Dr. MAHALINGAM COLLEGE OF ENGINEERING AND TECHNOLOGY

An Autonomous Institution Since 2011

Udumalai Road, Pollachi, Coimbatore District - 642003

Established in 1998 ♦ Approved by AICTE ♦ Affiliated to Anna University

(A DIVISION OF NIA EDUCATIONAL INSTITUTIONS)

NAAC A++ GRADE Cycle 3 (2023-2030) The Highest Grade

B.E. Electrical and Electronics Engineering

Curriculum and Syllabi

Semesters I to VIII

Regulations 2023

(from 2024 Batch Onwards)

Dr. Mahalingam College of Engineering and Technology, Pollachi 642003.
(An autonomous institution approved by AICTE and affiliated to Anna University)

Department of Electrical & Electronics Engineering

Vision

We develop globally competent Electrical and Electronics Engineer to solve real time problems of the industry and society and conduct research for the application of knowledge to the society

Mission:

In order to foster growth and empowerment, we commit ourselves to

- Develop electrical and electronics engineers of high caliber to meet the expectations of industries through effective teaching-learning process
- Improve career opportunities in core areas of electrical and electronics engineering.
- Inculcate leadership qualities with ethical and social responsibilities

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Programme Educational Objectives (PEOs)

B.E. Electrical and Electronics Engineering graduates will:

PEO1.Technical Expertise: Acquire a professional career and personal development in industries / higher studies / research assignments / entrepreneurs.

PEO2.Life-long learning: Sustain to develop their knowledge and skills throughout their career.

PEO3. Ethical Knowledge: Exhibit professionalism, ethical attitude, communication skills, team work and adapt to Current trends.

Programme Outcomes (POs) - Regulations 2023

On successful completion of B.E. Electrical and Electronics Engineering programme, graduating students/graduates will be able to:

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions for complex problems.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcomes (PSOs)

On successful completion of B.E. Electrical and Electronics Engineering programme, graduating students/graduates will be able to:

PSO1. Design and analyze systems associated with power sector, semiconductor, automotive, and automation industries.

PSO2. Develop hardware and software solutions to cater the societal and industrial needs considering recent technological developments in Electrical & Electronics Engineering.

Dr. Mahalingam College of Technology, Pollachi
2023 Regulations - Course Code Generation Procedure for UG Courses

Regulation

Mode of Assessment	
Character Type – Number	
T	Theory
I	Theory with Practical
L	Practical
	Practical with Theory
E	Elective
O	Open Elective
P	Project
S	Skill Development Course/Internship
C	Customized

Semester Number	
Character Type – Number	
1 to 8	Semester
0	Floating

Sequence Number
Character Type – Number
01, 02, 03, . . . , 99

1	2	3	4	5	6	7	8
2	**3**	**A**	**U**	**X**	**X**	**0**	**1**

Board/Department/Programme/Course Type			
Character Type – Alphabet			
AD	Artificial Intelligence & Data Science	**ME**	Mechanical
AM	CSE (Artificial Intelligence & Machine Learning)	**SC**	CSE (Cyber Security)
AU	Automobile	**PH**	Physics
CE	Civil	**CH**	Chemistry
CS	Computer Science	**EN**	English
EA	Advanced Communication Technology	**MA**	Mathematics
EC	Electronics and Communication	**ES**	Employability Skills
EE	Electrical and Electronics	**VA**	Value Added Course
EV	VLSI Design & Technology	**SA**	Studio Activities
IT	Information Technology		

Programme: B.E Electrical and Electronics Engineering
2023 Regulations

Course Category	Course Code	Course Title	Duration	Credits	Marks
VAC	23VAL101	Induction Program	3 Weeks	-	100

