U]
C434.2	Explain the construction, working principle and characteristics of DC machines.	[U]
C434.3	Compute various performance parameters of the machine, by conducting suitable tests.	[U]
C434.4	Draw the equivalent circuit of transformer and predetermine the efficiency and regulation	[U]
C434.5	Describe the working principle of auto transformer, three phase transformer with Different types of connections.	[U]

Course Contents

Unit–I	**ELECTROMECHANICAL ENERGY CONVERSION**	**9**

Fundamentals of Magnetic circuits- Statically and dynamically induced EMF - Principle of electromechanical energy conversion forces and torque in magnetic field systems- energy balance in magnetic circuits- magnetic force- co-energy in singly excited and multi excited magnetic field system MMF of distributed windings.

Unit–II	**DC GENERATORS**	**9**

Principle of operation, constructional details, armature windings and its types, EMF equation, wave shape of induced emf, armature reaction, demagnetizing and cross magnetizing Ampere turns, compensating winding, commutation, methods of improving commutation, interpoles, OCC and load characteristics of different types of DC Generators. Parallel operation of DC Generators, equalizing connections- applications of DC Generators.

Unit–III	**DC MOTORS**	**9**

Principle of operation, significance of back emf, torque equations and power developed by armature, speed control of DC motors, starting methods of DC motors, load characteristics of DC motors, losses and efficiency in DC machine, condition for maximum efficiency. Testing of DC Machines: Brake test, Swinburne's test, Hopkinson's test, Field test, Retardation test, Separation of core losses-applications of DC motors.

Unit–IV	**SINGLE PHASE TRANSFORMER**	**9**

Construction and principle of operation, equivalent circuit, phasor diagrams, testing - polarity test, open circuit and short circuit tests, voltage regulation, losses and efficiency, all day efficiency, back-to back test, separation of core losses, parallel operation of single-phase transformers, applications of single-phase transformer.

Unit–V	**AUTOTRANSFORMER AND THREE PHASE TRANSFORMER**	**9**

Construction and working of auto transformer, comparison with two winding transformers, applications of autotransformer. Three Phase Transformer- Construction, types of connections and their comparative features, Scott connection, applications of Scott connection.

	Total Hours	**45 Hours**

Text books

1	I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 5th Edition, 2017.
2	P. S. Bimbhra, "Electric Machinery", Khanna Publishers, 2nd Edition, 2021.

Reference Books

1	A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 6th Edition 2017.
2	A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2018.

Web References

1	https://archive.nptel.ac.in/courses/108/105/108105155/
2	https://nptel.ac.in/courses/108105017

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24EE435	Electronic Devices and Circuits	03	PC	3	0	2	4

Course Outcomes

Upon completion of the course, students shall have ability to		RBT
C435.1	Understand characteristics and applications of PN junction devices and rectifiers.	[U]
C435.2	Understand structure, operation, and characteristics of transistors and thyristors.	[U]
C435.3	Apply small-signal models to analyze and design BJT and MOSFET amplifiers.	[AP]
C435.4	Apply concepts of multistage and differential amplifiers to evaluate gain and frequency response.	[AP]
C435.5	Apply feedback concepts and analyze oscillator circuits.	[AP]

Course Contents

Unit – I	**PNJUNCTION DEVICES**	**9**

PN junction diode –structure, operation and V-I characteristics, diffusion and transition capacitance Clipping & Clamping circuits - Rectifiers – Half Wave and Full Wave Rectifier– Display devices- LED, Laser diodes, Zener diode characteristics- Zener diode Reverse characteristics – Zener diode as regulator.

Unit – II	**TRANSISTORS AND THYRISTORS**	**9**

BJT, JFET, MOSFET- structure, operation, characteristics and Biasing UJT, Thyristors and IGBT -Structure and characteristics.

Unit – III	**AMPLIFIERS**	**9**

BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response –MOSFET small signal model– Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.

Unit – IV	MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER	**9**

BIMOS cascade amplifier, Differential amplifier – Common mode and Difference mode analysis – FET input stages – Single tuned amplifiers – Gain and frequency response – Neutralization methods, power amplifiers –Types (Qualitative analysis).

Unit – V	**FEED BACK AMPLIFIERS AND OSCILLATORS**	**9**

Advantages of negative feedback – voltage / current, series, Shunt feedback –positive feedback Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

Total hours	**45**

Lab Component

List of Experiments

1.Characteristics of Semiconductor diode, Zener diode
2.Characteristics of NPN Transistor under common emitter , common collector and common base configurations
3. Design and frequency response characteristics of a Common Emitter amplifier.
4. Design and testing of RC phase shift oscillators.
5. Characteristics of Single Phase half-wave and full wave rectifiers with inductive and capacitive filters.

Total Hours	**30**

Learning Resources

Text books

1	David A. Bell , "Electronic devices and circuits", Oxford University higher education, 5th edition2008.
2	Sedra and smith,"Micro electronic circuits",7th Edition., Oxford University Press,2017

Reference Books

1	BalbirKumar,Shail.B.Jain,"Electronicdevicesandcircuits"PHIlearningprivatelimited,2nd edition 2014.
2	ThomasL.Floyd,"Electronicdevices"Conventionalcurrentversion,Pearsonprenticehall,10th Edition, 2017.

Web References

1	https://archive.nptel.ac.in/courses/108/102/108102097/
2	https://onlinecourses.nptel.ac.in/noc21_ee80/preview

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24CS336	PROBLEM SOLVING AND PYTHON PROGRAMMING	PC	03	3	0	2	4

Course Outcomes

Upon completion of the course, students shall have ability to

C336.1	Understand computational thinking, algorithm development, iteration, and recursion in the context of problem-solving.	U
C336.2	Demonstrate Python syntax, data types, expressions, and debugging techniques using the interpreter.	AP
C336.3	Develop and implement python programs using control flow, functions, and string manipulations.	AP
C336.4	Implement advanced data structures and perform complex data processing using list comprehension.	AP
C336.5	Apply file I/O operations and use modules and packages to build modular and reusable python programs.	AP

Course Contents

Unit – 1	COMPUTATIONAL THINKING AND PROBLEM SOLVING	9

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation, simple strategies for developing algorithms (iteration, recursion).

Unit – 2	DATA TYPES, EXPRESSIONS, STATEMENTS	9

Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments.

Unit – 3	CONTROL FLOW, FUNCTIONS, STRINGS	9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else),chained conditional (if-elif-else);Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays.

Unit – 4	LISTS, TUPLES, DICTIONARIES	9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension.

Unit – 5	FILES, MODULES, PACKAGES	9

Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages.

	Total Hours	45

Lab Components

List of Experiments

1	Python programming using simple statements and expressions.
2	Scientific problems using Conditionals and Iterative loops.
3	Implement the python program for exchanging the values of two variables, circulate the values of n variables.
4	Implement the python program for distance between two points.
5	Implementing real-time/technical applications using Sets, Dictionaries.
6	Implementing programs using Functions.
7	Implementing programs using Strings.
8	Implementing real-time/technical applications using File handling.
9	Implementing real-time/technical applications using Exception handling.
10	Implementing programs for word count, copy file, Voter's age validation, Marks range validation (0-100)
11	Mini Project
	Total Hours 30

Textbooks:

1	Allen B. Downey. Think Python: How to Think Like a Computer Scientist. 3rd Edition. 3rd Edition - 2 July 2024. ISBN-13: 978-1098155438 ISBN-10: 1098155432. 4.7

2	G Venkatesh and Madhavan Mukund, “Computational Thinking: A Primer for Programmers and Data Scientists”, 1st Edition, Notion Press, 2021.
Reference Books:	
1	Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021
2	Karl Beecher, “Computational Thinking: A Beginner's Guide to Problem Solving and Programming”, 1st Edition, BCS Learning & Development Limited, 2017.
3	John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data”, Third Edition, MIT Press, 2021.
Web References:	
1	https://wiki.python.org/moin/BeginnersGuide/Programmers
2	https://www.learnpython.org/
3	https://programiz.pro/resources/python

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24EE437	DC Machines and Transformers Laboratory	03	PC	0	0	4	2

Course Outcomes

Upon completion of the course, students shall have ability to

C437.1	Construct the circuit with appropriate connections for the given DC machine/transformer.	[AP]
C437.2	Experimentally determine the characteristics of different types of DC machines.	[AP]
C437.3	Demonstrate the speed control techniques for a DC motor for industrial applications.	[AP]
C437.4	Identify suitable methods for testing of transformer and DC machines	[AP]
C437.5	Predetermine the performance parameters of transformers and DC motor.	[AP]
C437.6	Understand DC motor starters and 3-phase transformer connections.	[AP]

List of Experiments:

1.	Open circuit and load characteristics of DC shunt generator- calculation of critical resistance and critical speed.
2.	Load characteristics of DC compound generator with differential and cumulative connections.
3.	Load test on DC shunt motor.
4.	Load test on DC compound motor.
5.	Load test on DC series motor.
6.	Swinburne's test and speed control of DC shunt motor.
7.	Hopkinson's test on DC motor – generator set.
8.	Load test on single-phase transformer and three phase transformers.
9.	Open circuit and short circuit tests on single phase transformer.
10.	Sumpner's test on single phase transformers.
11.	Separation of no-load losses in single phase transformer.
12.	Study of starters and 3-phase transformers connections.
	Total Hours 45

Textbooks:

1	I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 5th Edition, 2017.
2	P. S. Bimbhra, "Electric Machinery", Khanna Publishers, 2nd Edition, 2021.

Reference Books:

1	A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 6th Edition 2017.
2	A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2018.
3	M. G. Say, "Performance and design of AC machines", CBS Publishers, First Edition 2008

Web References:

1	https://nptel.ac.in/courses/108105017
2	https://referenceglobe.com/CollegeLibrary/library_books/

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24MA244	Statistics and Numerical Methods	BS	04	3	1	0	4

Course Outcomes

Upon completion of the course, students shall have ability to

C244.1	Apply the concept of testing of hypothesis for small and large samples in real life problems.	[AP]
C244.2	Apply the basic concepts of classifications of design of experiments in the field of agriculture.	[AP]
C244.3	Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.	[AP]
C244.4	Apply the various techniques and methods for solving first and second order ordinary differential equations.	[AP]
C244.5	Solve the ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.	[AP]

Course Contents

Unit – 1	**TESTING OF HYPOTHESIS**	**12**

Sampling distributions - Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

Unit – 2	**DESIGN OF EXPERIMENTS**	**12**

One way and two way classifications - Completely randomized design – Randomized block design – Latin square design -2^2 factorial design.

Unit – 3	**SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS**	**12**

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method.

Unit – 4	**INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION**	**12**

Lagrange's interpolation for unequal intervals – Newton's forward and backward difference interpolation – Approximation of derivates using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

Unit – 5	**NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**	**12**

Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order differential equations - Multi step methods: Milne's and Adams - Bash forth predictor corrector methods for solving first order differential equations.

TOTAL HOURS	**60**

Textbooks:

1	B. S. Grewal and J. S. Grewal, Numerical Methods in Engineering and Science, 10th ed. New Delhi, India: Khanna Publishers, 2015.
2	R. A. Johnson, I. Miller, and J. E. Freund, Miller and Freund's Probability and Statistics for Engineers, 9th ed. Boston, MA, USA: Pearson Education, 2023.

Reference Books:

1	R. L. Burden, J. D. Faires, and A. M. Burden, Numerical Analysis, 10th ed. Boston, MA, USA: Cengage Learning, 2016.
2	J. L. Devore, Probability and Statistics for Engineering and the Sciences, 9th ed. Boston, MA, USA: Cengage Learning, 2016.
3	Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7th Edition, 2007.
4	Gupta S.C. and Kapoor V. K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12th Edition, 2020.
5	M. R. Spiegel, J. J. Schiller, and R. A. Srinivasan, Schaum's Outline of Probability and Statistics, 6th ed. New York, NY, USA: McGraw-Hill Education, 2017.

Web References:

1	https://archive.nptel.ac.in/courses/111/107/111107105/
2	https://onlinecourses.nptel.ac.in/noc24_ma30/preview

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24EE442	Generation, Transmission and Distribution	04	PC	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to		RBT
C442.1	Understand power system structure and transmission line parameters.	[U]
C442.2	Analyze performance of transmission lines and related effects.	[U]
C442.3	Apply sag, tension calculations and study line supports & insulators.	[U]
C442.4	Understand underground cable construction and performance.	[U]
C442.5	Analyze distribution systems, voltage control, and modern trends.	[U]

Course Contents

Unit–I	STRUCTURE OF POWER SYSTEM-TRANSMISSION LINE PARAMETERS CALCULATION	9

Typical Layout of an Electrical Power System, Types of Renewable and Non Renewable energy sources, Overview of Power Plants, Resistance, inductance, capacitance of single phase and three phase lines with symmetrical and unsymmetrical spacing of solid and bundled conductors, effect of earth on capacitance, application of self and mutual GMD.

Unit – II	MODELLING AND PERFORMANCE OF TRANSMISSION LINES	9

Performance of Transmission lines – short line, medium line and long line – equivalent circuits, phasor diagram, attenuation constant, phase constant, surge impedance – transmission efficiency and voltage regulation, real and reactive power flow in lines – Ferranti effect – Formation of Corona – Critical Voltages – Effect on line Performance.

Unit–III	SAG CALCULATION AND LINE SUPPORTS	9

Mechanical design of overhead lines – Line Supports –Types of towers – Tension and Sag Calculation for different weather conditions – Methods of grounding - Insulators: Types, voltage distribution in insulator string, improvement of string efficiency, testing of insulators.

Unit–IV	UNDERGROUND CABLES	9

Underground cables – Types of cables – Construction of single-core and 3-core belted cables – Insulation Resistance – Potential Gradient – Capacitance of single-core and 3-core belted cables – Grading of cables – Power factor and heating of cables– DC cables.

Unit–V	DISTRIBUTION SYSTEMS	9

Distribution Systems – General Aspects – Kelvin's Law – AC and DC distributions –Concentrated and Distributed loading- Techniques of Voltage Control and Power factor improvement – Distribution Loss -Types of Substations – Trends in Transmission and Distribution: EHVAC, HVDC and FACTS

Total Hours	45

Learning Resources

Text books

1	D.P.Kothari, I.J. Nagarath, 'Power System Engineering', Mc Graw-Hill Publishing Company limited, New Delhi, Third Edition, 2019.
2	V.K. Mehta, "Principles of Power System", S. Chand Publication, 2011.

Reference Books

1	C.L.Wadhwa, 'Electrical Power Systems', New Age International Ltd, seventh edition 2022.
2	S.N. Singh, "Electric Power Generation, Transmission and Distribution", Second Edition, Prentice-Hall of India Private Limited, New Delhi, 2011.

Web References

1	http://textofvideo.nptel.iitm.ac.in/108102047/lec20.pd
2	http://nptel.ac.in/video.php?subjectId=108102047

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24EE443	Measurements and Instrumentation	04	PC	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to		**RBT**
C443.1	Understand the fundamental art of measurement in engineering.	[U]
C443.2	Understand the structural elements of various instruments.	[U]
C443.3	Understand the importance of bridge circuits.	[U]
C443.4	Understand about various transducers and their characteristics by experiments.	[U]
C443.5	Understand the concept of digital instrumentation and virtual instrumentation by experiments.	[U]

Course Contents

Unit–I	**CONCEPTS OF MEASUREMENTS**	9
Instruments: classification, applications – Elements of a generalized measurement system - Static and dynamic characteristics - Errors in measurement -Statistical evaluation of measurement data.		
Unit – II	**MEASUREMENT OF PARAMETERS IN ELECTRICAL SYSTEMS**	9
Classification of instruments – moving coil and moving iron meters – Induction type, dynamometer type watt meters – Energy meter – Megger – Instrument transformers (CT & PT).		
Unit–III	**AC/DC BRIDGES AND INSTRUMENTATION AMPLIFIERS**	9
Wheatstone bridge, Kelvin double bridge - Maxwell, Hay, Wien and Schering bridges – Errors and compensation in A.C. bridges - Instrumentation Amplifiers.		
Unit–IV	**TRANSDUCERS FOR MEASUREMENT OF NON- ELECTRICAL PARAMETERS**	9
Classification of transducers – Measurement of pressure, temperature, displacement, flow, angular velocity – Digital transducers – Smart Sensors.		
Unit–V	**DIGITAL INSTRUMENTATION**	9
A/D converters: types and characteristics – Sampling, Errors- Measurement of voltage, Current, frequency and phase - D/A converters: types and characteristics - DSO- Data Loggers – Basics of PLC programming and Introduction to Virtual Instrumentation - Instrument standards.		
	Total hours	**45**

Learning Resources

Text Books

1	A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, New Delhi, Edition 2011.
2	H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2019.

Reference Books

1	M.M.S. Anand, 'Electronics Instruments and Instrumentation Technology', Prentice Hall India, New Delhi, 2009.
2	J.J. Carr, 'Elements of Electronic Instrumentation and Measurement', Pearson Education India, New Delhi, 2011.
3	W.Bolton, Programmable Logic Controllers, 6th Edition, Elseiver, 2015.

Web References

1	https://archive.nptel.ac.in/courses/108/105/108105153/
2	https://education.ni.com/teach/resources/1282/measurements-and-instrumentation

Course Code	Course Name	Semester	Category	Hours / Week			C
				L	T	P	
24EE444	Synchronous and Induction Machines	04	PC	3	0	0	3

Course Outcomes

Upon completion of the course students shall have ability to		RBT
C444.1	Understand the construction and working principle of Synchronous generator	[U]
C444.2	Understand the construction and working principle of Synchronous Motor	[U]
C444.3	Understand the construction and working principle of Three Phase Induction Motor	[U]
C444.4	Acquire knowledge about the starting and speed control of induction motors.	[U]
C444.5	Gain knowledge about the basic principles and working of Single phase induction motors and Special Electrical Machines.	[U]

Course Contents

Unit–I SYNCHRONOUS GENERATOR **9**

Constructional details – Types of rotors –winding factors- EMF equation – Synchronous reactance –Armature reaction – Phasor diagrams of non-salient pole synchronous generator connected to infinite bus--Synchronizing and parallel operation – Synchronizing torque -Change of excitation and mechanical input-Voltage regulation – EMF, MMF, ZPF and A.S.A method – steady state power angle characteristics– Two reaction theory –slip test -short circuit transients - Capability Curves.

Unit–II SYNCHRONOUS MOTOR **9**

Principle of operation – Torque equation – Operation on infinite bus bars - V and Inverted V curves –Power input and power developed equations – Starting methods – Current loci for constant power input, constant excitation and constant power Developed-Hunting – natural frequency of oscillations – damper windings-synchronous condenser.

Unit–III THREE PHASE INDUCTION MOTOR **9**

Constructional details – Types of rotors –- Principle of operation – Slip –cogging and crawling-Equivalent circuit – Torque-Slip characteristics - Condition for maximum torque – Losses and efficiency – Load test - No load and blocked rotor tests - Circle diagram – Separation of losses Double cage induction motors –Induction generators – Synchronous induction motor.

Unit–IV STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR **9**

Need for starting – Types of starters – DOL, Rotor resistance, Autotransformer and Star delta starters– Speed control – Voltage control, Frequency control and pole changing – Cascaded Connection-V/f control – Slip power recovery Scheme-Braking of three phase induction motor: Plugging, dynamic braking and regenerative braking.

Unit–V SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES **9**

Constructional details of single phase induction motor – Double field revolving theory and operation – Equivalent circuit – No load and blocked rotor test – Performance analysis – Starting methods of single-phase induction motors – Capacitor-start capacitor run Induction motor- Shaded pole induction motor - Linear induction motor – Repulsion motor - Hysteresis motor - AC series motor- Servo motors-Stepper motors - introduction to magnetic levitation systems.

Total Hours **45**

Text books

1	D.P. Kothari and I.J. Nagrath, 'Electric Machines', McGraw Hill Publishing Company Ltd, 5th Edition 2017
2	P.S. Bimbhra, 'Electrical Machinery', Khanna Publishers, edition 2, 2021.

Reference Books

1	Vincent Del Toro, 'Basic Electric Machines' Pearson India Education, 2016.
2	M.N. Bandyo padhyay, Electrical Machines Theory and Practice, PHI Learning Pvt ltd., New Delhi, 2011.

Web References

1	https://archive.nptel.ac.in/courses/108/105/108105131/
2	https://archive.nptel.ac.in/courses/108/106/108106072/

Course Code	Course Name	Semester	Category	Hours / Week			C
				L	T	P	
24EE445	Linear Integrated Circuits	04	PC	3	0	0	3

Course Outcomes

Upon completion of the course students shall have ability to		RBT
C445.1	Describe operational amplifier concepts, characteristics, and parameters.	[U]
C445.2	Discuss the characteristics and basic applications of operational amplifiers.	[U]
C445.3	Explain the use of op-amps in amplifiers, filters, and data conversion circuits.	[U]
C445.4	Analyze the operation of special ICs such as 555 Timer, VCO, and PLL to determine their behavior in circuit applications.	[AN]
C445.5	Analyze voltage regulator and signal generation IC circuits to evaluate performance and output characteristics.	[AN]

Course Contents

Unit–I	Fundamentals of Operational Amplifier	9

General operational amplifier stages and internal circuit diagrams of IC 741,Basic Op-amp circuit, Op-Amp parameters – Input and output voltage, CMRR and PSRR, offset voltages and currents, Input and output impedances, Slew rate, Ideal OP-AMP characteristics, , Frequency response of op-amp.