Semester I

Course Category	Course Code	Course Title	Hours/Week L	T	P	Credits	Marks	Common to Programmes
AEC	23ENI101	Communication Skills I	2	0	2	3	100	All
Minor	23MAI102	Matrices and Calculus	3	0	2	4	100	AU, EA, EC, EE, EV, ME
Minor	23CHI101	Chemistry for Electrical Sciences	3	0	2	4	100	EC, EE
Major	23EET101	Basics of Electrical Engineering	3	0	0	3	100	-
Multi-Disciplinary	23MEL001	Engineering Drawing	1	0	3	2.5	100	AD, AM, AU, CS, EA, EC, EE, EV, IT, ME, SC
SEC	23EEL101	Workshop Practice for Electrical Engineers	0	0	3	1.5	100	-
VAC	23VAL102	Wellness for Students	0	0	2	1	100	All
VAC	23VAT101	தமிழர்மரபு /Heritage of Tamils	1	0	0	1	100	All
AEC	23SAL101	Studio Activities	0	0	2	-	-	All
Total			**13**	**0**	**16**	**20**	**800**	**-**

Semester II

Course Category	Course Code	Course Title	Hours/Week L	T	P	Credits	Marks	Common to Programmes
AEC	23ENI201	Communication Skills II	2	0	2	3	100	All
	23FLT201	Foreign Language-Japanese	3	0	0	3		
	23FLT202	Foreign Language-German	3	0	0	3		
Minor	23MAI202	Complex Variables and Transforms	3	0	2	4	100	AU, EC, EE, EV, ME
Minor	23PHI201	Physics for Electrical Sciences	3	0	2	4	100	EA, EC, EE
Major	23EET201	Solid State Devices	3	0	0	3	100	-
Multi-Disciplinary	23CSI201	Problem Solving using Python Programming	3	0	2	4	100	-
Major	23EEL201	Introduction to Programming with IoT	0	0	3	1.5	100	-
Major	23EEL202	Electron Devices Laboratory	0	0	3	1.5	100	-
SEC	23ESL201	Professional Skills 1:Problem solving skills & Logical Thinking 1	0	0	2	1	100	All
VAC	23VAT201	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	1	0	0	1	100	All
Multi-Disciplinary	23CHT202	Environmental Sciences	1	0	0	-	100	All
AEC	23SAL201	Studio Activities	0	0	2	-	-	All
		Total	**16**	**0**	**18**	**23**	**1000**	**-**

Semester III

Course Category	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
Minor	23MAT303	Numerical Methods and Linear Algebra	3	1	0	4	100	EC,EE
Major	23EET301	DC Machines and Transformers	3	0	0	3	100	-
Major	23EET302	Electric Circuits	3	1	0	4	100	-
Major	23EET303	Digital Electronics	3	0	0	3	100	-
Multi-Disciplinary	23CST304	Programming in C	3	0	0	3	100	CE,EA,EC EE& EV
Major	23EEL301	DC Machines and Transformers Laboratory	0	0	3	1.5	100	-
Multi-Disciplinary	23CSL302	Programming in C Laboratory	0	0	3	1.5	100	CE,EA,EC EE& EV
SEC	23ESL301	Professional Skills 2: Problem solving skills & Logical Thinking 2	0	0	2	1	100	All
VAC	23VAT003	Universal Human Values 2: Understanding Harmony	2	1	0	3	100	All
AEC	23SAL301	Studio Activities	-	-	2	-	-	All
		Total	**17**	**3**	**10**	**24**	**900**	**-**

Semester IV

Course Category	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
Minor	23MAT401	Probability and Statistics	3	1	0	4	100	AM,AU,CS,EC,EE, ME,SC &IT
Major	23EET401	Synchronous and Induction Machines	3	0	0	3	100	-
Major	23EET402	Electronic Circuits	3	0	0	3	100	-
Multi-Disciplinary	23CSI402	Data Structures and Algorithms	2	0	2	3	100	-
Major	23EET403	Measurement and Instrumentation	3	0	0	3	100	-
Major	23EEL401	Synchronous and Induction Machines Laboratory	0	0	3	1.5	100	-
Major	23EEL402	Analog and Digital Electronics Laboratory	0	0	3	1.5	100	-
SEC	23ESL401	Professional Skills 3: Professional Development and Etiquette	0	0	2	1	100	-
AEC	23SAL401	Studio Activities	0	0	2	-	-	All
		Total	**14**	**1**	**12**	**20**	**800**	**-**

Course Category	Course Code	Course Title	Duration	Credits	Marks	Common to Programmes
SEC	23XXXXXX	Internship - 1/Community Internship /Skill Development	2 Weeks – 4 Weeks	1	100	-

Semester V

Course Category	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
Major	23EET501	Control Systems	3	1	0	4	100	-
Major	23EET502	Embedded Controller	3	0	0	3	100	-
Major	23EET503	Linear Integrated Circuits	3	0	0	3	100	-
Major	23XXXXXX	Professional Elective – I	3	0	0	3	100	-
Major	23XXXXXX	Professional Elective – II	3	0	0	3	100	-
Major	23EEL501	Embedded Controller Laboratory	0	0	3	1.5	100	-
Major	23EEL502	Integrated Circuits Laboratory	0	0	3	1.5	100	-
SEC	23ESL501	Professional Skills 4: Communication Skills and Interview Essentials	0	0	2	1	100	-
Project	23EEP501	Reverse Engineering Project	0	0	6	3	100	-
AEC	23SAL501	Studio Activities	0	0	2	-	-	All
		Total	**15**	**1**	**16**	**23**	**900**	**-**

Semester VI

Course Category	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
Major	23EET601	Generation, Transmission and Distribution	3	0	0	3	100	-
Major	23EET602	Power Electronics	3	0	0	3	100	-
Major	23XXXXXX	Professional Elective – III	3	0	0	3	100	-
Major	23XXXXXX	Professional Elective – IV	3	0	0	3	100	-
Minor	23XXXXXX	Open Elective - I	3	0	0	3	100	-
Major	23EEL601	Power Electronics Laboratory	0	0	3	1.5	100	-
Major	23EEL602	Embedded Software Laboratory	0	0	3	1.5	100	-
SEC	23ESL601	Professional Skills 5: Ace and Elevate: Aptitude and Soft Skills	0	0	2	1	100	-
AEC	23SAL601	Studio Activities	0	0	2	-	-	All
		Total	**15**	**1**	**7**	**19**	**800**	**-**

Course Category	Course Code	Course Title	Duration	Credits	Marks	Common to Programmes
SEC	23XXXXXX	Internship - 2/ Research Internship/ Skill Development	2 Weeks – 4 Weeks	1	100	-

Semester VII

Course Category	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
Major	23EET701	Power System Analysis and Stability	3	1	0	4	100	-
Major	23EET702	Electric Drives and Control	3	0	0	3	100	-
Major	23XXXXXX	Professional Elective – V	3	0	0	3	100	-
Major	23XXXXXX	Professional Elective – VI	3	0	0	3	100	-
Minor	23XXXXXX	Open Elective – II	3	0	0	3	100	-
Major	23EEL701	Power System Lab	0	0	3	1.5	100	-
Major	23EEL702	Electric Drives and Control lab	0	0	3	1.5	100	-
Project	23EEP701	Project Phase - I	0	0	8	4	100	-
		Total	**15**	**1**	**14**	**23**	**800**	**-**

Semester VIII

Course Category	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
Project	23EEP801	Project Phase - II	0	0	12	6	200	-
SEC	23XXXXXX	Internship - 3 / Skill Development	8 Weeks			4	100	-
		Total	**6**	**0**	**12**	**10**	**300**	**-**

Total Credits: 164

Vertical wise Electives

Control and Automation							
Course Code	**Course Title**	**Hours/Week**			**Credits**	**Marks**	**Common to Programmes**
23EEE010	Digital Control Engineering	3	0	0	3	100	-
23EEE011	Industrial Data Communication Networks	3	0	0	3	100	-
23EEE012	Robotics and Automation	3	0	0	3	100	-
23EEE013	Smart Sensor Technology	3	0	0	3	100	-
23EEE014	Industrial Automation	3	0	0	3	100	-
23EEE015	Industrial Internet of Things	3	0	0	3	100	-