Unit–II	Characteristics of Operational Amplifier	9

DC characteristics and AC characteristics , Basic applications of OP-AMP -Inverting amplifier and Non-Inverting Amplifier - Logarithmic amplifier and Antilogarithmic amplifier, Integrator, differentiator, Adder, Subtractor, V/I & I/V converters, Clipper and clampers, Peak detector, S/H circuit.

Unit–III	Applications Of Operational Amplifier	9

Differential amplifier, Instrumentation amplifier, Analog multiplier & Divider, first and second order active filters, comparators, Schmitt trigger, D/A converter (R- 2R ladder and weighted resistor types), A/D converters (Flash type – Successive Approximation type -Dual Slope type)

Unit–IV	SPECIAL ICs	9

Functional block, characteristics of 555 Timer, Multivibrators (Astable and monostable) –IC 566 voltage controlled oscillator, IC 565-Phase locked loop and its applications.

Unit–V	APPLICATION ICs	9

IC voltage regulators - Fixed voltage regulators –LM78XX, LM79XX, Adjustable voltage regulator-LM317-General purpose voltage regulator - IC 723, Switching regulator- SMPS -ICL 8038 function generator IC.

Total Hours	45

Learning Resources

Text books

1	David A. Bell, 'Op-amp and Linear ICs',Oxford,ThirdEdition,2011
2	D.Roy Choudhary, Sheil B. Jani, 'Linear Integrated Circuits' New Age, Fourth Edition,2018.

Reference Books

1	Fiore, "Opamps & Linear Integrated Circuits Concepts& applications",Cengage,2010.
2	Floyd, Buchla,"Fundamentals of Analog Circuits, Pearson,2013.

Web References

1	https://archive.nptel.ac.in/courses/108/108/108108111/
2	https://nptel.ac.in/courses/108103378

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24CS346	Data Structures and Algorithms	O4	ES	3	0	2	4

Course Outcomes

Upon completion of the course, students shall have ability to

C346.1	Understand and implement linear data structures such as lists, stacks, queues, and linked lists, and apply them in solving real-world problems.	U
C346.2	Apply non-linear data structures like trees and their variations to represent hierarchical data efficiently.	AP
C346.3	Demonstrate knowledge of graph data structures and apply graph algorithms in solving complex problems.	AP
C346.4	Analyze algorithms in terms of time and space complexity using asymptotic notations and apply algorithmic paradigms to solve problems.	AP
C346.5	Implement and compare various searching and sorting techniques for problem-solving and optimization.	AP

Course Contents

Unit-1	**Linear ADT**	**9**

List - Arrays - Matrix - String - Applications –Stack - Queue - Circular Queue - Linked List - Singly Linked List, Doubly Linked List, Circular Linked List

Unit – 2	**Non-linear ADT - Trees**	**9**

Tree Terminology - Binary tree - Tree traversals - Expression Tree – Binary Search Tree - AVL Tree - B-tree - Binary Heap - Applications – Dictionary, kth smallest element, Hash Table – Hashing Techniques, Rehashing

Unit – 3	**Non-linear ADT - Graphs**	**9**

Graphs –Graph Terminology – Graph Representation – Graph traversals – Applications –Shortest path algorithm, Minimum Spanning Tree

Unit – 4	**Algorithmic Analysis**	**9**

Asymptotic Measures – Space Complexity – Time Complexity - Divide and Conquer method - Strassen's matrix multiplication - Greedy method - Knapsack problem – Dynamic Programming- Travelling salesman problem.

Unit – 5	**Searching and Sorting Techniques**	**9**

Selection, Bubble, Insertion, Merge, Quick sort - Address calculation - Linear search - Binary search.

Total Hours	**45**

List of Experiments

1	Implement simple ADTs as Python classes	C346.1
2	Implement recursive algorithms in Python	C346.1
3	Linked list implementations of List	C346.2
4	Implementation of Stack and Queue ADTs	C346.2
5	Implementation of Hash tables	C346.3
6	Tree representation and traversal algorithms	C346.3
7	Implementation of Binary Search Trees	C346.4
8	Implement Travelling sales man problem	C346.4
9	Implementation of sorting and searching algorithms	C346.5
10	Implement Bubble and Quick sort techniques	C346.5
	Total Hours	**30**

Textbooks:

1	M. A. Weiss, “Data Structures and Algorithm Analysis in python ”, First Edition, Addition - Wesley professional october 4 2022.
2	Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser”Data Structures & Algorithms in Python”Publisher: Wiley India Pvt. Ltd. in : 2021

Reference Books:

1	T. Cormen, C. Lieserson, R. Rivest, and C. Stein, “Introductions to Algorithms”, PrenticeHall/India, 3rd edition, 2009
2	M. A. Weiss, “Data Structures and Algorithm Analysis in Java”, Second Edition, Pearson Education, 2014

Web References:

1	Onlinecourses.nptel.ac.in

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24EE447	Synchronous and Induction Machines Laboratory	04	PC	0	0	4	2

Course Outcomes		
Upon completion of the course, students shall have ability to		
C447.1	Understand and analyze EMF and MMF methods	[AP]
C447.2	Analyze the characteristics of V and Inverted V curves	[AP]
C447.3	Acquire hands on experience of conducting various tests on alternators and obtaining their performance indices using standard analytical as well as graphical methods	[AP]
C447.4	Acquire hands on experience of conducting various tests on induction motors and obtaining their performance indices using standard analytical as well as graphical methods.	[AP]
C447.5	Ability to acquire knowledge on separation of losses	[AP]
List of Experiments:		**CO**
1.	Regulation of three phase alternator by EMF and MMF methods.	C447.1
2.	Regulation of three phase alternator by ZPF and ASA methods.	C447.2
3.	Regulation of three phase salient pole alternator by slip test.	C447.3
4.	Measurements of negative sequence and zero sequence impedance of alternators.	C447.3
5.	V and Inverted V curves of Three Phase Synchronous Motor.	C447.3
6.	Load test on three-phase induction motor.	C447.3
7.	No load and blocked rotor tests on three-phase induction motor (Determination of equivalent circuit parameters	C447.3
8.	Separation of No-load losses of three-phase induction motor.	C447.4
9.	Load test on single-phase induction motor.	C447.4
10.	No load and blocked rotor test on single-phase induction motor.	C447.4
11.	Study of Induction Motor Starters	C447.5
	Total Hours	**45**
Text books:		
1	I. J. Nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 5th Edition, 2017.	
2	P. S. Bimbhra, “Electric Machinery”, Khanna Publishers, 2nd Edition, 2021.	
Reference Books:		
1	A. E. Fitzgerald and C. Kingsley, "Electric Machinery”, New York, McGraw Hill Education, 6th Edition 2017.	
2	A. E. Clayton and N. N. Hancock, “Performance and design of DC machines”, CBS Publishers, 2018.	
3	M. G. Say, “Performance and design of AC machines”, CBS Publishers, First Edition 2008	
Web References:		
1	https://nptel.ac.in/courses/108105017	
2	https://referenceglobe.com/CollegeLibrary/library_books/	

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24EE448	Digital and Linear Integrated Circuits Laboratory	04	PC	0	0	4	2

Course Outcomes		
Upon completion of the course, students shall have ability to		
C448.1	Understand and implement Boolean Functions	AP
C448.2	Understand the importance of code conversion	AP
C448.3	Design and implement circuits with digital ICs like decoders, multiplexers, register.	AP
C448.4	acquire knowledge on Application of Op-Amp	AP
C448.5	Design and implement counters using analog ICs like timers, VCOs and digital ICs like Flip-flops and counters.	AP

List of Experiments		
Exp.No.	**Name of the Experiment**	
Digital Electronics		
1.	Design and implementation of Adder and Subtractor circuits.	
2.	Design and implementation of Excess-3 to BCD and Binary to Gray code converter and vice-versa.	
3.	Design and implementation of Encoders and Decoders AND multiplexer and demultiplexer.	
4.	Design and implementation of 3-bit synchronous counter using FF IC's.	
5.	Design and implementation of 3-bit Asynchronous counters using FF IC's.	
6.	Design and implementation of 4-bit shift registers in SISO, SIPO, PISO, PIPO Modes using suitability IC's.	
Analog Electronics		
1.	Design and implementation of Inverting and non-inverting amplifier.	
2.	Design and implementation of Integrator and Differentiator.	
3.	Design and implementation of Adder and comparator.	
4.	Design and implementation of astable and monostable multivibrator using 555 timer.	
5.	Design and implementation of Instrumentation amplifier.	
6.	Voltage Regulator using IC LM317, 723, 78XX, 79XX.	
	Total Hours	**60**

Learning Resources	
Online Resources	
1	https://www.youtube.com/playlist?list=PLrijwwbrySZ0spFuTY3FI3cA5pnzkjrKr
2	https://www.udemy.com/topic/c-programming/

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24MB151	PRINCIPLES OF MANAGEMENT	HS	05	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C151.1	Comprehend the basic concepts of management and evolution in management.	[U]
C151.2	Demonstrate the roles and skills in planning and decision making for the business.	[AP]
C151.3	Execute grouping of activities via departmentation and discharge various roles and responsibilities in the organization.	[AP]
C151.4	Apply various motivational and leadership theories in directing the workforce, improve their performance.	[AP]
C151.5	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-Crisis Management – Knowledge Management – Risk Management –Artificial Intelligence – Business Analytics – Six Sigma management – meaning- importance.

Total Hours	**45**

Textbooks:

1	P.C.Tripathy, P.N.Reddy, Ashish Bajpai Principles of Management,7th Edition, Tata McGraw Hill Education Pvt Ltd, NewDelhi (2023)
2	Harold Knootz, Heinz Weinhrich, Essential of Management, 11th Edition, Tata McGraw Hill Education Pvt Ltd, New Delhi. (2021)
3	Stephen P Robbins ,Mary Coulter& David De Cenzo, Fundamentals of Management: Essential Concepts and Applications, 9th Edn (2016)

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, Sultan Chand & Sons New Delhi (2024)
3	Dr Mosham Sinha & Dr Deepali Kapoor, Fundamentals of Management, DPS Publishing House,(2022)
4	Mrs M Saravanapriya, Fundamentals of Management, Astitva Prakashan, (2024)
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

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE452	Power Electronics	PC	05	3	0	0	3

Course Outcomes
Upon completion of the course, students will be able to

C452.1	Understand uncontrolled rectifiers and their performance parameters.	[U]
C452.2	Explain controlled rectifiers and SCR-based converters.	[U]
C452.3	Examine the operation of choppers and DC-DC converter circuits.	[AP]
C452.4	Apply inverter circuits and modulation techniques in power conversion systems.	[AP]
C452.5	Assess the working principle of AC-AC converters and their control strategies.	[AP]

Course Contents

Unit – 1	**Uncontrolled Rectifiers**	**9 Hrs**

Power Diodes: Characteristics, operation and applications in rectifier circuits - Rectifier Circuits: Single-phase half-wave rectifier, full-wave rectifier (mid-point transformer) and bridge rectifier - Performance Parameters - Effects of Source Inductance-Applications

Unit – 2	**Controlled Rectifiers**	**9 Hrs**

SCR Fundamentals: Construction, characteristics, and operation of SCR- Two-transistor analogy, turn-ON mechanism - Switching and Protection: Turn-ON losses, thermal protection methods, and safe operation of SCR- Single-phase controlled rectifiers (1-pulse and 2-pulse converters)- Three-phase controlled rectifiers (3-pulse and 6-pulse converters) - Performance Parameters - Effect of Source Inductance-Applications.

Unit – 3	**Choppers**	**9 Hrs**

MOSFET: Static and dynamic behavior, buck, boost, buck-boost converters - Isolated Converter Topologies: Fly back converter, Forward converter and Push-pull converter - Resonant Converters: Basic concepts of resonant switching, zero voltage switching (ZVS), zero current switching (ZCS) converters--Applications.

Unit – 4	**Inverters**	**9 Hrs**

IGBT: Static and dynamic behavior - single phase half bridge and full bridge inverters Three-Phase Voltage Source Inverters (VSI): Operation in 120° conduction mode and 180° conduction mode. Voltage control of inverters– Harmonic elimination techniques -Current Source Inverter-Applications.

Unit – 5	**AC to AC Converters**	**9 Hrs**

Single phase and Three phase AC voltage controllers– Operating principles and circuit configurations – phase angle and integral cycle control strategies- Power Factor Control – Multistage sequence control - Single phase and three phase cyclo converters - output voltage and frequency control– Introduction to matrix converters – topology, modulation techniques, advantages, limitations, and industrial applications.

Total Hours	**45**

Text books:

1	Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronics Converters, Applications and Design", 3rd edition, John Wiley &Sons edition 2011.
2	Muhammad H. Rashid, "Power Electronics: Devices, Circuits and Applications", 4th edition, Pearson Education, 2017
3	Bhimbra P S, "Power Electronics", 7th edition, Khanna Publishers, 2018.

Reference Books:

1	Vedam Subramanian, "Power Electronics" ,2nd edition,New age international , 2018
2	Singh M D, "Power Electronics", Tata McGraw-Hill, 2nd Edition 2014.
3	Bimal K. Bose, "Modern Power Electronics and amp; AC Drives", 1st edition,Pearson, 2015.

Web References:

1	https://nptel.ac.in/courses/108101038/
2	https://www.tutorialspoint.com/power_electronics/index.html
3	https://www.coursera.org/learn/power-electronics
4	https://nptel.ac.in/courses/108101038/
5	https://in.mathworks.com/help/sps/power-converters.html

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE456	Power System Analysis	PC	05	3	0	2	4

Course Outcomes		
Upon completion of the course, students shall have ability to		RBT
C456.1	Apply per unit system, network representation, and bus admittance matrix formation techniques to model power systems under steady-state conditions.	[AP]
C456.2	Apply iterative methods such as Gauss-Seidel and Newton-Raphson to perform power flow analysis of power systems.	[AP]
C456.3	Apply Thevenin's theorem and bus impedance matrix methods to compute symmetrical fault currents, post-fault voltages, and fault levels in power systems.	[AP]
C456.4	Analyze the behavior of power systems under unsymmetrical fault conditions using symmetrical components and sequence networks.	[AN]
C456.5	Analyze power system stability using swing equation, equal area criterion, and numerical methods.	[AN]

Course Contents		
Unit–I	**Modelling and Network**	9
Need for system planning and operational studies - Power scenario in India - Power system components, Representation - Single line diagram - per unit analysis -Network graph Theory - Bus incidence matrices, Primitive parameters, Formation of bus admittance matrix – Direct inspection method – Singular Transformation method.		
Unit–II	**Power Flow Analysis**	9
Bus classification - Formulation of Power Flow problem in polar coordinates - Power flow solution using Gauss Seidel method - Handling of Voltage controlled buses - Power Flow Solution by Newton Raphson method **–** Flow charts – Comparison of methods.		
Unit–III	**Symmetrical Fault Analysis**	9
Assumptions in short circuit analysis - Symmetrical short circuit analysis using Thevenin's theorem - Bus Impedance matrix building algorithm (without mutual coupling) - Symmetrical fault analysis through bus impedance matrix - Post fault bus voltages - Fault level - Current limiting reactors.		
Unit–IV	**Unsymmetrical Fault Analysis**	9
Symmetrical components - Sequence impedances - Sequence networks - Analysis of unsymmetrical faults at generator terminals: LG, LL and LLG - unsymmetrical fault occurring at any point in a power system.		
Unit–V	**Stability Analysis**	9
Classification of power system stability – Rotor angle stability - Power-Angle equation – Steady state stability - Swing equation – Solution of swing equation by step by step method - Swing curve, Equal area criterion - Critical clearing angle and time, Multi-machine stability analysis – modified Euler method.		
	Total theory Hours	**45**

Lab Experiments

1. Computation and modeling of transmission Lines.
2. Formation of Bus Admittance and Impedance Matrices.
3. Power Flow Analysis Using Gauss-Seidel Method.
4. Power Flow Analysis Using Newton Raphson Method.
5. Symmetrical and Unsymmetrical Fault Analysis.

Total Practical Hours	**30**

Textbooks

1	John J. Grainger, William D. Stevenson, Jr, 'Power System Analysis', Mc Graw Hill Education (India) Private Limited, New Delhi, 2017.
2	Kothari D.P. and Nagrath I.J., 'Power System Engineering', Tata McGraw-Hill Education, 3rd edition 2019.
3	Hadi Saadat, 'Power System Analysis', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.

Reference Books	
1	Pai M A, 'Computer Techniques in Power System Analysis', Tata Mc Graw-Hill Publishing Company Ltd., New Delhi, Second Edition, 2007.
2	J. Duncan Glover, Mulukutla S.Sarma, Thomas J. Overbye, 'Power System Analysis & Design', Cengage Learning, Fifth Edition, 2012.
3	P. Venkatesh, B. V. Manikandan, A. Srinivasan, S. Charles Raja, "Electrical Power Systems: Analysis, Security and Deregulation" Prentice Hall India (PHI), second edition- 2017.
4	Gupta B.R., 'Power System - Analysis and Design', S. Chand Publishing, Reissue edition 2005.
5	Kundur P., 'Power System Stability and Control', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2013.
Web References	
1	https://archive.nptel.ac.in/courses/108/105/108105067/
2	https://www.udemy.com/course/power-system-analysis/?srsltid=AfmBOoojBLZO6Du1GZr83jfQ2poxuLqtbx_aeK_XPoJaQ6qd6AIBhTDc&couponCode=NVDIN35
3	https://www.se.com/us/en/product-range/64256-power-system-analytical-studies/#overview
4	http://www.nsit.net.in/en/node/1017

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE457	Control Systems	PC	05	3	0	2	4

Course Outcomes

Upon completion of the course, students will be able to

C457.1	Represent simple systems in transfer function and state variable forms.	[AP]
C457.2	Analyze simple systems in time domain.	[AP]
C457.3	Examine simple systems in frequency domain.	[AP]
C457.4	Infer the stability of systems in time and frequency domain.	[U]
C457.5	Interpret characteristics of the system and find out solution for simple control problems.	[AN]

Course Contents

Unit – 1	**Modeling of Linear Time Invariant System (LTIV)**	**9**

Control system: Open loop and Closed loop – Feedback control system characteristics – First principle modeling: Mechanical, Electrical and Electromechanical systems – Transfer function representations (AC and DC Servo motor)- Block diagram reduction and Signal flow graph.

Unit – 2	**Time Domain Analysis**	**9**

Standard test inputs – Time response of first and second order system – Time domain specifications – Stability analysis: Concept of stability – Routh Hurwitz stability criterion – Root locus: Construction and Interpretation. Effect of adding poles and zeros

Unit – 3	**Frequency Domain Analysis**	**9**

Bode plot, Polar plot and Nyquist plot: – Frequency domain specifications Introduction to closed loop Frequency Response. Effect of adding lag and lead compensators.

Unit – 4	**State Variable Analysis**	**9**

State variable formulation – Non uniqueness of state space model – State transition matrix –Eigen values – Eigen vectors - Free and forced responses for Time Invariant and Time Varying Systems – Controllability – Observability

Unit – 5	**Design of Feed Back Control System**	**9**

Design specifications – Lead, Lag and Lag-lead compensators using Root locus and Bode plot techniques –Controller –P, PI, PID controllers.

Total Theory Hours 45

List of Experiments:

1. Numerical Simulation of given nonlinear differential equations.
2. Stability analysis using Pole zero maps and Routh Hurwitz Criterion in simulation platform.
3. Root Locus based analysis in simulation platform.
4. Determination of transfer functions of a physical system using frequency response and Bode's asymptotes.
5. Design of Lag, lead compensators and evaluation of closed loop performance.
6. Design of PID controllers and evaluation of closed loop performance.

Total Practical Hours 30

Text books:

1	Nagarath, I.J. and Gopal, M., "Control Systems Engineering", New Age International Publishers 2010.
2	Benjamin C. Kuo, "Automatic Control Systems", 7th edition PHI Learning Private Ltd, 2010.

Reference Books:

1	Katsuhiko Ogata, "Modern Control Engineering", PHI Learning Private Ltd, 5thEdition, 2010.
2	John J.D., Azzo Constantine, H. and Houpis Sttuart, N Sheldon, "Linear Control System Analysis and Design with MATLAB", CRC Taylor& Francis Reprint 2009.

Web References:

1	NPTEL Video Lecture Notes on "Control Engineering" by Prof.S.D.Agashe, IIT Bombay

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE458	Power Electronics Laboratory	PC	05	0	0	4	2

Course Outcomes

Upon completion of the course, students will be able to

C458.1	Examine the switching characteristics and operating principles of SCR and MOSFET devices.	[AP]
C458.2	Analyze the operation and output performances of single phase half and fully controlled converters with R and RL loads.	[AP]
C458.3	Investigate the working of step down and step up DC-DC chopper circuits.	[AP]
C458.4	Construct and evaluate PWM inverter and AC voltage controller circuits for power control applications.	[AP]
C458.5	Perform simulation studies of converters, choppers, inverters, and AC voltage controllers using simulation software.	[AP]

List of Experiments:		**CO**
1.	Study the Characteristics of SCR.	C458.1
2.	Study the Characteristics of MOSFET.	C458.1
3.	Single phase half controlled converter with R and RL load.	C458.2
4.	Single phase fully controlled converter with R and RL load.	C458.2
5.	Step down DC-DC chopper.	C458.3
6.	Step up DC-DC chopper.	C458.3
7.	IGBT based single phase PWM inverter.	C458.4
8.	Single phase AC Voltage controller.	C458.4
9.	Simulation of Single phase half controlled converter with RL load.	C458.5
10.	Simulation of Single phase fully controlled converter with RL load.	C458.5
11.	Simulation of step down DC-DC converter.	C458.5
12.	Simulation of step up DC-DC converter.	C458.5
13.	Simulation of single phase AC voltage controller.	C458.5
14.	Simulation of three phase AC voltage controller.	C458.5
	Total Hours	**60**

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE461	Power System Protection and Switchgear	PC	06	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C461.1	Understand and select proper protective scheme and type of earthing.	[U]
C461.2	Explain the operating principles of various relays.	[U]
C461.3	Suggest suitable protective scheme for the protection of various power system Apparatus.	[U]
C461.4	Understand the importance of static relays and numerical relays in power system Protection.	[U]
C461.5	Examine the merits and demerits and application areas of various circuit breakers.	[AP]

Course Contents

Unit – 1	**PROTECTION SCHEMES**	**9**

Significance and need for protective schemes – nature and causes of faults – types of faults Effects of faults - Zones of protection and essential qualities of protection – Types of Protection schemes - Power system Grounding and Methods of Grounding.