Converters and Drives							
Course Code	**Course Title**	**Hours/Week**			**Credits**	**Marks**	**Common to Programmes**
23EEE020	Power Electronic Applications to Renewable Energy	3	0	0	3	100	-
23EEE021	Control of Power Electronics Circuits	3	0	0	3	100	-
23EEE022	Switched Mode Power Converters	3	0	0	3	100	-
23EEE023	Advanced Electric Drives	3	0	0	3	100	-
23EEE024	Multilevel Power Converters	3	0	0	3	100	-
23EEE025	Power Management Integrated Circuits	3	0	0	3	100	-
23EEE026	Design of Power Electronic Converters	3	0	0	3	100	-
23EEE027	Design of Motor and Power Converters for Electric Vehicles	3	0	0	3	100	-

Electrical Vehicle Technology							
Course Code	**Course Title**	**Hours/Week**			**Credits**	**Marks**	**Common to Programmes**
23EEE030	Electric Vehicle Architecture	3	0	0	3	100	-
23EEE031	Sensors for Electric Vehicle	3	0	0	3	100	-
23EEE032	Automotive Electrical & Electronic Systems	3	0	0	3	100	-
23EEE033	Design of Electric Vehicle Charging System	3	0	0	3	100	-
23EEE034	Testing of Electric Vehicles	3	0	0	3	100	-

23EEE035	Electric Vehicle Design, Mechanics and Control	3	0	0	3	100	-
23EEE036	Intelligent Control of Electric Vehicles	3	0	0	3	100	-
23EEE037	Grid Integration of Electric Vehicles	3	0	0	3	100	-
23EEE038	Smart Grid Interface for EV	3	0	0	3	100	-

Power Engineering							
Course Code	**Course Title**	**Hours/Week**			**Credits**	**Marks**	**Common to Programmes**
23EEE040	Advanced Power System Protection	3	0	0	3	100	-
23EEE041	HVDC Transmission	3	0	0	3	100	-
23EEE042	Distributed Generation and Microgrid	3	0	0	3	100	-
23EEE043	Power System Reliability	3	0	0	3	100	-
23EEE044	Smart Grid	3	0	0	3	100	-
23EEE045	Transients in Power System	3	0	0	3	100	-
23EEE046	Restructured Power System	3	0	0	3	100	-
23EEE047	Under Ground Cable Engineering	3	0	0	3	100	-

Communication and Signal Processing							
Course Code	**Course Title**	**Hours/Week**			**Credits**	**Marks**	**Common to Programmes**
23EEE050	Analog and Digital Communication	3	0	0	3	100	-
23EEE051	Computer Communication Networks	3	0	0	3	100	-
23EEE052	Principles of Communication Systems	3	0	0	3	100	-
23EEE053	Biomedical Signal Processing	3	0	0	3	100	-
23EEE054	Fiber Optic Communication	3	0	0	3	100	-
23EEE055	Digital Image Processing	3	0	0	3	100	-
23EEE056	Wavelets and its Applications	3	0	0	3	100	-
23EEE057	Speech and Audio Processing	3	0	0	3	100	-
23EEE058	Wireless Communication	3	0	0	3	100	-
23EEE059	Information Theory and Coding	3	0	0	3	100	-

VLSI Domain							
Course Code	**Course Title**	**Hours/Week**			**Credits**	**Marks**	**Common to Programmes**
23EEE060	VLSI Design	3	0	0	3	100	-
23EEE061	CMOS Analog IC Design	3	0	0	3	100	-
23EEE062	ASIC Design	3	0	0	3	100	-
23EEE063	VLSI Design Flow RTL to GDS	3	0	0	3	100	-
23EEE064	Microelectronics: Devices to Circuits	3	0	0	3	100	-
23EEE065	Semiconductor device modeling	3	0	0	3	100	-
23EEE066	Introduction to Time Varying Electrical Networks	3	0	0	3	100	-
23EEE067	Circuit Analysis for Analog Designers	3	0	0	3	100	-
23EEE068	Testing of VLSI Circuits	3	0	0	3	100	-

Embedded Systems							
Course Code	**Course Title**	**Hours/Week**			**Credits**	**Marks**	**Common to Programmes**
23EEE070	Embedded Systems Design	3	0	0	3	100	-
23EEE071	Advanced Microprocessors	3	0	0	3	100	-
23EEE072	STM32 Microcontroller and Its Interfacing	3	0	0	3	100	-
23EEE073	Embedded Linux	3	0	0	3	100	-
23EEE074	IoT for Smart Systems	3	0	0	3	100	-
23EEE075	Embedded Control of Electric Drives	3	0	0	3	100	-
23EEE076	FPGA based System Design	3	0	0	3	100	-
23EEE077	Embedded Sensing, Actuation and Interfacing Systems	3	0	0	3	100	-

Diversified Electives

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programs
23EEE080	Renewable Energy Systems	3	0	0	3	100	-
23EEE081	Electrical Energy Utilization and Conservation	3	0	0	3	100	-
23EEE083	Protection and Switchgear	3	0	0	3	100	-
23EEE084	Hardware Description Language	3	0	0	3	100	-
23EEE085	Automotive Electronics	3	0	0	3	100	EC,EE & EV
23EEE086	Machine Learning Techniques	3	0	0	3	100	-
23EEE087	Steering and Control System For Electrical Engineers	3	0	0	3	100	-
23EEE088	Special Electrical Machines	3	0	0	3	100	-
23EEC037	Java Programming	3	0	0	3	100	EC&EE
23EEC038	Big data Analytics and Cloud Computing	3	0	0	3	100	EC&EE
23MEE008	PLM for Engineers	2	0	2	3	100	EC,EE&EV
23MEE030	Principles of Management	3	0	0	3	100	EC,EE&EV
23AUE050	Entrepreneurship Development	3	0	0	3	100	-
23AUE051	Design Thinking and Innovation	3	0	0	3	100	-
23SCE050	Cyber Security	3	0	0	3	100	-
23ITE047	Intellectual Property Rights	3	0	0	3	100	-

Open Elective

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programs
23EEO001	Electric and Hybrid Vehicles	3	0	0	3	100	-
23EEO002	Solar Energy System	3	0	0	3	100	-

SEMESTER I

Course Code:23VAL101		Course Title: Induction Program (Common to all B.E/B.Tech Programmes)
Course Category: VAC		Course Level: Introductory
Duration: 3 weeks	Mandatory Non-Credit Course	Max Marks:100

Pre–requisites

- NIL

Course Objectives

The course is intended to:

1. Explain various sources available to meet the needs of self, such as personal items and learning resources
2. Explain various career opportunities, opportunity for growth of self and avenues available in the campus
3. Explain the opportunity available for professional development
4. Build universal human values and bonding amongst all the inmates of the campus and the society.

List of Activities:

1. History of Institution and Management: Overview on NIA Educational Institutions – Growth of MCET – Examination Process –OBE Practices –Code of Conduct – Centre of Excellence.
2. Lectures, interaction sessions and Motivational Talks by Eminent people, Alumni, Employer and Industry Experts
3. Familiarisation of Department / Branch:HoD's & Senior Interaction- Department Associatio
4. Universal Human Value Modules : Aspirations and concerns, Self Management, Relations Social and Natural Environment.
5. Orientation on Professional Skills Courses
6. Proficiency Modules : Mathematics, English, Physics and Chemistry
7. Introduction to various Chapters, Cells, Clubs and its events
8. Creative Arts : Painting, Music and Dance
9. Physical Activity :Games, Sports and Yoga
10. Group Visits: Visit to local area and Campus Tour