Unit – 2	**BASICS OF RELAYS**	**9**

Operating principles of relays –Universal torque equation - R-X diagram –Electromagnetic Relays – Over current, Directional and non-directional, Distance, Differential, Negative sequence and Under frequency relays.

Unit – 3	**OVERVIEW OF EQUIPMENT PROTECTION**	**9**

Current transformers and Potential transformers and their applications in protection schemes - Protection of transformer, generator, motor, bus bars and transmission line.

Unit – 4	**STATIC RELAYS AND NUMERICAL PROTECTION**	**9**

Static relays – Phase, Amplitude Comparators – Synthesis of various relays using Static comparators – Block diagram of Numerical relays – Over current protection, transformer differential protection, and distance protection of transmission lines.

Unit – 5	**CIRCUIT BREAKERS**	**9**

Physics of arcing phenomenon and arc interruption – DC and AC circuit breaking – re-striking voltage and recovery voltage - rate of rise of recovery voltage - current chopping - interruption of capacitive current - resistance switching - Types of circuit breakers – air blast, oil, SF_6 and vacuum circuit breakers – comparison of different circuit breakers – HVDC Breaker.

Total Hours	**45**

Text books:

1	Sunil S.Rao, 'Switchgear and Protection', Khanna Publishers, New Delhi, Four Edition,2010.
2	Badri Ram,B.H. Vishwakarma, 'Power System Protection and Switchgear', New Age International Pvt Ltd Publishers, Second Edition 2011.
3	B.Rabindranath and N.Chander, 'Power System Protection and Switchgear', New Age International (P) Ltd., Second Edition, 2018.

Reference Books:

1	Y.G.Paithankar and S.R.Bhide, 'Fundamentals of power system protection', Second Edition,Prentice Hall of India Pvt. Ltd., New Delhi, 2013.
2	C.L.Wadhwa, 'Electrical Power Systems', 6th Edition, New Age International (P) Ltd., 2018
3	Bhavesh Bhalja, R.P. Maheshwari, Nilesh G. Chotani,'Protection and Switchgear' Oxford University Press, 2nd Edition 2018.

Web References:

1	https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ee110
2	https://nptel.ac.in/courses/108105167
3	http://www.digimat.in/nptel/courses/video/108107167/L03.html

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EC362	Digital Signal Processing	ES	06	3	1	0	4

Course Outcomes

Upon completion of the course, students will be able to

C362.1	Identify the continuous and discrete-time signals and systems	[U]
C362.2	Apply the concept of DFT for transforming time domain signal to frequency domain signal	[AP]
C362.3	Apply different techniques in digital IIR filter design for the given set of specifications	[AP]
C362.4	Analyze the different techniques in digital FIR filter design for the given set of specifications	[AN]
C362.5	Illustrate the concept of multirate signal processing	[U]

Course Contents

Unit – 1 Signals and Systems **12**

Overview of signals and systems, Standard Discrete time signals- Classifications of Discrete time signals, Sampling and Sampling Theorem, Quantization and Coding- Aliasing, Effects of Aliasing - system properties (linearity, time-invariance, memory, causality, BIBO stability) - LTI systems described by linear constant coefficient difference equations (LCCDE) - impulse response and convolution.

Unit – 2 Discrete Fourier Transform **12**

System representation through differential equations, System representation through difference equations-Realization of discrete time systems: Direct form – I, Direct form – II, Cascade form, Parallel form- Discrete Fourier Transform (DFT), Calculation of DFT-DFT properties: Linearity, Periodicity, Circular convolution, Time reversal, Circular time shift, Parseval's theorem- DFT using DIT-FFT algorithm Calculation of DFT using DIT-FFT, DFT using DIF-FFT algorithm, Calculation of DFT using DIF-FFT algorithm, Inverse DFT, Calculation of IDFT

Unit – 3 IIR Filters **12**

Design procedure of Analog Butterworth, Chebyshev Filter- Frequency transformation technique, Need of Pre-warping, Pre- warping- Quantitative treatment of Bilinear transform technique, Impulse invariance technique - Design of IIR Butterworth digital filters using bilinear transform technique and impulse invariant method-. Design of IIR Chebyshev digital filters using bilinear transform technique and Impulse invariant technique-Realization of IIR filters

Unit – 4 FIR Filters **12**

Design procedure of FIR filter by window technique, Rectangular, Hamming, Hanning and Blackmann Windows, Kaiser window. Design of low pass FIR filter: Calculation of window coefficients, Design of high pass FIR filter: Calculation of filter coefficients, Design of band pass FIR filter: Calculation of window coefficients -Design of bandpass FIR filter: Calculation of filter coefficients, Design of band stop FIR filter: Determination of window coefficients, Design of band stop FIR filter: Determination of filter coefficients, Realization of FIR filters: Transversal realization structure, Linear phase realization structure, Polyphase realization structure, Cascade structure.

Unit – 5 Introduction to Multirate DSP **12**

Introduction -Spectrum of down sampled signal and up-sampled signal- Anti-imaging filter- Identities- Cascading sample rate converter, Transversal structure and Poly phase structure of Decimator, Interpolator., multistage implementation of sampling rate conversion, Implementation of narrow band low pass filter, Filter Banks.

Total Hours **60**

Textbooks:

1	A. V. Oppenheim and R. W. Schafer, "Discrete-Time Signal Processing", Prentice Hall, third edition, 2014.
2	J. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", Pearson, fourth edition, 2014.

Reference Books:

1	S. Haykin and B. V. Veen, "Signals and Systems", John Wiley and Sons, second edition, 2021
2	H. P. Hsu, "Signals and systems", Schaum's series, McGraw Hill Education, second edition, 2017.

Web References:	
1	https://onlinecourses.nptel.ac.in/noc24_ee16/
2	https://extension.ucsd.edu/courses-and-programs/signals-and-systems

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE466	Electrical Drives	PC	06	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C466.1	Understand electric drive characteristics, motor dynamics, stability, and motor selection.	[U]
C466.2	Understand converter/chopper fed DC motor drives and their control & four quadrant operation.	[U]
C466.3	Control methods for induction motor drives like V/f control and inverter operation.	[U]
C466.4	Understand synchronous motor drives, including PMSM and control techniques.	[U]
C466.5	Design controllers for electric drives using speed and current feedback.	[AP]

Course Contents

Unit – 1	**DRIVE CHARACTERISTICS**	**9**

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, starting & stopping – typical load torque characteristics – Selection of motor.

Unit – 2	**CONVERTER / CHOPPER FED DC MOTOR DRIVE**	**9**

Steady state analysis of the single and three phase converter fed separately excited DC motor drive – Continuous and discontinuous conduction – Time ratio and current limit control – 4 quadrant operation of converter / chopper fed drive.

Unit – 3	**INDUCTION MOTOR DRIVES**	**9**

Stator voltage control – energy efficient drive – v/f control – constant air gap flux – field weakening mode – voltage / current fed inverter – closed loop control-Applications.

Unit – 4	**SYNCHRONOUS MOTOR DRIVES**	**9**

V/f control and self-control of synchronous motor: Margin angle control and power factor control – Permanent magnet synchronous motor-Switched Reluctance motor.

Unit – 5	**DESIGN OF CONTROLLERS FOR DRIVES**	**9**

Transfer function for DC motor / load and converter – closed loop control with current and speed feedback – armature voltage control and field weakening mode – design of controllers; current controller and speed controller-converter selection and characteristics.

Total Hours	**45**

Textbooks:

1	Gopal K.Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 2nd Edition January 2010.
2	Bimal K.Bose. Modern Power Electronics and AC Drives, Pearson Education, 2002 1st Edition.
3	S.K.Pillai, A First course on Electrical Drives, Wiley Eastern Limited, 3rd Edition 2012.

Reference Books:

1	Murphy J.M.D and Turnbull, Thyristor Control of AC Motor, Pergamon Press, Oxford 1988, 1st Edition.
2	Gopal K.Dubey, Power semiconductor controlled Drives, Prentice Hall Inc., New Jersey,1989,1ST Edition.
3	R.Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Prentice hall of India, 2001, 1st Edition.

Web References:

1	https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_ee94
2	https://nptel.ac.in/courses/108108077
3	http://acl.digimat.in/nptel/courses/video/108104140/L01.html

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EC367	Microcontrollers and its Applications	ES	06	3	0	2	3

Course Outcomes
Upon completion of the course, students will be able to

C367.1	Understand the fundamentals of microprocessors, microcontrollers, and memory organization and embedded systems.	[U]
C367.2	Apply 8085 architecture and instruction set to develop simple assembly programs and basic interfacing.	[AP]
C367.3	Understand the 8051 architecture and develop basic assembly level programs	[U]
C367.4	Implement Embedded C programs to control I/O ports, timers, interrupts and serial communication in 8051 microcontrollers	[AP]
C367.5	Design basic microcontroller-based interfacing systems using peripherals such as LED, seven segment display, LCD, keypad and stepper motor for embedded applications.	[AP]

Course Contents

Unit – 1	**INTRODUCTION TO EMBEDDED SYSTEMS AND 8085 ARCHITECTURE**	**9**

Microprocessor vs Microcontroller – Basic components of a microprocessor system – Overview of embedded systemsFunctional block diagram OF 8085 – Memory interfacing-I/O ports and data transfer concepts – Timing Diagram — Interrupt structure

PRACTICAL:

1. Study and analyze the functional block diagram of the 8085 microprocessor, including registers, ALU, program counter, stack pointer, interrupt structure, and timing diagrams using a simulator or development kit.

Unit – 2	**8085 INSTRUCTION SET, PROGRAMMING&INTERFACING**	**9**

Instruction format and addressing modes — Assembly language format — Data transfer, data manipulation & control instructions – Programming: Loop structure with counting & Indexing – Look up table – Subroutine instructions, stack. Study of Architecture and programming of ICs: 8255, Interfacing Keyboard and Seven segment display, 8254 Timer/Counter

PRACTICAL:

1. Write and execute simple 8085 assembly programs for arithmetic operations and data transfer.
2. Interfacing of 8255 Programmable Peripheral Interface with 8085 for keyboard input and seven segment display output

Unit – 3	**INTRODUCTION TO 8051 MICROCONTROLLER**	**9**

Architecture of 8051 microcontroller – Functional block diagram – Internal RAM and ROM organization – Special Function Registers – Addressing modes – Instruction set – Assembly language programming – Simple programs using loops, counters and delay generation

PRACTICAL:

1. Introduction to Microcontroller Kit, and basic arithmetic operation (Addition, Subtraction, Multiplication & Division) ,Sorting of data- a) Ascending order b) Descending order

Unit – 4	**PERIPHERALS AND EMBEDDED C PROGRAMMING**	**9**

I/O port programming in 8051 – Timer and counter concepts – Timer programming – Interrupt structure and programming – Serial communication basics. Introduction to Embedded C – Structure of Embedded C program–Data types and Time Delays in C – Logic Operations in C – Data conversion in C – Accessing ROM – Data Serialization – I/O programing – Interrupt programming in C

PRACTICAL:

1. Embedded C program for 8051 to perform I/O port programming with LED control and generate time delay using timer programming
2. Embedded C program to demonstrate interrupt handling and serial communication (UART) in 8051 for data transmission between microcontroller and PC

Unit – 5	**MICROCONTROLLER INTERFACING AND APPLICATIONS**	**9**

Interfacing concepts – LED and switch interfacing – Seven segment display interfacing – LCD interfacing – Keypad interfacing – Stepper motor interfacing

PRACTICAL:

1. Control of stepper motor

2. Interface a 16×2 LCD display with the 8051 microcontroller and write a program to display characters/messages on the LCD	
Total Theory Hours	**45**
Total Practical Hours	**30**
Textbooks:	
1	Microprocessor Architecture, Programming and Applications with the 8085 Ramesh S. Gaonkar, Penram International Publishing, 6th Edition / Reprint 2013
2	The 8051 Microcontroller and Embedded Systems: Using Assembly and C Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin D. McKinlay, Pearson Education, 2nd Edition, 2013
Reference Books:	
1	The 8051 Microcontroller: Architecture, Programming and Applications Kenneth J. Ayala, Cengage Learning, 2nd Edition, 2004
2	Microprocessors and Interfacing: Programming and HardwareDouglas V. Hall, McGraw-Hill Education, 2nd Edition, 1992
3	Embedded Systems: Architecture, Programming and Design Raj Kamal, McGraw-Hill Education, 2nd Edition, 2008
4	Embedded Systems: Introduction to ARM Cortex-M Microcontrollers Jonathan W. Valvano, CreateSpace Independent Publishing, 5th Edition, 2017
Web References:	
1	https://onlinecourses.nptel.ac.in/noc22_ee12/preview

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24HS171	HUMAN VALUES AND ETHICS	HS	07	2	0	0	2

Course Outcomes

Upon completion of the course, students will be able to

C171.1	Understand value education and develop a sense of self respect	[U]
C171.2	Develop an understanding towards to human values and respect others.	[U]
C171.3	Acquire ethical and leadership qualities in managing self and others	[U]
C171.4	Gain clarity on personal and professional ethics	[U]
C171.5	Understand the core values that shape the ethical behavior of an engineer	[U]

Course Contents

Unit – 1	**VALUE EDUCATION**	**6**

Value Education: Definition, Concept and Need for Value Education - The Content and Process of Value Education-Self-Exploration as a means of Value Education-Happiness and Prosperity as parts of Value Education

Unit – 2	**HUMAN VALUES**	**6**

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality

Unit – 3	**ETHICS & LEADERSHIP QUALITIES**	**6**

Ethical values: Ethics, Social Ethics, Public Policy - Leadership qualities: Integrity, Character, Courage - Personality development. Inter-culture Tolerance

Unit – 4	**INTRODUCTION TO PROFESSIONAL ETHICS**	**6**

Basic concepts, Governing Ethics, Personal and Professional Ethics, Ethical Dilemmas, AI ethics, Life Skill, Professional Association, Professional Risks, Professional Accountabilities, Professional Success

Unit – 5	**ENGINEERING ETHICS**	**6**

The History of Ethics-Purposes for Engineering Ethics-Engineering Ethics- Consensus and Controversy –Professional and Professionalism –Professional Roles to be played by an Engineer–Self Interest, Customs and Religion-Uses of Ethical Theories-Types of Inquiry.

Total Hours	**30**

Textbooks:

1	Jayasree Suresh and B. S. Raghavan, Human Values and Professional Ethics, 3rd Edition, S. Chand Publications,2009
2	Mike W Martin and Roland Schinzinger, “Ethics in Engineering”, 4th Edition, McGraw-Hill, New York 2017.
3	Govindarajan M, Natarajan S and Senthil Kumar VS, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2013.

Reference Books:

1	P S R Murthy : “Indian Culture, Values and Professional Ethics”, 2nd Edition, B S Publications, Hyderabad. 2013
2	A. Alavudden, R. Kalil Rahaman & M . Jayakumaran : “Professional Ethics & Human Values”, 1st Edition, University Science Press (An Imprint of Laxmi Publications Pvt Ltd., Chennai, Bangalore. 2008
3	Ethics in Engineering” by Mike W. Martin and Roland Schinzinger – Tata McGraw-Hill – 2003.
4	“Engineering Ethics” by Harris, Pritchard and Rabins, CENGAGE Learning, India Edition, 2009.

Web References:

1	https://courseware.cutm.ac.in/wp-content/uploads/2020/05/Professional-Ethics-and-Human-Values-by-R.S-NAAGARAZAN.pdf
2	https://www.scribd.com/document/436935802/Engineering-Ethics

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24EE871	Industrial Practices	07	IP	0	0	0	2

Course Objectives

The student should be made to:

1. Understand the working environment, organizational structure, and safety practices followed in industries.
2. Gain practical exposure to industrial processes, equipment, and engineering applications related to Electrical and Electronics Engineering.
3. Apply theoretical knowledge to real-world engineering problems through industrial observation and participation.
4. Develop professional ethics, communication skills, teamwork, and problem-solving abilities in an industrial environment.
5. Prepare a technical report and present the knowledge and experience gained during industrial training.

Course Outcomes

Upon completion of the course, students shall have ability to

C871.1	Explain the organizational structure, industrial processes, safety practices, and professional ethics followed in engineering industries.	AP
C871.2	Demonstrate an understanding of industrial equipment, manufacturing processes, testing procedures, and engineering practices relevant to Electrical and Electronics Engineering.	AP
C871.3	Apply engineering knowledge to analyze industrial operations and identify practical solutions to engineering problems.	AP
C871.4	Prepare a comprehensive industrial training report and effectively communicate the learning outcomes through presentations and discussions.	AP
C871.5	Recognize the importance of continuous learning, technological advancements, teamwork, and sustainable engineering practices for professional development.	AP

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24EE771	PROJECT WORK PHASE I	07	PW	0	0	4	2

Course Objectives

1. To identify a relevant engineering problem through literature survey and industry needs.
2. To formulate clear project objectives and define the scope of the proposed work.
3. To develop the methodology, system architecture, and implementation plan.
4. To enhance technical knowledge through design, simulation, and feasibility analysis.
5. To improve teamwork, technical documentation, and presentation skills.

Course Outcomes

Upon completion of the course, students shall have ability to

C771.1	Identify, formulate, and analyze a real-world engineering problem using principles of science and engineering.	AP
C771.2	Conduct a comprehensive literature survey and select appropriate engineering tools, software, and methodologies for the proposed project.	AP
C771.3	Design the proposed system architecture, prepare implementation methodology, and perform preliminary simulation/design validation.	AP
C771.4	Demonstrate effective technical communication through project proposal, review presentations, and documentation while working collaboratively in a team.	AP
C771.5	Recognize ethical, societal, environmental, and sustainability aspects related to the proposed project and plan for lifelong learning.	AP

Course Code	Course Name	Semester	Category	Hours/Week			C
				L	T	P	
24EE781	PROJECT WORK PHASE II	08	PW	0	0	24	12

Course Objectives

1. To implement the proposed project through hardware/software development.
2. To validate the performance of the developed system using appropriate testing methods.
3. To analyze results and compare them with existing techniques.
4. To prepare a comprehensive technical report and present the project effectively.
5. To demonstrate professional ethics, teamwork, and lifelong learning abilities.

Course Outcomes

Upon completion of the course, students shall have ability to

C781.1	Develop and implement the proposed engineering solution using appropriate hardware, software, and engineering tools.	AP
C781.2	Test, analyze, and validate the performance of the developed system to solve engineering and societal problems.	AP
C781.3	Evaluate project outcomes through experimentation, data analysis, optimization, and interpretation of results.	AP
C781.4	Prepare a professional project report and effectively present the project findings while demonstrating leadership, teamwork, and ethical responsibilities.	AP
C781.5	Demonstrate awareness of emerging technologies, sustainable engineering practices, and the importance of lifelong learning for continuous professional development.	AP

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE501	Utilization and Conservation of Electrical Energy	PE	-	3	0	0	3

Course Outcomes **Upon completion of the course, students will be able to**		**RBT**
C501.1	Explain electric drive fundamentals, traction systems, and motor characteristics	[U]
C501.2	Understand illumination concepts, light sources, and lighting system design.	[U]
C501.3	Understand electric heating methods and welding techniques.	[U]
C501.4	Examine energy conservation methods and power factor improvement techniques.	[AP]
C501.5	Explain electrical energy utilization concepts in domestic systems and appliances.	[U]

Course Contents

Unit – 1	**Electric Drives and Traction**	**9 Hrs**

Fundamentals of electric drive - choice of an electric motor - application of motors for particular services traction generator set, traction motors, power transformers - characteristic features of traction motor - systems of railway electrification - electric braking - train movement and energy consumption - traction motor control - track equipment and collection gear.

Unit – 2	**Illumination**	**9 Hrs**

Introduction - definition and meaning of terms used in illumination engineering - classification of light sources - incandescent lamps, sodium vapour lamps, mercury vapour lamps, fluorescent lamps – design of illumination systems - indoor lighting schemes - factory lighting halls - outdoor lighting schemes - flood lighting - street lighting - energy saving lamps, LED.

Unit – 3	**Heating and Welding**	**9 Hrs**

Introduction - advantages of electric heating – modes of heat transfer - methods of electric heating resistance heating - arc furnaces - induction heating - dielectric heating - electric welding – types resistance welding - arc welding - power supply for arc welding - radiation welding.

Unit – 4	**Energy Conservation and its Importance**	**9 Hrs**

Energy conservation act 2001 and its Features-Review of Industrial Energy Conservation-Energy conservation in electrical Industries-Simulation study of energy conservation using power factor controller. (Three phase circuit simulation with and without capacitor)

Unit – 5	**Domestic Utilization of Electrical Energy**	**9 Hrs**

House wiring - working principle of air conditioning system, Induction based appliances, Online and OFF line UPS, Batteries - Power quality aspects – nonlinear and domestic loads – Earthing system for Domestic, Industrial and Substation.

Total Hours	**45**

Textbooks:

1	N.V. Surya narayana, “Utilisation of Electric Power”, Wiley Eastern Limited, New Age International Limited, 1994 & Second Edition 2017 Feb.
2	J.B. Gupta, “Utilisation Electric power and Electric Traction”, S.K.Kataria and sons, 2000 2012th Edition, 2013, January.
3	G.D.Rai, “Non-Conventional Energy Sources”, Khanna publications Ltd., New Delhi 1998
4	D.P.Kothari, K.C.Singal, Rakesh Ranjan, “Renewable Energy Sources and Emerging Technologies”, PHI Learing Private Limited, 3rd Edition 2022.
5	Industrial Energy Conservation, Volume I-II, S C Bhatia, Sarvesh Devraj, Energy conservation and Managment by Akshay A pujara1st edition, June 2018.

Reference Books:

1	R.K.Rajput, Utilisation of Electric Power, Laxmi publications 2nd Edition 2016.
2	C.L.Wadhwa, “Generation, Distribution and Utilisation of Electrical Energy”, New Age international Pvt. Ltd., 3rd Edition, 2015 January.

Web References:

1	https://onlinecourses.nptel.ac.in/noc23_ch76/preview
2	https://www.coursera.org/learn/renewable-power-electricity-systems

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE502	Renewable Energy Systems	PE	-	3	0	0	3

Course Outcomes **Upon completion of the course, students will be able to**		**RBT**
C502.1	Understand renewable energy sources, sustainability, and energy scenario.	[U]
C502.2	Apply principles of wind energy and WPP operation.	[AP]
C502.3	Examine solar PV and thermal systems and their performance.	[AP]
C502.4	Infer biomass, geothermal and small hydro energy systems.	[U]
C502.5	Evaluate emerging energy sources and hybrid energy systems.	[U]

Course Contents

Unit – 1	**Renewable Energy Resources**	**9 Hrs**

Environmental consequences of fossil fuel use, Importance of renewable sources of energy, Sustainable Design and development, Types of RE sources, Limitations of RE sources, Present Indian and international energy scenario of conventional and RE sources.

Unit – 2	**Wind Energy**	**9 Hrs**

Power in the Wind – Types of Wind Power Plants(WPPs)–Components of WPPs-Working of WPPs-Sitting of WPPs-Grid integration issues of WPPs.

Unit – 3	**Solar PV and Thermal Systems**	**9 Hrs**

Solar Radiation, Radiation Measurement, Solar Thermal Power Plant, Central Receiver Power Plants, Solar Ponds.- Thermal Energy storage system with PCM- Solar Photovoltaic systems : Basic Principle of SPV conversion – Types of PV Systems- Types of Solar Cells, Photovoltaic cell concepts: Cell, module, array ,PV Module I-V Characteristics, Efficiency & Quality of the Cell, series and parallel connections, maximum power point tracking, Applications.

Unit – 4	**Biomass Energy**	**9 Hrs**

Introduction-Bio mass resources –Energy from Bio mass: conversion processes-Biomass Cogeneration-Environmental Benefits. Geothermal Energy: Basics, Direct Use, Geothermal Electricity. Mini/micro hydro power: Classification of hydropower schemes, Classification of water turbine, Turbine theory, Essential components of hydroelectric system.

Unit – 5	**Other Energy Sources**	**9 Hrs**

Tidal Energy: Energy from the tides, Barrage and Non Barrage Tidal power systems. Wave Energy: Energy from waves, wave power devices. Ocean Thermal Energy Conversion (OTEC) - Hydrogen Production and Storage- Fuel cell – Construction and Working Principle - Applications - Energy Storage System- Hybrid Energy Systems.

	Total Hours	**45**

Textbooks:

1	John Twid well and Tony Weir, “Renewable Energy Resources”, 3rd Edition, Routledge, 2015
2	B.H. Khan, “Non-Conventional Energy Resources”, 2nd Edition, Tata McGraw Hill, New Delhi, 2010
3	Rai, G.D, “Non Conventional Energy Sources”, Khanna Publishers, 2010.

Reference Books:

1	G.N. Tiwari, “Solar Energy”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
2	Aldo Vieira Da Rosa, “Fundamentals of Renewable Energy Processes”, Academia Press, 2012.
3	G. Masters, “Renewable and Efficient Electric Power Systems”, IEEE-Wiley Publishers, 2013.

Web References:

1	http://unfccc.int/kyoto_protocol/items/2830.php
2	https://www.coursera.org/learn/wind-energy
3	https://www.edx.org/course/solar-energy-delftx-et3034x-0

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE503	High Voltage Engineering	PE	-	3	0	0	3

Course Outcomes **Upon completion of the course, students will be able to**		**RBT**
C503.1	Understand concepts of over voltages and protection methods in power systems.	[U]
C503.2	Apply dielectric properties and breakdown mechanisms in electrical systems.	[AP]
C503.3	Understand techniques for generation and measurement of high voltages and currents.	[U]
C503.4	Apply high voltage testing methods and insulation coordination practices.	[AP]
C503.5	Understand high voltage engineering concepts in industrial applications.	[U]

Course Contents

Unit – 1	**Over Voltages in Electrical Power Systems**	**9 Hrs**

Causes of over voltages and its effects on power system – Lightning, switching surges and temporary over voltages – Reflection and Refraction of Travelling waves- protection against over voltages_ Insulation Coordination.

Unit – 2	**Dielectric Breakdown**	**9 Hrs**

Properties of Dielectric materials - Gaseous breakdown in uniform and non-uniform fields –Corona discharges – Vacuum breakdown – Conduction and breakdown in pure and commercial liquids, Maintenance of oil Quality – Breakdown mechanisms in solid and composite dielectrics- Applications of insulating materials in electrical equipment.

Unit – 3	**Generation and Measurements of High Voltages and High Currents**	**9 Hrs**

Generation of High DC, AC, impulse voltages and currents - Analysis of DC/AC and Impulse generator circuits - Tripping and control of impulse generators, Measurement of High voltages and High currents – High Resistance with series ammeter – Dividers - Resistance, Capacitance and Mixed dividers - Peak Voltmeter, Generating Voltmeters, Electrostatic Voltmeters – Sphere Gaps, High current shunts- Digital techniques in high voltage measurement.

Unit – 4	**High Voltage Testing and Insulation Coordination**	**9 Hrs**

High voltage testing of electrical power apparatus- International and Indian standards – Power frequency, impulse voltage and DC testing of Insulators, circuit breakers, bushing, isolators and transformers - Insulation Coordination.

Unit – 5	**Application in Industry**	**9 Hrs**

Introduction – electrostatic applications- electrostatic precipitation, separation, painting / coating, spraying, imaging, printing, Transport of materials – manufacturing of sand paper – Smoke particle detector – Electrostatic spinning, pumping, propulsion – Ozone generation – Biomedical applications.

Total Hours	**45**

Textbooks:

1	M.S.Naidu and V. Kamaraju, 'High Voltage Engineering', Tata McGraw Hill, Fifth Edition, 2013.
2	C.L. Wadhwa, 'High voltage Engineering', New Age International Publishers, Fourth Edition, 2020.

Reference Books:

1	C.L.Wadhwa, High voltage Engineering, New Age International Publishers, Fourth Edition, 2020
2	Mazen Abdel – Salam, Hussein Anis, Ahdab A-Morshedy, RoshdayRadwan, High Voltage Engineering – Theory &Practice, Second Edition, Taylor & Francis Gourp, 2019
3	Subir Ray." An Introduction to High Voltage Engineering "PHI Learning Private Limited, New Delhi, Second Edition-2011

Web References:

1	https://archive.nptel.ac.in/courses/108/104/108104048/
2	https://www.reddit.com/r/ElectricalEngineering/comments/102du43/high_voltage_engineering_resources/?rdt=44189

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE504	Energy Management and Auditing	PE	-	3	0	0	3

Course Outcomes:		
C504.1	Demonstrate understanding of key provisions of the Indian Energy Systems and Energy Conservation Act.	[U]
C504.2	Differentiate and compare between various types of energy audits and select suitable projects based on financial evaluation techniques.	[AP]
C504.3	Apply Energy Audit Concepts in Real-World Industrial and Commercial Electrical Systems.	[AP]
C504.4	Explain Energy-Efficient Solutions in Motors and Fans.	[AP]
C504.5	Understand Energy-Efficient Solutions in Pumps and Lighting Systems.	[AP]

Course Contents

Unit – 1	**Energy Scenario**	**9**
Indian Energy Scenario-Sector wise energy consumption in India-Integrated Energy Policy-Energy Intensity on Purchasing Power Parity (PPP)-Electricity Pricing in India-Energy Security-Energy Conservation Act 2001, Energy Conservation (Amendment)Act 2010, Electricity Act 2003.		
Unit – 2	**Energy Audit & Financial Management**	**9**
Energy Audit: Need for Energy Audit-Types of Energy Audit and Approach-Understanding Energy Costs-Maximizing System Efficiencies-Optimizing Input Energy Requirements-Instruments and Metering for Energy Audit-Financial Analysis Techniques: Simple Payback Period, Return on Investment, Net Present Value, Internal Rate of Return.		
Unit – 3	**Energy Audit in Electrical Systems**	**9**
Electrical Load Management and Maximum Demand Control-Power Factor Improvement and Benefits-Distribution Losses in Industrial Systems-Assessment of Transmission and Distribution Losses in Power Systems-Estimation of Technical Losses in Distribution Systems-Demand Side Management-Analysis of Electrical Power Systems.		
Unit – 4	**Energy Audit in Motors and Fans**	**9**
Motor: Motor Efficiency-Energy Efficient Motors-Factors Affecting Energy Efficiency and Minimizing Motor Losses in Operation-Rewinding Effects on Energy Efficiency-Fan: Fan Types-Fan Performance Evaluation and Efficient System Operation-Fan Design and Selection Criteria-Flow Control Strategy-Fan Performance Assessment-Energy Saving Opportunities.		
Unit – 5	**Energy Audit in Pumps and Lighting Systems**	**9**
Pumps: Pump Types-System Characteristics-Pump Curves-Factors Affecting Pump Performance-Efficient Pumping System Operation-Flow Control Strategies-Lighting Systems: Lighting Source and Lamp Types-Recommended Illuminance levels various Tasks/Activities/Locations-Methods of Calculating Illuminance-General Energy Saving Opportunities-Energy Efficient Lighting Controls.		
	Total Hours	**45**

Textbooks:	
1	'Energy Managers and Energy Auditors Guide book', Bureau of Energy Efficiency, 2006.
Reference Books:	
1	Mehmet Kanoglu, Yunus A Cengel, "Energy Efficiency and Management for Engineers", McGraw-Hill Education, First Edition, 2020.
2	Sonal Desai, 'Handbook of Energy Audit', McGraw Hill Education (India) Private Limited, 2015.
3	Thomas D.Eastop, 'Energy Efficiency: For Engineers and Technologists', Longman Scientific & Technical, 1990, 1st Edition.
4	Larry C. Witte, Philip S.Schmidt, David R.Brown, 'Industrial Energy Management and Utilization', Springer Berlin Heidelberg, 1988.
Web References:	
1	http://digimat.in/nptel/courses/video/124105552/L31.html
2	https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr25_ed50

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE505	Power Quality	PE	-	3	0	0	3

Course Outcomes **Upon completion of the course, students will be able to**		**RBT**
C505.1	Understand power quality issues and standards.	[U]
C505.2	Apply system analysis for linear and nonlinear loads.	[AP]
C505.3	Infer harmonic mitigation techniques.	[U]
C505.4	Apply DSTATCOM control strategies for compensation.	[AP]
C505.5	Evaluate series compensation techniques like DVR and UPQC.	[AP]

Course Contents

Unit – 1	**Introduction**	**9 Hrs**

Introduction – Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Non-linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.

Unit – 2	**Analysis of Single Phase And Three Phase System**	**9 Hrs**

Single phase linear and non-linear loads – single phase sinusoidal, non-sinusoidal source – supplying linear and nonlinear loads – three phase balanced system – three phase unbalanced system – three phase unbalanced and distorted source supplying non-linear loads – concept of power factor – three phase- three wire – three phase - four wire system.

Unit – 3	**Mitigation of Power System Harmonics**	**9 Hrs**

Introduction - Principle of Harmonic Filters – Series-Tuned Filters – Double Band-Pass Filters – damped Filters – Detuned Filters – Active Filters – Power Converters – Harmonic Filter Design – Tuned Filter – Second-Order Damped Filter – Impedance Plots for Filter Banks – Impedance Plots for a Three-Branch 33 kV Filter.

Unit – 4	**Load Compensation Using DSTATCOM**	**9 Hrs**

Compensating single – phase loads – Ideal three phase shunt compensator structure – generating reference currents using instantaneous PQ theory – Instantaneous symmetrical components theory – Generating reference currents when the source is unbalanced –Realization and control of DSTATCOM – DSTATCOM in Voltage control mode.

Unit – 5	**Series Compensation of Power Distribution System**	**9 Hrs**

Rectifier supported DVR – DC Capacitor supported DVR – DVR Structure – Voltage Restoration – Series Active Filter – Unified Power Quality Conditioner.

	Total Hours	**45**

Textbooks:

1	Arindam Ghosh and Gerad Ledwich “Power Quality Enhancement Using Custom Power Devices”, Kluwer Academic Publishers, First Edition,2012
2	G.T.Heydt, “Electric Power Quality”, Stars in a Circle Publication, Second Edition, 2011.
3	George J. Wakileh, “Power System Harmonics – Fundamentals, Analysis and Filter Design”, Springer – Verlag Berlin Heidelberg, New York, 2019.

Reference Books:

1	R.C.Duggan “Electric Power Systems Quality”, Tata MC Graw Hill Publishers, Third Edition, 2012
2	Arrillga “Power System Harmonics”, John Wiely and Sons, 2003 2nd Edition.
3	Derek A.Paice “Power Electronic Converter Harmonics” IEEE Press, 1995, Wiley – IEE Press 1999, 18th Edition.

Web References:

1	https://archive.nptel.ac.in/courses/108/102/108102179/
2	https://americas.hammondpowersolutions.com/en/resources/introduction-to-power-quality

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE506	Power System Operation and Control	PE	-	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C506.1	Understand power system operation, load forecasting, and tariff concepts.	[U]
C506.2	Apply load frequency control techniques for single and multi-area systems.	[AP]
C506.3	Examine reactive power control and voltage regulation methods.	[AP]
C506.4	Evaluate economic operation of power systems including dispatch and unit commitment.	[AP]
C506.5	Understand computer-aided control methods like SCADA, EMS, and state estimation.	[U]

Course Contents

Unit – 1 Introduction **9 Hrs**

Power scenario in Indian grid – National and Regional load dispatching centres – Requirements of good power system – Necessity of voltage and frequency regulation – real power vs frequency and reactive power vs voltage control loops - System load variation, load curves – Load forecasting – Computational methods in load forecasting – Load shedding and Islanding – deregulation - Basics of electrical energy tariff.

Unit – 2 Real Power Frequency Control **9 Hrs**

Basics of speed governing mechanisms and modeling – Speed regulation of two generators in parallel Load Frequency Control (LFC) of single area system – Static and dynamic analysis – LFC of two area system –Tie line modeling – Block diagram representation of two area system – Static and dynamic analysis – Tie line with frequency bias control – State variable model – Integration of economic dispatch control with LFC.

Unit – 3 Reactive Power – Voltage Control **9 Hrs**

Generation and absorption of reactive power – Basics of reactive power control – Automatic Voltage Regulator (AVR) – Brushless AC excitation system – Block diagram representation of AVR loop static and dynamic analysis – Stability compensation – Voltage drop in transmission line – Methods of reactive power injection – Tap changing transformer, SVC and STATCOM for voltage control.

Unit – 4 Economic Operation of Power System **9 Hrs**

Statement of economic dispatch problem – Input and output characteristics of thermal plant incremental cost curve – Optimal operation of thermal units without and with transmission losses (no derivation of transmission loss coefficients) – Lambda–iteration method – Base point and participation factors method. Statement of Unit Commitment (UC) problem – Constraints on UC problem – Solution of UC problem using priority list – Special aspects of short term and long-term hydrothermal scheduling problems.

Unit – 5 Computer Aided Control of Power System **9 Hrs**

Need of computer control of power system – Concept of energy control centers and functions – PMU system monitoring, Data acquisition and controls – System hardware configurations – SCADA and EMS functions – State estimation – Measurements and errors – Weighted least square estimation – Various operating states – State transition diagram.

Total Hours 45

Text books:

1	Olle. I. Elgerd, 'Electric Energy Systems theory – An introduction', McGraw Hill Education Pvt. Ltd., New Delhi, 2nd edition, 2017.
2	Allen. J. Wood and Bruce F. Wollen berg, 'Power Generation, Operation and Control', John Wiley & Sons, Inc., 3rd edition, 2013.

Reference Books:

1	Kothari D.P. and Nagrath I.J., 'Power System Engineering', Tata McGraw– Hill Education, Second Edition, Reprint 2018.
2	Hadi Saadat, 'Power System Analysis', McGraw Hill Education Pvt. Ltd., New Delhi, 23rd reprint, 2015.
3	Kundur P., 'Power System Stability and Control, McGraw Hill Education Pvt. Ltd., New Delhi,

	12th reprint, 2015.
4	B.M. Weedy, B.J. Cory et al, 'Electric Power systems', Wiley, Fifth Edition, 2012.
Web References:	
1	https://archive.nptel.ac.in/courses/108/104/108104052/
2	https://www.swinburne.edu.au/course/unit/e/eee40007/

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE507	Power Electronics for Renewable Energy Systems	PE	-	3	0	0	3

Course Outcomes **Upon completion of the course, students will be able to**		**RBT**
C507.1	Understand concepts of renewable energy systems and environmental aspects.	[U]
C507.2	Explain the operation and analysis of electrical machines in wind energy systems.	[U]
C507.3	Infer power converters and analyze solar PV system performance.	[AP]
C507.4	Examine power converter techniques in wind energy conversion systems.	[AP]
C507.5	Apply hybrid renewable energy system concepts and MPPT techniques.	[AP]

Course Contents

Unit – 1	**Renewable Energy Resources and Conversion Technologies**	**9 Hrs**

Classification of Energy Sources – Importance of Non-conventional energy sources – Advantages and disadvantages of conventional energy sources - Environmental aspects of energy - Impacts of renewable energy generation on the environment - Qualitative study of renewable energy resources: Ocean energy, Biomass energy, Hydrogen energy, - Solar Photovoltaic (PV), Fuel cells: Operating principles and characteristics, Wind Energy: Nature of wind, Types, control strategy, operating area.

Unit – 2	**Electrical Generators for Wind Energy Systems**	**9 Hrs**

Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) - Permanent Magnet Synchronous Generator (PMSG).

Unit – 3	**Solar Photovoltaic Systems and Power Electronic Converters**	**9 Hrs**

Power Converters: Line commutated converters (inversion-mode) - Boost and buck-boost converters-selection of inverter, battery sizing, array sizing. Simulation of line commutated converters, buck/boost converters. Analysis: Block diagram of the solar PV systems - Types of Solar PV systems: Stand-alone PV systems, Grid integrated solar PV Systems - Grid Connection Issues.

Unit – 4	**Grid-Connected Wind Energy Conversion Systems**	**9 Hrs**

Power Converters: Three-phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid-Interactive Inverters - Matrix converter.

Unit – 5	**Hybrid Renewable Energy Systems and MPPT Techniques**	**9 Hrs**

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Diesel-PV, Wind-PV, Micro hydel-PV and Biomass-Diesel systems - Maximum Power Point Tracking (MPPT).

Total Hours	**45**

Text books:

1	S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 2009, 7th impression.
2	Rashid .M. H “Power electronics Hand book”, Academic press, 4th Edition,2017
3	Rai. G.D, “Non-conventional energy sources”, Khanna publishers, 6th Edition, 2017.

Reference Books:

1	Rai. G.D,” Solar energy utilization”, Khanna publishers, 5th Edition, 2008.
2	Gray, L. Johnson, “Wind energy system”, prentice hall of India, 4th Edition,2017.
3	H. Khan "Non-conventional Energy sources,, Tata McGraw-hill Publishing Company, New Delhi, 2017, 3rd Edition.

Web References:

1	https://onlinelibrary.wiley.com/doi/book/10.1002/9781118755525
2	https://ieeexplore.ieee.org/document/4915139

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE508	Advanced Power Semiconductor Devices	PE	-	3	0	0	3

Course Outcomes **Upon completion of the course, students will be able to**		**RBT**
C508.1	Understand the concepts of power semiconductor devices	[U]
C508.2	Understand the static and dynamic characteristics of current controlled power semiconductor devices	[U]
C508.3	Understand the static and dynamic characteristics of voltage controlled power semiconductor devices	[U]
C508.4	Understand the control and firing circuit for different devices.	[U]
C508.5	Understand thermal protection of power electronic circuits	[U]

Course Contents

Unit – I	**Introduction**	**9 Hrs**

Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); Device selection strategy – On-state and switching losses – EMI due to switching - Power diodes - Types, forward and reverse characteristics, switching characteristics – rating.

Unit – II	**Current Controlled Devices**	**9 Hrs**

BJT's – Construction, static characteristics, switching characteristics; Negative temperature coefficient and secondary breakdown; Power Darlington - Thyristors – Physical and electrical principle underlying operating mode, Two transistor analogy – concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; series and parallel operation; comparison of BJT and Thyristor – steady state and dynamic models of BJT & Thyristor.

Unit – III	**Voltage Controlled Devices**	**9 Hrs**

Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs - Basics of GTO, MCT, FCT, RCT and IGCT.

Unit – IV	**Firing and Protecting Circuits**	**9 Hrs**

Necessity of isolation, pulse transformer, opto coupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. - Over voltage, over current and gate protections; Design of snubbers.

Unit – V	**Thermal Protection**	**9 Hrs**

Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapour – phase cooling; Guidance for hear sink selection – Thermal resistance and impedance –Electrical analogy of thermal components, heat sink types and design – Mounting types.

	Total Hours	**45**

Text books:

1	Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronics Converters, Applications and Design", 3rd edition, John Wiley &Sons edition 2011.
2	Rashid M.H., " Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004.

Reference Books:

1	MD Singh and K.B Khanchandani, "Power Electronics", Tata McGraw Hill, 2001.

Web References:

1	https://www.google.co.in/books/edition/Advanced_Power_Semiconductor_Devices/Q34eAQAAIAAJ?hl=en
2	https://ieeexplore.ieee.org/document/7961138
3	https://archive.nptel.ac.in/courses/108/107/108107128/

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE509	Embedded control of Electrical Drives	PE	-	3	0	0	3

Course Outcomes
Upon completion of the course, students will be able to

C509.1	Understand electric drives, their classification, and optimization techniques	[U]
C509.2	Describe embedded systems, sensors, and IoT applications in motor control.	[U]
C509.3	Explain control techniques for three-phase induction motor drives.	[U]
C509.4	Understand control methods for BLDC motor drives using embedded systems.	[U]
C509.5	Understand control strategies for SRM motor drives using embedded systems.	[U]

Course Contents

Unit – 1	**Introduction to Electric Drives**	**9 Hrs**
Electric drives and its classification-Four-quadrant drive-Solid State Controlled Drives-Machine learning and optimization techniques for electrical drives.		
Unit – 2	**Embedded System for Motor Control**	**9 Hrs**
Embedded Processors choice for motor control- Sensors and interface modules for Electric drives-IoT for Electrical drives applications		
Unit – 3	**Induction Motor Control**	**9 Hrs**
Speed control methods-PWM techniques- VSI fed three-phase induction motor- Fuzzy logic Based speed control for three-phase induction motor- Embedded processor based three phase induction motor speed control.		
Unit – 4	**BLDC Motor control**	**9 Hrs**
Overview of BLDC Motor -Speed control methods -PWM techniques- Embedded processor based BDLC motor speed control.		
Unit – 5	**SRM Motor control**	**9 Hrs**
Overview of SRM Motor -Speed control methods -PWM techniques- Embedded processor based SRM motor speed control.		
	Total Hours	**45**

Text books:

1	R.Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", Prentice-Hall of India Pvt.Ltd., New Delhi,2010, 1st Edition.
2	Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization" Willey, 2007, 1st Edition.
3	Vedam Subramanyam, "Electric Drives – Concepts and Applications", Tata McGraw- Hill publishing company Ltd., New Delhi, 2002, 2nd Edition.

Reference Books:

1	K. Venkataratnam ,Special Electrical Machines, Universities Press, 2014, 1st Edition.
2	Steve Furber, 'ARM system on chip architecture', Addision Wesley, 2nd Edition 2015.
3	Ron Sass and AnderewG.Schmidt, " Embedded System design with platform FPGAs: Principles and Practices", Elsevier, 2010, 1st Edition.

Web References:

1	https://archive.nptel.ac.in/courses/108/104/108104140/
2	https://www.e3sconferences.org/articles/e3sconf/pdf/2019/13/e3sconf_SeFet2019_01004.pdf
3	http://kaliasgoldmedal.yolasite.com/resources/SEM/SRM.pdf

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE510	Analysis of Power Converters	PE	-	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C510.1	Understand single-phase AC-DC converters under various loads and operating modes.	[U]
C510.2	Examine performance of three-phase AC-DC converters and their applications.	[U]
C510.3	Understand operation and PWM control of single-phase inverters.	[U]
C510.4	Analyze three-phase inverters and voltage control techniques.	[AN]
C510.5	Compare multilevel inverters and study modern inverter technologies.	[AP]

Course Contents

Unit – 1	**Single Phase AC-DC Converter**	**9 Hrs**

Static Characteristics of power diode, SCR and GTO, half controlled and fully controlled converters with R-L, R-L-E loads and freewheeling diodes – continuous and discontinuous modes of operation - inverter operation and its limit –Sequence control of converters – performance parameters – effect of source impedance and overlap-reactive power and power balance in converter circuit.

Unit – 2	**Three Phase AC-DC Converter**	**9 Hrs**

Half controlled and fully controlled converters with R, R-L, R-L-E loads and freewheeling diodes – inverter operation and its limit – performance parameters – effect of source impedance and overlap - 12 pulse converter –Applications - Excitation system, DC drive system.

Unit – 3	**Single Phase Inverters**	**9 Hrs**

Introduction to self-commutated switches : MOSFET and IGBT - Principle of operation of half and full bridge inverters – Performance parameters – Voltage control of single phase inverters using various PWM techniques – various harmonic elimination techniques – Design of UPS - VSR operation

Unit – 4	**Three Phase Inverters**	**9 Hrs**

180 degree and 120 degree conduction mode inverters with star and delta connected loads – voltage control of three phase inverters: single, multi pulse, sinusoidal, space vector modulation techniques – VSR operation-Application – Induction heating, AC drive system – Current source inverters.

Unit – 5	**Modern Inverters**	**9 Hrs**

Multilevel concept – diode clamped – flying capacitor – cascaded type multilevel inverters - Comparison of multilevel inverters - application of multilevel inverters – PWM techniques for MLI – Single phase &Three phase Impedance source inverters – Filters.

Total Hours	**45**

Text books:

1	Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Pearson, fourth Edition,10th Impression 2021.
2	Jai P. Agrawal, "Power Electronics System Theory and Design", Pearson Education, First Edition, 2015
3	Bimal.K.Bose "Modern Power Electronics and AC Drives", Pearson Education, Second Edition, 2003.

Reference Books:

1	Ned Mohan, T.M.Undeland and W.P.Robbins, "Power Electronics: converters, Application and design", 3rd edition Wiley, 2007.
2	Philip T. Krein, "Elements of Power Electronics" Indian edition Oxford University Press-2017
3	P.C.Sen, "Modern Power Electronics", S.Chand Publishing 2005.

Web References:

1	https://www.researchgate.net/topic/Power-Converters/publications
2	https://onlinecourses.nptel.ac.in/noc22_ee16/preview
3	https://www.mdpi.com/2079-9292/9/4/654

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE511	SMPS and UPS	PE	-	3	0	0	3

Course Outcomes Upon completion of the course, students will be able to		RBT
C511.1	Describe the operation and analysis of non-isolated DC–DC converters.	[U]
C511.2	Describe isolated DC–DC converter topologies and SMPS design concepts.	[U]
C511.3	Explain converter dynamics and modeling techniques.	[U]
C511.4	Understand controller design concepts for DC–DC converters.	[U]
C511.5	Describe power conditioners, UPS systems, and filtering techniques.	[U]

Course Contents

Unit – 1	Analysis of Non-Isolated DC-DC converters	9 Hrs

Basic topologies: Buck, Boost and Buck-Boost - Principles of operation – Continuous conduction mode– Concepts of volt-sec balance and charge balance – Analysis and design based on steady state relationships – Introduction to discontinuous conduction mode.

Unit – 2	Analysis of Isolated DC-DC converters	9 Hrs

Introduction - classification- forward- fly back- push pull – half bridge – full bridge topologies- Cuk converter as cascade combination of boost followed by buck – isolated version of Cuk converter - design of SMPS – Introduction to design of magnetic components for SMPS, using relevant software- Simulation of bidirectional DC-DC converter (both non-isolated and isolated) considering EV as an example application.

Unit – 3	Converter Dynamics	9 Hrs

AC equivalent circuit analysis – State space averaging – Circuit averaging – Transfer function model for buck, boost and buck-boost converters – Simulation of basic topologies using state space model derived – Comparison with the circuit model based simulation already carried out.

Unit – 4	Controller Design	9 Hrs

Review of P, PI, and PID control concepts – gain margin and phase margin – Bode plot based analysis – Design of controller for buck, boost and buck-boost converters.

Unit – 5	Power conditioners and UPS	9 Hrs

Introduction – Power line disturbances – Power conditioners – UPS: Offline and On-line – Need for filters – Filter for PWM VSI – Front-end battery charger – boost charger.

Total Hours	45

Textbooks:

1	Robert W. Erickson & Dragon Maksimovic, ” Fundamentals of Power Electronics”, Third Edition, 2020
2	Ned Mohan,” Power Electronics: A First Course”, Johnwiley, 2013.
3	Marian K. Kazimierczuk and Agasthya Ayachit,”Laboratory Manual for Pulse-Width Modulated DC– DC Power Converters”, Wiley 2016.

Reference Books:

1	Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition 2017.

Web References:

1	https://ieeexplore.ieee.org/document/496435
2	https://archive.nptel.ac.in/courses/108/108/108108036/
3	https://ee.iisc.ac.in/wp-content/uploads/2023/01/SMPC_VRamnarayanan.pdf

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE512	Industrial Drives	PE	-	3	0	0	3

Course Outcomes
Upon completion of the course, students will be able to

C512.1	Describe dynamics of electrical drives and load characteristics.	[U]
C512.2	Analyze performance of DC motor drives using rectifier and chopper control.	[AN]
C512.3	Explain synchronous motor drives and their control methods.	[U]
C512.4	Analyze performance and control of induction motor drives.	[AN]
C512.5	Describe stepper motor drives and industrial drive applications.	[U]

Course Contents

Unit – 1	**Dynamics of Electrical Drives**	**9 Hrs**

Fundamental Torque Equations, Speed Torque Conventions and Multi-quadrant Operation. Equivalent Values of Drive Parameters, Components of Load Torques, Nature and Classification of Load Torques, Calculation of Time and Energy Loss in Transient Operations, Steady State Stability, Load Equalization.

Unit – 2	**Direct Current Motor Drives**	**9 Hrs**

Rectifier Fed DC Drives, Single Phase Fully Controlled Rectifier Control of DC Separately Excited Motor, Single Phase Half Controlled Rectifier Control of DC Separately Excited Motor, Three Phase Fully Controlled Rectifier Control of DC Separately Excited Motor, Three Phase Half Controlled Rectifier Control of DC Separately Excited Motor, Supply Harmonics, Power Factor and Ripple in Motor Current, Chopper Control of Separately Excited DC Motor, Chopper Control of Series Motor.

Unit – 3	**Synchronous Motor Drives**	**9 Hrs**

Operation from fixed frequency supply-starting, synchronous motor variable speed drives, variable frequency control of multiple synchronous motors. Self-controlled synchronous motor drive employing load commutated thyristor inverter, Starting Large Synchronous Machines, Permanent Magnet AC (PMAC) Motor Drives, Sinusoidal PMAC Motor Drives, and Brushless DC Motor Drives.

Unit – 4	**Induction Motor Drives**	**9 Hrs**

Analysis and Performance of Three Phase Induction Motors, Operation with Unbalanced Source Voltage and Single Phasing, Operation with Unbalanced Rotor Impedances, Analysis of Induction Motor Fed From Non-Sinusoidal Voltage Supply, Starting, Braking, Transient Analysis. Speed Control Techniques-Stator Voltage Control, Variable Voltage Frequency Control from Voltage Sources.

Unit – 5	**Stepper Motor Drives and Industrial Drives**	**9 Hrs**

Stepper Motor Drives: Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping rate Characteristics, Drive Circuits for Stepper Motor. Industrial Drives :Textile Mills, Steel Rolling Mills, Cranes and Hoists, Machine Tools

Total Hours	**45**

Textbooks:

1	Fundamentals of Electrical Drives Gopal K. Dubey Narosa Publishing 2 nd Edition, 2001
2	Electrical Drives: Concepts and Applications (Refer to chapter 07 for Industrial Drives Vedum Subrahmanyam McGraw Hill 2 nd Edition, 2011

Reference Books:

1	Electric Drives N.K De,P.K. Sen PHI Learning 1 st Edition, 2009

Web References:

1	https://nptel.ac.in/courses/108108077
2	http://kcl.digimat.in/nptel/courses/video/108108077/L23.html

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24EE513	Special Electrical Machines	PE	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C513.1	Explain the construction, principle of operation, characteristics and drive circuits of stepper motors.	[U]
C513.2	Understand the construction, torque production, control methods and performance of switched reluctance motors.	[U]
C513.3	Examine the operation, magnetic circuit analysis, EMF and torque equations of permanent magnet brushless DC motors.	[U]
C513.4	Understand the construction, phasor diagram, control techniques and performance characteristics of PMSM drives.	[U]
C513.5	Discuss the construction, operation and characteristics of other special machines such as hysteresis motor, synchronous reluctance motor, linear induction motor and repulsion motor.	[U]

Course Contents

Unit – 1	**STEPPER MOTORS**	**9 Hrs**

Constructional features –Principle of operation –Types – Torque predictions – Linear Analysis – Characteristics – Drive circuits – Closed loop control – Concept of lead angle –Synchronous reluctance motor-Applications.

Unit – 2	**SWITCHED RELUCTANCE MOTORS (SRM)**	**9 Hrs**

Constructional features –Principle of operation- Torque prediction–Characteristics Steady state performance prediction – Analytical Method – Power controllers – Control of SRM drive- Sensor less operation of SRM – Applications.

Unit – 3	**PERMANENT MAGNET BRUSHLESS D.C. MOTORS**	**9 Hrs**

Fundamentals of Permanent Magnets- Types- Principle of operation- Magnetic circuit analysis- EMF and Torque equations- Power Converter Circuits and their controllers - Characteristics and control- Applications.

Unit – 4	**PERMANENT MAGNET SYNCHRONOUS MOTORS (PMSM)**	**9 Hrs**

Constructional features -Principle of operation – EMF and Torque equations - Sine wave motor with practical windings - Phasor diagram - Power controllers – performance characteristics -Digital controllers – Applications.

Unit – 5	**OTHER SPECIAL MACHINES**	**9 Hrs**

Constructional features – Principle of operation and Characteristics of Hysteresis motor- Synchronous Reluctance Motor–Linear Induction motor-Repulsion motor- - Applications of Servo motor Applications

Total Hours	**45**

Textbooks:

1	K.Venkataratnam, 'Special Electrical Machines', Universities Press (India) Private Limited, 2008.
2	E.G. Janardanan, Special Electrical Machines, PHI Learning, 1st Edition, 2014
3	Simmi P. Burman, Special Electrical Machines, S.K. Kataria & Sons, 2nd Edition, 2013

Reference Books:

1	R.Krishnan, 'Switched Reluctance Motor Drives – Modeling, Simulation, Analysis,Design and Application', CRC Press, New York, 2001.
2	Jigneshkumar P. Desai, Special Electrical Machinery, Wiley, 1st Edition, 2024
3	P.C. Sen, Principles of Electric Machines and Power Electronics, Wiley, 3rd Edition, 2013.
4	R.Srinivasan, 'Special Electrical Machines', Lakshmi Publications, 2013.

Web References:

1	https://nptel.ac.in/courses/108108191
2	https://tjsec.digimat.in/nptel/courses/video/108102156/L25.html

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE514	Design of Electrical Machines	PE	-	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C514.1	Explain basics of electrical machine design, materials, thermal effects, and ratings.	[AP]
C514.2	Design DC machines and evaluate performance.	[AP]
C514.3	Design transformers and analyze characteristics.	[AP]
C514.4	Design induction motors and determine performance.	[AP]
C514.5	Design synchronous machines and estimate parameters.	[AP]

Course Contents

Unit – 1	**Introduction**	**9**

Major considerations in Electrical Machine Design - Electrical Engineering Materials – Space factor – Choice of Specific Electrical and Magnetic loadings - Thermal considerations - Heat flow – Temperature rise and Insulating Materials - Rating of machines – Standard specifications.

Unit – 2	**DC Machines**	**9**

Output Equations – Main Dimensions – Choice of Specific Electric and Magnetic Loading - Magnetic Circuits Calculations - Carter's Coefficient - Net length of Iron –Real & Apparent flux densities – Selection of number of poles – Design of Armature – Design of commutator and brushes – performance prediction using design values.

Unit – 3	**Transformers**	**9**

Output Equations – Main Dimensions - kVA output for single and three phase transformers – Window space factor – Design of core and winding – Overall dimensions – Operating characteristics – No load current – Temperature rise in Transformers – Design of Tank - Methods of cooling of Transformers.

Unit – 4	**Induction Motors**	**9**

Output equation of Induction motor – Main dimensions – Choice of Average flux density – Length of air gap- Rules for selecting rotor slots of squirrel cage machines – Design of rotor bars & slots – Design of end rings – Design of wound rotor – Magnetic leakage calculations – Leakage reactance of poly phase machines- Magnetizing current - Short circuit current – Operating characteristics- Losses and Efficiency.

Unit – 5	**Synchronous Machines**	**9**

Output equations – choice of Electrical and Magnetic Loading – Design of salient pole machines – Short circuit ratio – shape of pole face – Armature design – Armature parameters – Estimation of air gap length – Design of rotor –Design of damper winding – Determination of full load field mmf – Design of field winding – Design of turbo alternators – Rotor design.

Total Hours 45

Textbooks:

1	Sawhney, A.K., 'A Course in Electrical Machine Design', Dhanpat Rai & Sons, New Delhi, 1984.
2	M.V.Deshpande "Design and Testing of Electrical Machine Design" Wheeler Publications, 2010.

Reference Books:

1	A.Shanmuga Sundaram, G.Gangadharan, R.Palani 'Electrical Machine Design Data Book', New Age International Pvt. Ltd., Reprint, 2007.
2	R.K.Agarwal " Principles of Electrical Machine Design" Esskay Publications, Delhi, 2002.
3	Sen, S.K., 'Principles of Electrical Machine Designs with Computer Programmes', Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1987.

Web References:

1	http://www.digimat.in/nptel/courses/video/108108191/L21.html
2	https://nptel.ac.in/courses/108102372

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE515	Modeling and Analysis of Electrical Machines	PE	-	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C515.1	Model and analyze brushed DC machines using state equations.	[AP]
C515.2	Apply reference frame transformations for machine analysis.	[AP]
C515.3	Analyze and simulate induction machines under various conditions.	[AP]
C515.4	Model synchronous machines using Park's equations.	[AP]
C515.5	Understand modeling and applications of multiphase machines.	[AP]

Course Contents

Unit – 1	**MODELING OF BRUSHED-DC ELECTRIC MACHINERY**	**9**

Fundamentals of Operation − Introduction − Governing equations and modeling of Brushed DC-Motor −Shunt, Series and Compound − State model derivation − Construction of Model of a DC Machine using state equations- Shunt, Series and Compound

Unit – 2	**REFERENCE FRAME THEORY**	**9**

Historical background − phase transformation and commutator transformation − transformation of variables from stationary to arbitrary reference frame.

Unit – 3	**INDUCTION MACHINES**	**9**

Three phase induction machine - equivalent circuit− free acceleration characteristics − voltage and torque equations in machine variables and arbitrary reference frame variables − Simulation under noload and load conditions- Machine variable form, arbitrary reference variable form.

Unit – 4	**SYNCHRONOUS MACHINES**	**9**

Three phase synchronous machine - voltage and torque equations in machine variables and rotor reference frame variables (Park's equations).

Unit – 5	**MULTIPHASE MACHINES CONCEPTS**	**9**

Preliminary Remarks - Necessity of Multiphase Machines - Evolution of Multiphase Machines- Advantages of Multiphase Machines - Working Principle - Multiphase Induction Machine, Multiphase Synchronous Machine -Modeling of 'n' phase machine. Applications of Multiphase Machines

Total Hours	**45**

Textbooks:

1	Paul C.Krause, Oleg Wasyzczuk, Scott S, Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley, Second Edition, 2010
2	P S Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 2008
3	A.E, Fitzgerald, Charles Kingsley, Jr, and Stephan D, Umanx, " Electric Machinery", Tata McGraw Hill, 5th Edition, 1992

Reference Books:

1	Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 7th Edition, 2020.
2	Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition,Power Electronics and Motor Drives, CRC Press, 2011, 1st Edition.
3	Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek, "Analysis of ElectricMachinery and Drive Systems", 3rd Edition, Wiley-IEEE Press, 2013.
4	R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Pearson Education, 1stImprint, 2015, 1st Edition.

Web References:

1	http://www.digimat.in/nptel/courses/video/108106023/L25.html
2	http://kcl.digimat.in/nptel/courses/video/108106023/L29.html

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE516	Machine Monitoring System	PE	-	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C516.1	Explain basics of machine condition monitoring and fault prognosis.	[U]
C516.2	Describe maintenance strategies and reliability analysis methods.	[U]
C516.3	Analyze vibration characteristics for fault diagnosis.	[U]
C516.4	Apply signal processing techniques for condition monitoring.	[U]
C516.5	Use machine learning techniques for machinery fault detection.	[U]

Course Contents

Unit – 1	**Introduction to Machine Condition Monitoring**	**9 Hrs**
Machinery condition monitoring - Present status - Fault prognosis - Future needs.		
Unit – 2	**Machinery Maintenance**	**9 Hrs**
Maintenance strategies – Reactive, Preventive, and Predictive – Benefits of planned maintenance – Bath tub curve – Failure Modes Effects and Criticality Analysis (FMECA).		
Unit – 3	**Introduction to Machinery Vibration and Monitoring**	**9 Hrs**
Characteristics of Vibration systems – Mode shapes & operational deflection shapes –Experimental modal analysis – Principles of vibration monitoring – Machinery faults diagnosed by vibration analysis.		
Unit – 4	**Signal Processing in Machinery Monitoring**	**9 Hrs**
FFT analysis – Time domain analysis – Time-frequency analysis – Signal filtering – Cepstrum analysis – Health condition of compressor & engine.		
Unit – 5	**Machine Learning for Condition Monitoring**	**9 Hrs**
Machine Learning: Feature extraction and feature selection methods – Feature reduction – Classification techniques – Case studies of condition monitoring in nuclear plant components, Distillation column.		
	Total Hours	**45**

Textbooks:

1	Cornelius Scheffer and Paresh Girdhar, "Practical Machinery Vibration Analysis and PredictiveMaintenance", Elsevier, 2004, 1st Edition.
2	A. R. Mohanty, "Machinery Condition Monitoring: Principles and Practices", CRC Press,Taylor & Francis, 1st Edition, 2017.

Reference Books:

1	Stephen Marsland, Machine Learning: An Algorithmic Perspective, 2nd Edition, 2014, CRC,Press.
2	Collacot, "Mechanical Fault Diagnosis and Condition Monitoring", Chapman- Hall, 1st Edition,2011.
3	Davies, "Handbook of Condition Monitoring – Techniques and Methodology", Springer, 1st Edition, 2011.

Web References:

1	https://onlinecourses.nptel.ac.in/noc22_cs29/preview
2	https://www.udemy.com/topic/maintenance-management/
3	https://www.vi-institute.org/analyst-categories/
4	https://in.mathworks.com/help/predmaint/ug/condition-monitoring-and-prognostics-usingvibration-signals.html

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE517	Computer Aided Design of Electrical Apparatus	PE	-	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C517.1	Understand conventional design limits and need for field analysis.	[U]
C517.2	Apply electromagnetic equations to field problems.	[AP]
C517.3	Analyze problems using Finite Element Method.	[AP]
C517.4	Use CAD tools for modeling and field analysis.	[AP]
C517.5	Evaluate practical design applications like insulators, actuators, SRM.	[U]

Course Contents

Unit – 1	**Introduction**	**9**

Conventional design procedures – Limitations – Need for field analysis based design – Review of Basic principles of energy conversion – Development of Torque/Force.

Unit – 2	**Mathematical Formulation of Field Problems**	**9**

Electromagnetic Field Equations – Magnetic Vector/Scalar potential – Electrical vector /Scalar potential – Stored energy in Electric and Magnetic fields – Capacitance - Inductance- Laplace and Poisson's Equations – Energy functional.

Unit – 3	**Philosophy of Finite Element Method**	**9**

Mathematical models – Differential/Integral equations – Finite Difference method – Finite element method – Energy minimization – Variational method- 2D field problems – Discretisation – Shape functions – Stiffness matrix – Solution techniques.

Unit – 4	**CAD Packages**	**9**

Elements of a CAD System –Pre-processing – Modelling – Meshing – Material properties- Boundary Conditions – Setting up solution – Post processing.

Unit – 5	**Design Applications**	**9**

Voltage Stress in Insulators – Capacitance calculation - Design of Solenoid Actuator – Inductance and force calculation – Torque calculation in Switched Reluctance Motor.

Total Hours	**45**

Text books:

1	S.J Salon, 'Finite Element Analysis of Electrical Machines', Springer, YesDEE publishers, Indian reprint, 2007.
2	Nicola Bianchi, 'Electrical Machine Analysis using Finite Elements', CRC Taylor & Francis, 2005.

Reference Books:

1	Joao Pedro, A. Bastos and Nelson Sadowski, 'Electromagnetic Modeling by Finite Element Methods', Marcell Dekker Inc., 2003.
2	P.P.Silvester and Ferrari, 'Finite Elements for Electrical Engineers', Cambridge University Press, 1983.
3	D.A.Lowther and P.P Silvester, 'Computer Aided Design in Magnetics', Springer Verlag, New York, 1986.
4	S.R.H.Hoole, 'Computer Aided Analysis and Design of Electromagnetic Devices', Elsevier, New York, 1989

Web References:

1	http://acl.digimat.in/nptel/courses/video/108102372/L39.html
2	http://www.digimat.in/nptel/courses/video/108102372/L09.html
3	https://www.classcentral.com/course/swayam-computer-aided-design-of-electrical-machines-269686

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24EE518	Wind Energy Conversion Systems	PE	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C518.1	Describe wind energy conversion systems and aerodynamic principles.	[U]
C518.2	Discuss wind turbine characteristics and power regulation methods.	[U]
C518.3	Explain fixed speed wind energy systems and generator operation.	[U]
C518.4	Illustrate variable speed wind energy systems and their control schemes.	[U]
C518.5	Understand grid-connected wind systems and their requirements and impact.	[U]

Course Contents

Unit – 1	**Introduction**	**9 Hrs**

Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory- Power coefficient-Sabinin's theory-Aerodynamics of Wind turbine

Unit – 2	**Wind Turbines**	**9 Hrs**

HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations- Tip speed ratio-No. Of Blades-Blade profile-Power Regulation-yaw control Pitch angle control- stall control-Schemes for maximum power extraction.

Unit – 3	**Fixed Speed Systems**	**9 Hrs**

Generating Systems- Constant speed constant frequency systems –Choice of Generators Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor – Drive Train model- Generator model for Steady state and Transient stability analysis.

Unit – 4	**Variable Speed Systems**	**9 Hrs**

Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG –Variable speed generators 53odeling – Variable speed variable frequency schemes.

Unit – 5	**Grid Connected Systems**	**9 Hrs**

Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of the power system including modeling issue.

Total Hours	**45**

Textbooks:

1	S.N.Bhadra, D.Kastha,S.Banerjee, "Wind Electrical Systems", Oxford University Press,2010.
2	Ion Boldea, "Variable speed generators", Taylor & Francis group,2006.

Reference Books:

1	Kaldellis. J.K, Stand–alone and Hybrid Wind Energy Systems, CRC Press, 2010
2	John D Sorensen and Jens N Sorensen, Wind Energy Systems, Wood head Publishing Ltd, 2011
3	Mario Garcia–Sanz, Constantine H. Houpis, Wind Energy Systems, CRC Press, 2012

Web References:

1	http://www.digimat.in/nptel/courses/video/101104546/L09.html
2	https://archive.nptel.ac.in/content/storage2/courses/downloads_new/103103206/

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE519	Electric Vehicle Architecture	PE	-	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C519.1	Understand EV architectures, types, and specifications.	[U]
C519.2	Apply vehicle mechanics for motion and propulsion analysis.	[U]
C519.3	Analyze sizing of power train components and braking systems.	[U]
C519.4	Understand hybrid vehicle control and mode strategies.	[U]
C519.5	Explain construction, working, and advantages of PHEVs.	[U]

Course Contents

Unit – 1	**Vehicle Architecture And Sizing**	**9 Hrs**

Electric Vehicle History and Evolution of Electric Vehicles. Series, Parallel and Series parallel Architecture, Micro and Mild architectures. Mountain Bike - Motorcycle- Electric Cars and Heavy Duty EVs. -Details and Specifications.

Unit – 2	**Vehicle Mechanics**	**9 Hrs**

Vehicle mechanics- Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire –Road mechanics, Propulsion System Design.

Unit – 3	**Power Components and Brakes**	**9 Hrs**

Power train Component sizing- Gears, Clutches, Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Power train sizing,

Unit – 4	**Hybrid Vehicle Control Strategy**	**9 Hrs**

Vehicle supervisory control, Mode selection strategy, Modal Control strategies.

Unit – 5	**Plug-In Hybrid Electric Vehicle**	**9 Hrs**

Introduction-History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV-Block diagram and components-Charging Mechanisms-Advantages of PHEVs.

Total Hours	**45**

Textbooks:

1	Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.
2	Build Your Own Electric Vehicle,Seth Leitman , Bob Brant, McGraw Hill, Third Edition 2013.
3	Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, First edition 2017.

Reference Books:

1	The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks,Motorcycles, andBicycles -- Includes EV Components, Kits, and Project Vehicles Mark Warner, HP Books,2011.
2	Heavy-duty Electric Vehicles from Concept to Reality, Shashank Arora, Alireza TashakoriAbkenar, Shantha Gamini Jayasinghe, Kari Tammi, Elsevier Science, 2021
3	Electric Vehicles Modern Technologies and Trends, Nil Patel, Akash Kumar Bhoi,Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen Springer, 2020
4	Hybrid Electric Vehicles: A Review of Existing Configurations and Thermodynamic Cycles,Rogelio León , Christian Montaleza , José Luis Maldonado , Marcos Tostado-Véliz andFrancisco Jurado, Thermo, 2021, 1, 134–150. https://doi.org/10.3390/thermo1020010.

Web References:

1	https://archive.nptel.ac.in/content/storage2/courses/108103009/module3/lec5/1.html
2	https://onlinecourses.nptel.ac.in/noc22_ee53/preview

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE520	Design of Motor and Power Converters for Electric Vehicles	PE	-	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C520.1	Explain electric vehicle dynamics including drive cycles, tractive force, and performance parameters.	[U]
C520.2	Apply torque, speed, power, and energy requirements of electric vehicles under various operating conditions.	[AP]
C520.3	Understand different electric motors and their speed–torque control strategies for EV applications.	[U]
C520.4	Apply control system concepts to develop transfer functions, time response, and frequency response models.	[AP]
C520.5	Analyze DC-DC converters including small-signal and power stage transfer functions.	[AN]

Course Contents

Unit – 1	**Electric Vehicle Dynamics**	**9 Hrs**

Standard drive cycles-Dynamics of Electric Vehicles-Tractive force-Maximum speed, torque, power, energy requirements of EVs.

Unit – 2	**Motors for Electric Vehicles**	**9 Hrs**

Introduction – Speed And Torque control of above and below rated speed-Speed control of EV in the constant power region of electric motors. DC Motors, Induction Motor, Permanent Magnet Synchronous Motors (PMSM), Brushless DC Motors, Switched Reluctance Motors (SRMs).Synchronous Reluctance Machines-Choice of electric machines for EVs.

Unit – 3	**Basics of Simulation in Control Systems**	**9 Hrs**

Transfer Function-How to build transfer function, identify Poles, zeros, draw time response plots, bode plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHP Zero Functions), state space modelling-transfer function from state space Model.

Unit – 4	**Modeling of DC-DC Converters**	**9 Hrs**

Overview of PWM Converter Modelling -Power Stage Modelling - PWM Block Modelling – Voltage Feedback Circuit and Small-Signal Model of PWM Converter - Averaging Power Stage Dynamics - Average Models for buck/boost Converter - Small-Signal Model of Converter Power Stage -Frequency Response of Converter.

Unit – 5	**POWER STAGE TRANSFER FUNCTIONS OF DC-DC CONVERTERS**	**9 Hrs**

Power Stage Transfer Functions of buck-boost Converter in CCM Operation, Input-to-Output Transfer Function, Duty Ratio-to-Output Transfer Function, and Load Current-to-Output Transfer Function.

Total Hours	**45**

Text books:

1	Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition 2017.
2	Fundamentals of Power Electronics with MATLAB, Randall Shaffer, 2nd Edition, 2013, Lakshmi Publications.
3	Feedback Control problems using MATLAB and the Control system tool box, Dean Frederick and Joe Cho, 2000, 1st Edition, Cengage learning.

Reference Books:

1	Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor &

	Francis, 2005,1st Edition.
2	Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Wiley,2021, 1st Edition.
3	Emerging Power Converters for Renewable Energy and Electric Vehicles Modeling, Design, and Control, Md. Rabiul Islam,Md. Rakibuzzaman Shah, Mohd. Hasan Ali, CRC Press,2021,1st Edition.
Web References:	
1	https://onlinecourses.nptel.ac.in/noc26_ee27/preview
2	https://onlinecourses.nptel.ac.in/noc22_ee53/preview

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE521	Electric Vehicle Design, Mechanics and Control	PE	-	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C521.1	Explain IC engine performance and emission control.	[U]
C521.2	Analyze EVs and compare with IC engine vehicles.	[AN]
C521.3	Explain battery types, modeling, and charging methods.	[U]
C521.4	Understand control system fundamentals and stability analysis.	[U]
C521.5	Understand control techniques of AC machines.	[U]

Course Contents

Unit – 1	**INTERNAL COMBUSTION ENGINES**	**9 Hrs**

IC Engines, BMEP and BSFC, Vehicle Fuel Economy, Emission Control Systems, Treatment of Diesel Exhaust Emissions.

Unit – 2	**ELECTRIC VEHICLES AND VEHICLE MECHANICS**	**9 Hrs**

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings- Comparisons of EV with internal combustion Engine vehicles- Fundamentals of vehicle mechanics.

Unit – 3	**BATTERY MODELING, TYPES AND CHARGING**	**9 Hrs**

Batteries in Electric and Hybrid Vehicles - Battery Basics -Battery Parameters. Types- Lead Acid Battery - Nickel-Cadmium Battery - Nickel-Metal-Hydride (NiMH) Battery - Li-Ion Battery - Li-Polymer Battery, Zinc-Air Battery, Sodium-Sulphur Battery, Sodium-Metal-Chloride, Research and Development for Advanced Batteries. Battery Modelling, Electric Circuit Models. Battery Pack Management, Battery Charging.

Unit – 4	**CONTROL PRELIMINARIES**	**9 Hrs**

Control Design Preliminaries - Introduction - Transfer Functions – Bode plot analysis for First order and second order systems - Stability - Transient Performance- Power transfer function for boost converter - Gain margin and Phase margin study-open loop mode.

Unit – 5	**CONTROL OF AC MACHINES**	**9 Hrs**

Introduction- Reference frame theory, basics-modelling of induction and synchronous machine in various frames-Vector control- Direct torque control.

Total Hours	**45**

Text books:

1	Electric and Hybrid Vehicles, Design Fundamentals, Third Edition, Iqbal Husain, CRC Press,2021.
2	Power Electronic Converters,: Dynamics and Control in Conventional and Renewable Energy Applications, Teuvo Suntio, Tuomas Messo, Joonas Puukko, 1st Edition, Wiley - VCH.
3	Ali Emadi, Mehrdad Ehsani, John M.Miller, “Vehicular Electric Power Systems”, Special Indian Edition, Marcel dekker, Inc 2003, 1st Edition.

Reference Books:

1	C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press,2001, 1st Edition.
2	Wie Liu, “Hybrid Electric Vehicle System Modeling and Control”, Second Edition, John Wiley &Sons, 2017, 2nd Edition.
3	Dynamic Simulation of Electric Machinery using MATLAB, Chee Mun Ong, Prentice Hall,1997,1st Edition.

Web References:

1	https://onlinecourses.nptel.ac.in/noc26_ee27/preview

2	http://digimat.in/nptel/courses/video/108102121/L01.html

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE522	Design of Electric Vehicle Charging System	PE	-	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C522.1	Understand EV charging methods, infrastructure & standards.	[U]
C522.2	Analyze power electronic converters used in EV charging.	[AN]
C522.3	Evaluate renewable energy–based EV charging systems.	[AP]
C522.4	Explain wireless power transfer techniques for EVs.	[U]
C522.5	Apply power factor correction in EV charging systems.	[AP]

Course Contents

Unit – 1	**CHARGING STATIONS AND STANDARDS**	**9 Hrs**

Introduction-Charging technologies- Conductive charging, EV charging infrastructure, international standards and regulations - Inductive charging, need for inductive charging of EV, Modes and operating principle, Static and dynamic charging, Bidirectional power flow, international standards and regulations-Types of charging station.

Unit – 2	**POWER ELECTRONICS FOR EV CHARGING**	**9 Hrs**

Layouts of EV Battery Charging Systems-AC charging-DC charging systems- Power Electronic Converters for EV Battery Charging- AC–DC converter with boost PFC circuit, with bridge and without bridge circuit - Bidirectional DC–DC Converters- Non-isolated DC–DC bidirectional converter topologies- Half-bridge bidirectional converter.

Unit – 3	**EV CHARGING USING RENEWABLE AND STORAGE SYSTEMS**	**9 Hrs**

Introduction- - EV charger topologies, EV charging/discharging strategies - Integration of EV charging-home solar PV system, Operation modes of EVC-HSP system, Control strategy of EVCHSP system - fast-charging infrastructure with solar PV and energy storage.

Unit – 4	**WIRELESS POWER TRANSFER**	**9 Hrs**

Introduction - Inductive, Magnetic Resonance, Capacitive types. Wireless Chargers for Electric Vehicles - Types of Electric Vehicles - Battery Technology in EVs -Charging Modes in EVs – Benefits of WPT. - WPT Operation Modes - Standards for EV Wireless Chargers, SAE J2954, IEC 61980. ISO: 19363.

Unit – 5	**POWER FACTOR CORRECTION IN CHARGING SYSTEM**	**9 Hrs**

Need for power factor correction- Boost Converter for Power Factor Correction, Sizing the Boost Inductor, Average Currents in the Rectifier and calculation of power losses.

Total Hours	**45**

Textbooks:

1	Mobile Electric Vehicles Online Charging and Discharging, Miao Wang Ran Zhang Xuemin(Sherman) Shen, Springer 2016, 1st Edition.
2	Alicia Triviño-Cabrera, José M. González-González, José A. Aguado, Wireless Power Transferor Electric Vehicles: Foundations and Design Approach, Springer Publisher 1st Edition.2020.
3	Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, ElectricVehicles Modern Technologies and Trends. Springer Publisher 1st Edition, 2021.

Reference Books:

1	Cable Based and Wireless Charging Systems for Electric Vehicles, Technology and control,management and grid integration, Rajiv Singh, Sanjeevikumar Padmanaban, Sanjeet Dwivedi,Marta Molinas and Frede Blaabjerg, IET 2021, 1st Edition.
2	Electric and Hybrid Electric Vehicles, James D Halderman, Pearson, 2022, 1st Edition.
3	Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis,2005.

Web References:

1	https://onlinecourses.nptel.ac.in/noc25_ee134/preview
2	http://digimat.in/nptel/courses/video/108106170/L65.html

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24EE523	Grid Integration of Electric Vehicles	PE	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C523.1	Explain V2G concepts, applications, and power market integration.	[U]
C523.2	Understand benefits of V2G in technical, economic, and environmental aspects.	[U]
C523.3	Apply technical, economic, and regulatory challenges of V2G.	[AP]
C523.4	Apply the impact of EV and V2G on smart grid and renewable systems.	[AP]
C523.5	Apply grid integration and management techniques for EV systems.	[AP]

Course Contents

Unit – 1	**V2G Fundamentals and Applications**	**9 Hrs**

Defining Vehicle to Grid (V2G) - History and Development of V2G. Incorporating V2G to the EV, Auditing and Metering, V2G in Practice, V2G - Power Markets and Applications. Electricity Markets and V2G Suitability, Long-Term Storage, Renewable Energy, and Other Grid Applications, Beyond the Grid: Other Concepts Related to V2G.

Unit – 2	V2G Benefits and Value Creation	**9 Hrs**

Benefits of V2G, Technical Benefits: Storage Superiority and Grid Efficiency, Economic Benefits: EV Owners and Societal Savings, Environment and Health Benefits: Sustainability in Electricity and Transport, Other Benefits.

Unit – 3	**Challenges and Regulatory Aspects of V2G**	**9 Hrs**

Technical Challenges-Battery Degradation, Charger Efficiency, Aggregation and Communication, V2G in a Digital Society. The Economic and Business Challenges to V2G - Evaluating V2G Costs and Revenues, EV Costs and Benefits, Adding V2G Costs and Benefits, Additional V2G Costs, The Evolving Nature of V2G Costs and Benefits. Regulatory and Political Challenges to V2G, V2G and Regulatory Frameworks, Market Design Challenges. Other V2G Regulatory and Legal Challenges.

Unit – 4	**EV and V2G Integration in Smart Grids**	**9 Hrs**

Introduction - Types of Electric Vehicles - Motor Vehicle Ownership and EV Migration - Impact of Estimated EVs on Electrical Network - Impact on Drivers and the Smart Grid - Standardization and Plug-and-Play - IEC 61850 Communication Standard and IEC 61850-7-420 Extension.

Unit – 5	**Communication and Energy Management for EV Grid Integration**	**9 Hrs**

Introduction - Machine to Machine (M2M) in distributed energy management systems - M2M communication for EVs - M2M communication architecture (3GPP) - Electric vehicle data logging - Scalability of electric vehicles -M2M communication with scheduling.

Total Hours	**45**

Textbooks:

1	Advanced Electric Drive Vehicles, Ali Emadi, CRC Press 2017, 1st Edition.
2	Plug In Electric Vehicles in Smart Grids, Charging Strategies, Sumedha Rajakaruna, FarhadShahnia and Arindam Ghosh,Springer,2015, 1st Edition.
3	ICT for Electric Vehicle Integration with the Smart Grid, Nand Kishor 1; Jesus Fraile-Ardanuy,IET 2020, 1st Edition.

Reference Books:

1	Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid, Junwei Lu and Jahangir Hossain,IET 2015, 1st Edition.
2	Lance Noel · Gerardo Zarazua de Rubens Johannes Kester · Benjamin K. Sovacool, Vehicleto-Grid A Sociotechnical Transition Beyond Electric Mobility, 2019, 1st Edition.

Web References:

1	https://onlinecourses.nptel.ac.in/noc23_ee60/preview

2	http://www.digimat.in/nptel/courses/video/108106170/L17.html

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE524	Intelligent Control of Electric Vehicles	PE	-	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C524.1	Analyze BLDC motor modeling and characteristics.	[AN]
C524.2	Apply speed control techniques for electric drives.	[AP]
C524.3	Explain fuzzy logic concepts and control systems.	[U]
C524.4	Apply FPGA and VHDL for control applications.	[AP]
C524.5	Apply real-time control of BLDC motor using FPGA.	[AP]

Course Contents

Unit – 1	**MATHEMATICAL MODEL AND CHARACTERISTICS ANALYSIS OF THE BLDC MOTOR**	**9 Hrs**

Structure and Drive Modes - Basic Structure, General Design Method, Drive Modes. Mathematical Model, Differential Equations, Transfer Functions, State-Space Equations. Characteristics Analysis, Starting Characteristics, Steady-State Operation, Dynamic Characteristics, Load Matching Commutation Transients.

Unit – 2	**SPEED CONTROL FOR ELECTRIC DRIVES**	**9 Hrs**

Introduction -PID Control Principle, Anti windup Controller, Intelligent Controller. Vector Control. Control applied to BLDC motor.

Unit – 3	**FUZZY LOGIC**	**9 Hrs**

Membership functions: features, fuzzification, methods of membership value assignments Defuzzification: lambda cuts - methods - fuzzy arithmetic and fuzzy measures: fuzzy arithmetic - extension principle - fuzzy measures - measures of fuzziness -fuzzy integrals - fuzzy rule base and approximate reasoning : truth values and tables, fuzzy propositions, formation of rules decomposition of rules, aggregation of fuzzy rules, fuzzy reasoning-fuzzy inference systems, overview of fuzzy expert system-fuzzy decision making.

Unit – 4	**FPGA AND VHDL BASICS**	**9 Hrs**

Introduction – FPGA Architecture-Advantages-Review of FPGA family processors- Spartan 3, Spartan 6 and Spartan 7. VHDL Basics- Fundamentals-Instruction set-data type-conditional statements- programs like arithmetic, sorting, PWM generation, Speed detection.

Unit – 5	**REAL TIME IMPLEMENTATION**	**9 Hrs**

Inverter design, identifying rotor position via hall effect sensors, open loop and fuzzy logic control of BLDC motor using FPGA. .

Total Hours	**45**

Textbooks:

1	Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric andFuel Cell Vehicles, John G. Hayes, G. Abas Goodarzi, Wiley 1st Edition 2018.
2	VHDL Primer, A (3rd Edition), Jayaram Bhasker, Prentice Hall, 1st Edition 2015.
3	Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Third Edition" CRC Press, Taylor & Francis Group, 2021, 1st Edition.

Reference Books:

1	Chang-liang, Permanent Magnet Brushless DC Motor Drives and Controls, Xia Wiley 2012, 1st Edition.
2	M.N. Cirstea, A. Dinu, J.G. Khor,M. McCormick, Neural and Fuzzy Logic Control of Drives and Power Systems, Newnes publications, 1st Edition, 2002.
3	Wei Liu, Hybrid Electric Vehicle System Modeling and Control, Wiley 2017, 2nd Edition.

Web References:

1	http://digimat.in/nptel/courses/video/108102121/L01.html
2	https://onlinecourses.nptel.ac.in/noc20_ee18/preview

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24EE525	Embedded System Design	PC	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C525.1	Understand basics of embedded systems architecture and hardware components	[U]
C525.2	Analyze embedded communication protocols and networking interfaces	[U]
C525.3	Apply interrupt handling and device driver concepts in system design	[U]
C525.4	Design RTOS-based embedded systems with scheduling and task management	[U]
C525.5	Develop real-time embedded applications for practical systems	[U]

Course Contents

Unit – 1	**INTRODUCTION TO EMBEDDED SYSTEMS**	**9 Hrs**

Introduction to Embedded Systems - Structural units in Embedded processor, selection of processor& memory devices- DMA - Memory management methods - Timer and Counting devices, Real Time Clock, In-circuit emulator, Target Hardware Debugging.

Unit – 2	**EMBEDDED NETWORKING**	**9 Hrs**

Embedded Networking: Introduction, I/O Device Ports & Buses–Serial Bus communication protocols RS232 standard–RS485–CANBus- Serial Peripheral Interface (SPI)–Inter- Integrated Circuits (I2C).

Unit – 3	**INTERRUPTS THE SERVICE MECHANISM AND DEVICE DRIVER**	**9 Hrs**

Programmed-I/O busy-wait approach without interrupt service mechanism-ISR concept-interrupt sources – multiple interrupts– context and periods for context switching, interrupt latency and deadline–Introduction to Device Drivers

Unit – 4	**RTOS – BASED EMBEDDED SYSTEM DESIGN**	**9 Hrs**

Introduction to basic concepts of RTOS - Task, process& threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication-shared memory, message passing- Inter process Communication- Introduction to process synchronization using semaphores.

Unit – 5	**EMBEDDED SYSTEM APPLICATION DEVELOPMENT**	**9 Hrs**

Open-loop and Closed Loop Control Systems-Application Examples-Washing Machine, Automotive Systems, Smart Card system, Auto-focusing digital camera, Air-conditioner, Elevator Control System, ATM System.

Total Hours	**45**

Text books:

1	Rajkamal, "Embedded system-Architecture Programming Design", McGraw-Hill Edu, 3rd edition 2017
2	Peckol, "Embedded system Design", John Wiley & Sons, 2010

Reference Books:

1	Shibu.K.V, "IntroductiontoEmbeddedSystems", TataMcgrawHill, 2ndedition2017
2	LyaB.Das, "EmbeddedSystems", PearsonEducation, 1stedition 2012.
3	Parag H.Dave, Himanshu B.Dave," Embedded Systems - Concepts, Design and Programming, Pearson Education, 2015, 1st edition
4	Elicia White,"Making Embedded systems",O'ReillySeries, SPD,2011, 1stedition
5	Jonathan W. Valvano, "Embedded Microcomputer Systems Real-time Interfacing", Cengage Learning , 3rd edition 2010
6	Tammy Noergaard, "Embedded Systems Architecture", Newnes, 2ndedition, 2013

Web References:

1	https://nptel.ac.in/courses/108102045
2	https://www.circuitbasics.com/basics-of-the-i2c-communication-protocol
3	https://www.theengineeringprojects.com/2016/11/examples-of-embedded-systems

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24EE526	Embedded C Programming	PC	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C526.1	Apply basic C programming concepts to develop structured programs.	[AP]
C526.2	Develop efficient embedded C programs with real-time features.	[AP]
C526.3	Implement C programs for 8051 Microcontroller operations and data handling.	[U]
C526.4	Design serial communication and interrupt-based programs using 8051 Microcontroller.	[AP]
C526.5	Develop interfacing applications with peripherals using 8051 Microcontroller.	[AP]

Course Contents

Unit – 1	**BASIC C PROGRAMMING**	**9 Hrs**

Typical C Program Development Environment - Introduction to C Programming - Structured Program Development in C - Data Types and Operators - C Program Control - C Functions - Introduction to Arrays.

Unit – 2	**EMBEDDED C**	**9 Hrs**

Adding Structure to 'C' Code: Object-oriented programming with C, Header files for Project and Port, Examples. Meeting Real-time constraints: Creating hardware delays - Need for timeout mechanism - Creating loop timeouts - Creating hardware timeouts

Unit – 3	**8051 PROGRAMMING IN C**	**9 Hrs**

Data types and time delay in 8051, I/O programming in 8051, Logic operations in 8051, Data conversion program in8051Accessing code ROM space in 8051, Data serialization using 8051

Unit – 4	**8051 SERIAL PORT AND INTERRUPT PROGRAMMING IN C**	**9 Hrs**

Basics of serial communication, 8051 interface to RS232- serial port programming in 8051. 8051 interrupts and programming, Programming for timer configuration.

Unit – 5	**8051 INTERFACING**	**9 Hrs**

8051: ADC interfacing, DAC interfacing, Sensor interfacing, LCD interfacing, Stepper motor interfacing, seven segment display interfacing

Total Hours 45

Textbooks:

1	Paul Deitel and Harvey Deitel, "C How to Program", 9th Edition, Pearson Education Limited, 2022, 1st edition.
2	Michael J Pont, "Embedded C", Addison-Wesley, Anim print of Pearson Education, 2002
3	William v on Hagen, "The Definitive Guide to GCC", 2ndEdition, A press Inc., 2006
4	Gowrishankar S and Veena A, "Introduction to Python Programming", CRC Press, Taylor & Francis Group, 2019

Reference Books:

1	Noel Kalicharan, "Learn to Program with C", A press Inc., 2015, 1st edition
2	Steve Oual line, "Practical C programming", O'Reilly Media, 1997, 3rd edition
3	Muhammad Ali Mazidi, Janice G. Mazidi and Rolin D. McKinlay, 'The 8051 Microcontroller and Embedded Systems' Prentice Hall, 2nd Edition 2007.

Web References:

1	https://nptel.ac.in/courses/108102045
2	https://onlinecourses.nptel.ac.in/noc20_ee98/preview

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24EE527	Smart System Automation	PC	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C527.1	Understand components and communication protocols of smart systems.	[U]
C527.2	Design home automation systems with security considerations.	[AP]
C527.3	Evaluate smart appliances and energy management using smart meters.	[AP]
C527.4	Explain wearable devices, sensors, and their healthcare applications.	[U]
C527.5	Understand embedded systems and basic robotics applications.	[U]

Course Contents

Unit – 1	**INTRODUCTION**	**9 Hrs**
Overview of a smart system – Hardware and software selection – Smart sensors and Actuators– Communication protocols used for smart systems.		
Unit – 2	**HOME AUTOMATION**	**9 Hrs**
Home Automation – System Architecture – Essential Components – Design Considerations: Control Unit, Sensing Requirements, Communication, Data Security		
Unit – 3	**SMART APPLIANCES AND ENERGY MANAGEMENT**	**9 Hrs**
Significance of smart appliances for energy management – Smart Meters: Significance, Architecture & Energy Measurement Technique – Security Considerations.		
Unit – 4	**SMART WEARABLE DEVICES**	**9 Hrs**
Body Area Networks – Sensors – communication protocol for Wearable devices – Application of Smart Wearable in Healthcare & Activity Monitoring		
Unit – 5	**EMBEDDED SYSTEMS AND ROBOTICS**	**9 Hrs**
Fundamental concepts in Robotics- Robots and Controllers components- Embedded processor based: pick and place robot- Mobile Robot Design - UAV		
	Total Hours	**45**

Textbooks:

1	Grimm, Christoph, Neumann, Peter, Mahlknech and Stefan, Embedded Systems for Smart Appliances and Energy Management, Springer 2013, 1stEdition
2	Kazem Sohraby, Daniel Minoliand Taieb Znati, Wireless Sensor Networks Technology, Protocols, and Applications, John Wiley & Sons, 2007, 1st Edition
3	Nilanjan Dey, Amartya Mukherjee, Embedded Systems and Robotics with Open-Source Tools, CRC press, 2016, 1st Edition

Reference Books:

1	Raj Kamal, Embedded Systems - Architecture, Programming and Design, McGraw-Hill, 2008
2	Karim Yaghmour, Embedded Android, O'Reilly, 2013
3	Steven Good win, Smart Home Automation with Linux and Raspberry Pi, Apress, 2013
4	C.K.Toh, AdHoc mobile wireless networks, Prentice Hall, Inc,2002.

Web References:

1	https://microcontrollerslab.com/home-automation-projects-ideas
2	https://www.learnrobotics.org/blog/simple-robot/
3	https://robolabor.ee/homelab/en/iot

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE528	Embedded System for Automotive Applications	PE	-	3	0	0	3

Course Outcomes
Upon completion of the course, students will be able to

C528.1	Explain modern automotive systems, fuel economy, emission standards, and ECU architecture.	[U]
C528.2	Apply knowledge of automotive sensors and actuators for interfacing and real-time vehicle data acquisition.	[AP]
C528.3	Analyze vehicle management systems including energy management, ABS, adaptive cruise control, and safety systems.	[AN]
C528.4	Describe onboard diagnostics and automotive communication protocols such as CAN, LIN, FlexRay, and MOST	[U]
C528.5	Understand recent trends in automotive systems including autonomous vehicles, navigation systems, and IoT applications.	[U]

Course Contents

Unit – 1	**INTRODUCTION TO AUTOMOTIVE SYSTEMS**	**9 Hrs**

Overview of modern automotive systems and their functional architecture. Fundamentals of fuel economy, air–fuel ratio control, emission standards, and vehicle performance parameters. Introduction to electronic control units (ECUs), ECU architecture, and the concept of open-source ECU platforms.

Unit – 2	**SENSORS AND ACTUATORS FOR AUTOMOTIVES**	**9 Hrs**

Overview and classification of automotive sensors used in vehicle systems - Types and sensors and actuators - Interfacing of sensors with the ECU for real-time data acquisition. Concept of smart sensors and intelligent actuators used in modern automotive control systems and their applications in vehicle monitoring and control.

Unit – 3	**VEHICLE MANAGEMENT SYSTEMS**	**9 Hrs**

Introduction to vehicle management and control systems. Energy management systems in vehicles, adaptive cruise control mechanisms, anti-lock braking systems (ABS), and advanced safety systems for collision detection and avoidance.

Unit – 4	**ONBOARD DIAGONSTICS AND COMMUNICATION**	**9 Hrs**

Introduction to on-board diagnostics (OBD) for monitoring vehicle performance and detecting faults. Automotive communication protocols and in-vehicle networks including Bluetooth, Controller Area Network (CAN), Local Interconnect Network (LIN), FlexRay, and Media Oriented Systems Transport (MOST).

Unit – 5	**RECENT TRENDS**	**9 Hrs**

Emerging technologies in automotive systems including vehicle navigation systems, autonomous vehicles, and the role of Internet of Things (IoT) in connected and intelligent automotive applications.

Total Hours	**45**

Text books:

1	William B.Ribbens, "Understanding Automotive Electronics", Elseiver, 8thEdition, 2017.
2	L.Vlacic, M.Parent, F.Harahima," Intelligent Vehicle Technologies", SAE International, 2001, 1stEdition, 2017.

Reference Books:

1	Ali Emedi, Mehrdedehsani, John M Miller , "Vehicular Electric power system- land, Sea, Air and Space Vehicles" Marcel Decker, 2004, 1st Edition.
2	Jack Erjavec, Jeff Arias," Alternate Fuel Technology - Electric, Hybrid & Fuel Cell Vehicles", Cengage , 2012, 2nd Edition.

Web References:

1	https://www.coursera.org/learn/introduction-to-automotive-embedded-systems
2	https://www.wasilzafar.com/pages/2026/01/automotive-embedded-systems-guide.html

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24EE529	Introduction to VLSI Design	PC	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C529.1	Explain CMOS technology, MOSFET scaling, and CMOS logic design techniques	[U]
C529.2	Describe IC fabrication processes and VLSI layout design rules.	[U]
C529.3	Apply programmable logic devices such as PAL, PLA, and CPLD in digital system design.	[AP]
C529.4	Analyze FPGA architecture and reconfigurable computing systems for application development.	[AN]
C529.5	Describe digital designs using Verilog HDL including ALU, adders, and shift registers.	[U]

Course Contents

Unit – 1	**CMOS BASICS**	**9 Hrs**

Introduction to CMOS technology and its significance in digital integrated circuits. MOSFET scaling principles and their impact on device performance. Fundamentals of CMOS logic design. Dynamic CMOS logic techniques, transmission gate structures, and the concept and applications of Bi CMOS technology.

Unit – 2	**IC FABRICATION**	**9 Hrs**

Overview of CMOS integrated circuit fabrication processes. Description of fabrication technologies including n-well, p-well, twin-tub, and silicon-on-insulator (SOI) processes. Design rules for VLSI layout and introduction to layout design techniques used in integrated circuit development.

Unit – 3	**PROGRAMABLE LOGIC DEVICES**	**9 Hrs**

Introduction to programmable logic devices and their role in digital system design. Architecture and working principles of Programmable Array Logic (PAL), Programmable Logic Array (PLA), and Complex Programmable Logic Devices (CPLD). Applications of programmable logic devices in digital systems.

Unit – 4	**RECONFIGURABLE PROCESSOR**	**9 Hrs**

Concept of reconfigurable computing systems. Architecture of Field Programmable Gate Arrays (FPGA) and their components. FPGA-based application development and implementation techniques. Introduction to Field Programmable Analog Arrays (FPAA) and their applications.

Unit – 5	**HDL PROGRAMMING**	**9 Hrs**

Overview of hardware description languages with emphasis on Verilog HDL. Structural and behavioral modeling concepts. Design and implementation examples using Verilog including carry look-ahead adders, arithmetic logic units (ALU), and shift registers.

Total Hours	**45**

Textbooks:

1	M.J.S Smith, "Application Specific integrated circuits", Addition Wesley Longman Inc. 1st Edition2010.
2	Kamran Eshraghian, Douglas A. pucknell and sholeh Eshraghian," Essentials of VLSI circuits and system", Prentice Hall India,2005, 1st Edition

Reference Books:

1	Donald G. Givone, "Digital principles and Design", Tata Mc Graw Hill 2002, 1st Edition.
2	Charles H. Roth Jr., "Fundamentals of Logic design", Thomson Learning, 7thEdition 2013.
3	Nurmi, Jari (Ed.) "Processor Design System – On – Chip Computing for ASICs and FPGA s " Springer, 2007, 1st Edition.

4	Joao Card oso, Michael Hübner, "Reconfigurable Computing: From FPG As to Hardware/ Software Co design" Springer, 2011, 1st Edition.
5	Pierre – Emmanuel Gaillard on, Reconfigurable Logic: Architecture, Tools, and Applications, 1stEdition, CRC Press, 2018.
Web References:	
1	https://natalieagus.github.io/50002/notes/cmostechnology
2	https://elearning.aisat.ac.in/courses/vlsi-circuit-design/lessons/transmission-gate-logic/
3	https://graphsearch.epfl.ch/en/lecture/0_5ak1ctut

Course Code	Course Name	Category	Semester	Hours/Week			C
				L	T	P	
24EE530	MEMS and NEMS	PE	-	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C530.1	Explain MEMS and NEMS basics.	[U]
C530.2	Describe micromachining techniques.	[U]
C530.3	Understand micro sensors and actuators.	[U]
C530.4	Understand NEMS technology.	[U]
C530.5	Describe MEMS and NEMS applications.	[U]

Course Contents

Unit – 1	**INTRODUCTION TO MEMS and NEMS**	**9 Hrs**

Overview of Micro electromechanical Systems (MEMS) and Nano electromechanical Systems (NEMS), including their devices, technologies, and evolution. Laws of scaling and their impact on miniaturized systems. Materials used in MEMS and NEMS fabrication. Applications of MEMS and NEMS in modern engineering and technology.

Unit – 2	**MICRO – MACHINING AND MICROFABRICATION TECHNIQUES**	**9 Hrs**

Introduction to micromachining processes used in MEMS fabrication. Photolithography techniques for micro-scale patterning. Micro-manufacturing methods including bulk micromachining, surface micromachining, and the LIGA process used for high-precision microstructures.

Unit – 3	**MICRO SENSORS AND MICRO ACTUATORS**	**9 Hrs**

Concepts of micro sensors and micro actuators developed using micromachining techniques. Design and working principles of capacitive sensors, piezoresistive sensors, and piezoelectric actuators used in MEMS devices.

Unit – 4	**NEMS TECHNOLOGY**	**9 Hrs**

Fundamentals of nanoscale engineering and atomic-scale precision manufacturing. Nanofabrication techniques used in NEMS technology. Design and applications of NEMS-based sensors and actuators in advanced engineering systems.

Unit – 5	**MEMS and NEMS APPLICATION**	**9 Hrs**

Applications of MEMS and NEMS in various domains including Bio MEMS, optical NEMS systems, micro motors, and smart sensors. Discussion on recent developments and emerging trends in MEMS and NEMS technologies.

Total Hours	**45**

Textbooks:

1	ChangLiu, "Foundations of MEMS", Pearson International Edition, 2011, 2nd Edition.
2	Tai Ran Hsu, "MEMS and Microsystems: design, manufacture and Nano scale"- 2ndEdition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008.
3	Lyshevski, S.E. "Nano - and Micro – Electro mechanical Systems: Fundamentals of Nano - and Micro engineering " (2nd ed.). CRC Press, 2005.

Reference Books:

1	Marc F madou "Fundamentals of micro fabrication" CRC Press 2002, 2nd Edition Marc Madou.
2	M.H.Bao "Micromechanical transducers: Pressure sensors, accelerometers and gyroscopes", Elsevier, Newyork, 16 Oct 2000, 1st Edition.
3	Maluf, Nadim "An introduction to MicroElectro - mechanical Systems Engineering" AR Tech house, Boston, June 30 2004, 2nd Edition.

Web References:

1	https://www.academia.edu/Lectures_on_MEMS_and_MICROSYSTEMS_DESIGN_AND_MANUFACTURE
2	https://onlinecourses.nptel.ac.in/noc22_ee36/preview

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE601	Text Analytics	OE	3	0	0	3

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 withterm 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 matrixfactorization 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, DataExploration and the search for noval patterns, sentiment tracking, visual analytics and FutureLens, 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 semanticanalysis, 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.

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE602	Introduction to Artificial Intelligence	OE	3	0	0	3

Course Outcomes

Upon completion of the course, students will be able to

C602.1	Enumerate the history and foundations of Artificial Intelligence.	[U]
C602.2	Apply the basic principles of AI in problem solving. (Apply-L3).	[AP]
C602.3	Illustrate the different searching algorithms to find and optimize the solution for the given problem.	[AP]
C602.4	Illustrate the different gaming algorithms and identify the importance of knowledge representation in Artificial Intelligence.	[AP]
C602.5	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 2nd 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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE603	Health Informatics	OE	3	0	0	3

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	ChandanK.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.
ReferenceBooks:	
1	Vikas Kumar, "Health Care Analysis Made Simple", Packt Publishing, 2018.
2	NilanjanDey, Amira Ashour , Simon James Fong, ChintanBhatl, "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 Goodfelllow, YoshuaBenjio, Aaron Courville, The MIT Press.
Web References:	
1	https://onlinecourses.nptel.ac.in/noc22_hs40/preview.

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE604	MANAGEMENT ANALYTICS	HS	3	0	0	3

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 withOrganisational Decision Making-Analytics in Decision Making-BA for CompetitiveAdvantage.		
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 –Visualisingand Exploring Data – DescriptiveStatistics - 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 Predictiveanalytics.		
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-proficience/prescriptive-analytics-jm-2025/	

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE605	Data Science Essentials	OE	3	0	0	3

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	U

Course Contents

Unit – I	**INTRODUCTION**	**9**

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**	**9**

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**

Text books:

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://archive.nptel.ac.in/courses/106/106/106106139/

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE606	Fundamentals of computer vision	OE	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to

C606.1	To understand basic knowledge, theories and methods in image processing and computer vision.	U
C606.2	To know basic and some advanced image processing techniques in OpenCV.	U
C606.3	To apply 2D a feature-based 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**	9

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**	9

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**	9

2D and 3D feature-based alignment - Pose estimation - Geometric intrinsic calibration - Triangulation - Two-frame structure from motion - Factorization - Bundle adjustment - Constrained structure and 109 motion - Translational alignment - Parametric motion - Spline-based motion - Optical flow - Layered motion.

Unit – 4	**3D RECONSTRUCTION**	9

Shape from X - Active rangefinding - Surface representations - Point-based representationsVolumetric representations - Model-based reconstruction - Recovering texture maps and albedosos

Unit – 5	**IMAGE-BASED RENDERING AND RECOGNITION**	9

View interpolation Layered depth images - Light fields and Lumigraphs - Environment mattes - Videobased rendering-Object detection - Face recognition - Instance recognition - Category recognition - Context and scene understanding- Recognition databases and test sets.

Total Hours	**45**

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	Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006
3	E. R. Davies, Computer and Machine Vision, Fourth Edition, Academic Press, 2012

Web References:

1	onlinecourses.nptel.ac.in

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE607	Machine Learning and its Applications	OE	3	0	0	3
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	**ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING**					9
Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization.						
Unit – 5	**DESIGN AND ANALYSIS OF MACHINE LEARNING EXPERIMENTS**					9
Guidelines for machine learning experiments, Cross Validation (CV) and resampling – K-fold CV, bootstrapping, measuring classifier performance, assessing a single classification algorithm and comparing two classification algorithms – t test, McNemar's test, K-fold CV paired t test.						
					Total Hours	**45**
Text books:						
1	Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Fourth Edition, 2020.					
2	Stephen Marsland, "Machine Learning: An Algorithmic Perspective, "Second Edition", CRC Press, 2014.					
3						
Reference Books:						
1	Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.					
2	Tom Mitchell, "Machine Learning", McGraw Hill, 3rd Edition, 1997.					
3	Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, "Foundations of Machine Learning", Second Edition, MIT Press, 2012, 2018.					

4	Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016
5	Sebastain Raschka, 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/

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE608	Deep Learning Techniques	OE	3	0	0	3

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 auto encoders and generative models for suitable applications.	AP

Course Contents

Unit – 1	**DEEP NETWORKS BASICS**	**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**	**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**	**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**	**8**

Performance metrics -- Baseline Models -- Hyperparameters: Manual Hyperparameter -- Automatic Hyperparameter -- Grid search -- Random search -- Debugging strategies.

Unit – 5	**AUTOENCODERS AND GENERATIVE MODELS**	**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.

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE609	Language engineering	OE	3	0	2	4

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, DynamicProgramming parsing – Shallow 85 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 Javall, 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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE610	Neural Networks	OE	3	0	0	3
Course Outcomes **Upon completion of the course, students shall have ability to**						
C610.1	Apply Convolution Neural Network for image processing.					AP
C610.2	Apply the basics of associative memory and unsupervised learning networks.					AP
C610.3	Analyze Competitive nets and vector quantization					AP
C610.4	To apply architectures of various neural networks					AP
C610.5	Apply CNN and its variants for suitable applications.					AP
Course Contents						
Unit – 1	INTRODUCTION					9
Neural Networks-Application Scope of Neural Networks-Artificial Neural Network: An Introduction Evolution of Neural Networks-Basic Models of Artificial Neural Network- Important Terminologies of ANNs-Supervised Learning Network.						
Unit – 2	ASSOCIATIVE MEMORY					9
Training Algorithms for Pattern Association-Auto associative Memory Network-Heteroassociative Memory Network-Bidirectional Associative Memory (BAM)-Hopfield Networks-Iterative Autoassociative Memory Networks- Temporal Associative Memory Network						
Unit – 3	UNSUPERVISED LEARNING NETWORKS					9
Fixed Weight Competitive Nets-Kohonen Self-Organizing Feature Maps-Learning Vector Quantization-Counter propagation Networks-Adaptive Resonance Theory Network.						
Unit – 4	THIRD-GENERATION NEURAL NETWORKS					9
Spiking Neural Networks-Convolutional Neural Networks-Deep Learning Neural Networks-Extreme Learning Machine Model						
Unit – 5	CONVOLUTIONAL NEURAL NETWORKS					9
Convolutional Neural Networks: The Convolution Operation – Motivation – Pooling – Variants of the basic Convolution Function – Structured Outputs – Data Types – Efficient Convolution Algorithms – Neuroscientific Basis – Applications: Computer Vision, Image Generation, Image Compression.						
					Total Hours	**45**
Textbooks:						
1	Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016					
2	Francois Chollet, “Deep Learning with Python”, Second Edition, Manning Publications, 2021.					
Reference Books:						
1	Josh Patterson, Adam Gibson, “Deep Learning: A Practitioner’s Approach”, O’Reilly Media, 2017.					
2	Charu C. Aggarwal, “Neural Networks and Deep Learning: A Textbook”, Springer International Publishing, 1st Edition, 2018.					
3	Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018					
4	S Rajasekaran, G A Vijayalakshmi Pai, “Neural Networks, FuzzyLogic and Genetic Algorithm, Synthesis and Applications”, PHI Learning, 2017.					
5	James A Freeman, David M S Kapura, “Neural Networks Algorithms, Applications, and Programming Techniques”, Addison Wesley, 2003.					
Web References:						
1	Onlinecourses.nptel.ac.in					

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE611	Database Fundamentals	OE	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to

C611.1	To understand basics of Databases	[U]
C611.2	To understand basics of Relational Databases	[U]
C611.3	To design database using ER model and normalize the database	[AP]
C611.4	To apply database concepts on distributed Databases	[AP]
C611.5	To apply database concepts on Database Security	[AP]

Course Contents

Unit – 1	**Introduction**	**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**	**10**

Introduction to relational databases – Relational Model – Keys – Relational Algebra – SQL fundamentals – Advanced SQL features – Embedded SQL– Dynamic SQL

Unit – 3	**Database Design**	**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**	**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**	**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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE612	Basics of Image Processing	OE	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to

C612.1	To understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms	[U]
C612.2	To understand on images using the techniques of smoothing, sharpening and enhancement	[U]
C612.3	To apply the restoration concepts and filtering techniques.	[AP]
C612.4	To learn the basics of segmentation methods	[AP]
C612.5	To Comprehend compression and recognition concepts.	[AP]

Course Contents

Unit – 1	**DIGITAL IMAGE FUNDAMENTALS**	**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**	**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**	**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**	**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**	**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.
	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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE613	Vehicular ADHOC Networks	OE	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to

C613.1	To understand VANET Basics	[U]
C613.2	To comprehend the message forwarding strategies.	[U]
C613.3	To understand the challenges in VANET	[U]
C613.4	To apply VANET in different services and to understand through simulation	[AP]
C613.5	To apply VANET concepts in different applications	[AP]

Course Contents

Unit – 1	**INTRODUCTION TO VANET**	**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**	**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**	**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**	**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**	**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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE614	Web Technology Fundamentals	OE	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to

C614.1	To understand responsive web pages using HTML5 and CSS3	[U]
C614.2	To build dynamic client-side functionality with JavaScript and DOM manipulation	[AP]
C614.3	To implement server-side functionality using PHP, Java Servlets, and Node.js.	[AP]
C614.4	To create and connect web applications to databases using JDBC and MySQL	[AP]
C614.5	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**	**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**	**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**	**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**	**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**	**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 Expressand 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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE615	App Development Fundamentals	OE	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to

C615.1	To understand various mobile app development model.	[U]
C615.2	To design simple native and cross-platform mobile applications	[AP]
C615.3	To apply frameworks such as React Native and Ionic effectively	[AP]
C615.4	To evaluate frameworks based on performance and development needs	[AP]
C615.5	To understand app deployment, debugging, and maintenance fundamentals	[AP]

Course Contents

Unit – 1	**FUNDAMENTALS OF WEB AND MOBILE APPLICATION DEVELOPMENT**	**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**	**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**	**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**	**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**	**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.

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.

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE616	Introduction to Augmented Reality / Virtual Reality	OE	3	0	0	3

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 Annotation Navigation-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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE617	Software Engineering	OE	3	0	0	3

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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE618	Foundation of cloud computing	OE	3	0	0	3

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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE619	JAVA PROGRAMMING	OE	3	0	0	3

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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE620	Block Chain Technology	OE	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to

C620.1	Understand emerging abstract models of block chain 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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE621	Introduction to VLSI design	OE	3	0	0	3

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, Addision 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", Addisson Wesley, 1997
4	R.Jacob Baker, Harry W.LI., David E.Boyee, "CMOS Circuit Design, Layout and Simulation", 2005 Prentice Hall of India

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE622	Communication Engineering	OE	3	0	0	3

Course Outcomes:

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 COMMUICATION 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: PhaseModulation, 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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
240E623	Sensors and Actuators	OE	3	0	0	3

Course Outcomes		
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
C623.4	Understand the operation of the sensors, actuators and electronic control.	U
C623.5	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 INDUTANCE SENSORS**	**9**

Principle of operation- Construction details- Characteristics and applications of resistive potentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezo resistive sensors Inductive potentiometer- Variable reluctance transducers:- EI pickup 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.

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE624	Basics of Hardware Description Languages	OE	3	0	0	3

Course Outcomes

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]

Course Contents

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 – State machines -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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE625	Introduction to Internet of Things	OE	3	0	0	3

Course Outcomes		
Upon completion of the course, students shall have ability to		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 Contents		
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.
Web References	
1	https://www.arduino.cc/
2	https://www.ibm.com/smarterplanet/us/en/?ca=v_smarterplanet

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

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 Contents

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 :45 Hours	

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	
24OE627	Electric Vehicle Technology	OE	3	0	0	3

Course Outcomes

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:45 Hours

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

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

Text books

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.

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

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 : 45 Hours

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	
24OE630	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

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"

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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE632	Basics of Drone Technology	OE	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to

C632.1	Know about a various type of drone technology, drone fabrication and programming.	U
C632.2	Execute the suitable operating procedures for functioning a drone	U
C632.3	Select appropriate sensors and actuators for Drones	U
C632.4	Develop a drone mechanism for specific applications	U
C632.5	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	Zavrsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018.

Web References:

1	https://dronelaunchacademy.com/
2	https://www.airsight.com/knowledge-hub/drone-basics

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE633	3D PRINTING	OE	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to

C633.1	Apply the features of robots and the technology involved in their control.	AP
C633.2	Apply basic engineering knowledge and relevant laws for the design of robotics.	AP
C633.3	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
C633.4	Apply the principles of kinematics, degeneracy, dexterity, and trajectory planning in robotics applications.	AP
C633.5	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.

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE634	DIGITAL MANUFACTURING	OE	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to

C634.1	Impart knowledge to use various elements in the digital manufacturing.	U
C634.2	Differentiate the concepts involved in digital product development life cycle process and supply chain management in digital environment.	AP
C634.3	Select the proper procedure of validating practical work through digital validation in Factories.	AP
C634.4	Implementation the concepts of IoT and its role in digital manufacturing.	AP
C634.5	Analyze 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	ɒ 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

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE635	Composite Materials	OE	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to

C635.1	Explain the classification, characteristics, and applications of composite materials	U
C635.2	Identify and describe types of reinforcement and matrix materials used in composites	U
C635.3	Apply suitable composite manufacturing techniques for specific applications	AP
C635.4	Analyze the mechanical behavior and failure mechanisms in composite materials	AP
C635.5	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.

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE636	Fundamentals of Operations Research	OE	3	0	0	3
Course Outcomes **Upon completion of the course, students shall have ability to**						
C636.1	Apply linear programming techniques to solve optimization problems.					[AP]
C636.2	Solve transportation, assignment, network, and project scheduling problems.					[AP]
C636.3	Apply inventory models for effective inventory control.					[AP]
C636.4	Analyze queueing models to improve system performance.					[AP]
C636.5	Apply decision models, game theory, replacement models, and dynamic programming for decision-making.					[AP]
Course Contents						
Unit -1	LINEAR MODELS					**9**
The phase of an operation research study – Linear programming – Graphical method– Simplex algorithm – Duality formulation – Sensitivity analysis.						
Unit -2	TRANSPORTATION MODELS AND NETWORK MODELS					**9**
Transportation Assignment Models –Traveling Salesman problem-Networks models – Shortest route – Minimal spanning tree – Maximum flow models –Project network – CPM and PERT networks – Critical path scheduling – Sequencing models.						
Unit-3	INVENTORY MODELS					**9**
Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.						
Unit-4	QUEUEING MODELS					**9**
Queueing models - Queueing systems and structures – Notation parameter – Single server and multi server models – Poisson input – Exponential service – Constant rate service – Infinite population – Simulation.						
Unit - 5	DECISION MODELS					**9**
Decision models – Game theory – Two person zero sum games – Graphical solution- Algebraic solution– Linear Programming solution – Replacement models – Models based on service life – Economic life– Single / Multi variable search technique – Dynamic Programming – Simple Problem.						
					Total Hours	**45**
Textbooks:						
1	Taha H.A., "Operations Research", Sixth Edition, Prentice Hall of India, 2003.					
2	Shennoy G.V. and Srivastava U.K., "Operation Research for Management", Wiley Eastern, 1994.					
Reference Books:						
1	Philip D.T. and Ravindran A., "Operations Research", John Wiley, 1992.					
2	Budnick F.S., "Principles of Operations Research for Management", Richard D Irwin, 1990.					
3	Bazara M.J., Jarvis and Sherali H., "Linear Programming and Network Flows", John Wiley, 1990.					

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE637	Organizational Behaviour	OE	3	0	0	3
Course Outcomes **Upon completion of the course, students shall have ability to**						
C637.1	Comprehend the fundamental concepts in organizational behaviour					[U]
C637.2	Explain the difference in the individual behaviour					[U]
C637.3	Relate motivation, morale and attitude					[U]
C637.4	Demonstrate the significance of working as a group and understand leadership					[U]
C637.5	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 organizationalclimate.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", 8th Edition, Pearson Education Ltd, 2022					
Reference Books:						
1	Aswathappa. K,"OrganizationalBehavior", Himalaya Publishing House, 2024					
2	Fred Luthans, "OrganisationalBehaviour", McGraw Hill Book Co.,14th edition,2020					

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE638	Total Quality Management	OE	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to

C638.1	Explain the concepts, principles, frameworks, and importance of Total Quality Management, including customer focus and cost of quality.	[U]
C638.2	Apply TQM principles such as leadership, employee involvement, continuous improvement, and supplier partnership to enhance organizational quality practices.	[AP]
C638.3	Apply quality management tools and techniques, including the seven QC tools, Six Sigma, benchmarking, and FMEA, to solve quality-related problems.	[AP]
C638.4	Apply control charts, process capability analysis, QFD, Taguchi methods, and TPM concepts to improve process performance and product quality.	[AP]
C638.5	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.Besterfiled, 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.

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE639	Intellectual Property Rights	OE	3	0	0	3
Course Outcomes **Upon completion of the course, students shall have ability to**						
C639.1	Explain the fundamental concepts, types, significance, and need for Intellectual Property Rights, including patents, copyrights, geographical indications, TRIPS, and WIPO.					[U]
C639.2	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]
C639.3	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]
C639.4	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]
C639.5	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.					

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE640	Emotional Intelligence	OE	3	0	0	3
Course Outcomes **Upon completion of the course, students shall have ability to**						
C640.1	Comprehend the basic concepts of management and evolution in management.					[U]
C640.2	Demonstrate the roles and skills in planning and decision making for the business.					[U]
C640.3	Discover personal competencies and manage emotions					[U]
C640.4	Gain insight into positive relationship through EI					[U]
C640.5	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					

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE641	Algebra and Number Theory	OE	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to		RBT
C641.1	Apply algebraic structures and mappings to solve problems related to groups and rings.	[AP]
C641.2	Utilize properties of finite fields to analyze and factor expressions within polynomial systems.	[AP]
C641.3	Implement number-theoretic techniques from divisibility and decomposition to perform structured arithmetic computations.	[AP]
C641.4	Solve modular equations and systems using methods from Diophantine analysis and congruences.	[AP]
C641.5	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, Discrete and Combinatorial Mathematics: An Applied Introduction, 5th ed. New Delhi, India: Pearson Education, 2019.
2	T. Koshy, Elementary Number Theory with Applications, 2nd ed. Burlington, MA, USA: Academic Press, 2007.

Reference Books

1	S. Ling and C. Xing, Coding Theory: A First Course, 1st ed. Cambridge, U.K.: Cambridge University Press, 2004.
2	I. Niven, H. S. Zuckerman, and H. L. Montgomery, An Introduction to the Theory of Numbers, 5th ed. Singapore: John Wiley and Sons, 2004.
3	R. Lidl and G. Pilz, Applied Abstract Algebra, 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/

Course Code	Course Name	Category	Hours/Week			C
			L	T	P	
24OE642	Linear Algebra	OE	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to		RBT
C642.1	Test the consistency and solve system of linear equations.	[AP]
C642.2	Find the basis and dimension of vector space.	[AP]
C642.3	Obtain the matrix of linear transformation and its eigen values and eigen vectors	[AP]
C642.4	Find ortho normal basis of inner product space and find least square approximation.	[AP]
C642.5	Find eigen values 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, Numerical Methods, 4th ed. Boston, MA, USA: Cengage Learning, 2012.
2	S. H. Friedberg, A. J. Insel, and L. E. Spence, Linear Algebra, 5th ed. New Delhi, India: Pearson Education, 2019.

Reference Books

1	B. Kolman and D. R. Hill, Introductory Linear Algebra, 8th ed. New Delhi, India: Pearson Education, 2009.
2	S. Kumaresan, Linear Algebra: A Geometric Approach, Reprint, New Delhi, India: Prentice Hall of India, 2010.
3	R. Bronson, Schaum's Outline of Matrix Operations, 2nd ed. New York, NY, USA: McGraw-Hill, 2011.
4	G. Strang, Linear Algebra and Its Applications, 5th ed. New Delhi, India: Pearson Education, 2023.
5	V. Sundarapandian, Numerical Linear Algebra, 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	Category	Hours/Week			C
			L	T	P	
24OE643	Advanced Engineering Chemistry	OE	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to		RBT
C643.1	Understand the basic principles of semiconductors, including periodic trends, band gaps, conductivity, and their applications in various electronic and optoelectronic devices.	[U]
C643.2	Select appropriate modern engineering alloys based on their composition and properties for specific applications in electronics, telecommunications, and aerospace.	[AP]
C643.3	Classify different types of refractories and abrasives and describe their properties and manufacturing processes with respect to industrial usage.	[U]
C643.4	Describe the types and mechanisms of adsorption, interpret adsorption isotherms, and explain their significance in catalytic and surface chemistry applications.	[U]
C643.5	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 Jersy, 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	Category	Hours/Week			C
			L	T	P	
24OE644	Nanotechnology And NLO Materials	OE	3	0	0	3

Course Outcomes

Upon completion of the course, students shall have ability to		RBT
C644.1	Understand the basic concepts of nanotechnology.	[U]
C644.2	Explained the method of synthesizing nanostructures with desired size, shape, and surface properties.	[AP]
C644.3	Apply characterization results to optimize the synthesis process and enhance the functionality of nanomaterials for targeted applications.	[AP]
C644.4	Utilize nanomaterials for the design of high-performance sensing devices.	[AP]
C644.5	Utilize nonlinear optical concepts to enhance and develop technologies in recent engineering.	[AP]

Course Content

Unit – I	**INTRODUCTION TO NANOMATERIALS**	**09**

History of nanomaterials, Classification of Nanomaterials, 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	
24OE645	English for Competitive Examinations	HS	3	0	0	3

Course Outcomes		
Upon completion of the course, students shall have ability		**RBT**
C645.1	Understanding of common English words and phrases, building their vocabulary to communicate.	AP
C645.2	Recognize different types of sentence structures.	AP
C645.3	Learn to write précis and notes with clarity.	AP
C645.4	Express ideas in a clear and concise manner.	AP
C645.5	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, The King's Grammar. New Delhi, India: Blackie ELT Books, 2008.
2	C. D. Sidhu, P. Nath, and K. Kapoor, Comprehensive English Grammar and Composition. New Delhi, India: Khosla Publishing House, 2004.
3	P. C. Wren and H. Martin, High School English Grammar & Composition. New Delhi, India: S. Chand & Company, 2007.
Reference Books	
1	C. Baldick, The Oxford Dictionary of Literary Terms. Oxford, U.K.: Oxford University Press, 2009.
3	J. Mathew, Fine Tune Your English. New Delhi, India: Orient Blackswan Pvt. Ltd., 2010.
Web References	
1	https://byjus.com/govt-exams/general-english-competitive-exams//