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 **BOS Chairman**

Course Outcomes	Cognitive Leve
At the end of this course, students will be able to:	
CO1 : Explain various sources available to meet the needs of self, such as personal items and learning resources through visit to local areas and campus	Understand
CO2: Explain various career opportunities and avenues available in the campus through orientation sessions	Understand
CO3: Explain the opportunity available for professional development through professional skills, curricular, co-curricular and extracurricular activities	Understand
CO4: Build universal human values and bonding amongst all the inmates of the campus and society for having a better life	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	-	-	2	1	2	-	-	-	-
CO2	1	-	-	-	-	-	-	2	1	2	-	-	-	-
CO3	1	-	-	-	-	-	-	2	1	2	-	-	-	-
CO4	2	-	-	-	-	-	-	2	1	2	-	-	-	-

High : 3, Medium :2, Low: 1

Text Book(s):

T1. Reading material, Workbook prepared by PS team of the college

Reference Book(s):

R1. Sean Covey, “Seven habits of highly effective teenagers”, Simon & Schuster Uk, 2004.

R2. Vethathiri Maharishi Institute For Spiritual and Intuitional Education, aliyar, “value educat harmonious life (Manavalakalai Yoga)”, Vethathri Publications, Erode, 2010.

R3. Dr.R.Nagarathna, Dr.H.R. Nagendra, “ Integrated approach of yoga therapy for positive Swami Vivekananada Yoga Prakashana Bangalore,2008 Ed.

Web References:

1. https://youtube.com/playlist?list=PLYwzG2fd7hzc4HerTNkc3pS_IvcCfKznV
2. https://www.youtube.com/watch?v=P4vjfEVk&list=PLWDeKF97v9SO0frdgmpaghDMjkom1
3. https://fdp-si.aicte-india.org/download/AboutSIP/About%20SIP.pdf

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 **BOS Chairman**

Course Code: 23ENI101	**Course Title: Communication Skills I (Common to all B.E/B.Tech Programmes)**		
Course Category: AEC		**Course Level: Introductory**	
L:T:P(Hours/Week) 2:0:2	**Credits: 3**	**Total Contact Hours:60**	**Max Marks:100**

Course Objectives

The course is intended to impart formal and informal language effectively and accurately in various real-life contexts on par with B1 level of CEFR Scale.

Module I **20 Hours**

Grammar: Synonyms & Antonyms -Tense forms - Modals - Passives – Reported Speech – Comparatives and Descriptive adjectives.

Listening: Listening for gist and specific information - Listening to past events, experiences and job preferences - Listening to descriptions of monuments - Listening for excuses - Listening to description: transportation systems and public places.

Speaking: Introducing oneself - Exchanging personal information – Effective Conversations: Role Play Situations (Describing personality traits - Describing landmarks, monuments and festivals - Making polite requests and excuses - Discussing facts - Asking for and giving information – Expressing wishes - Talking about lifestyle changes - Talking about transportation and its problems - Describing positive and negative features of things and places - Making comparisons)

Reading: Skimming and Scanning - Reading Comprehension - Reading and comprehending online posts and emails – Case Studies

Writing: Letter writing (Permission letters - Online cover letter for job applications) - Instructions - Recommendations - Write a blog (General) - Report Writing (Industrial Visit Report and Event Reports) - formal and informal emails.

Module II **20 Hours**

Grammar: Sequence adverbs - Phrasal verbs - Relative clauses – Imperatives - Infinitives - Conditionals.

Listening: Listening to review of food items - Listening to results of surveys- Listening to motivational talks & podcasts

Speaking: Expressing likes and dislikes - Describing a favourite snack - Giving advices and suggestions - Speculating about past and future Events – Group Discussion

Reading: Reading different expository texts - Reading to factual texts - Print and online media- Reading Comprehension

Writing: Process Descriptions – Email Writing (Requesting for information) - Reviewing Movie – Social media feeds/posts (Any Social Media)

List of Experiments: **20 Hours**

1. Mini Presentation and Picture Prompt Discussion
2. Debate Tournament
3. Listening, Mind Mapping & Summarization
4. Listening to Stories and Providing the Innovative Climax
5. Reading Comprehension
6. Writing - Interpretation of Visuals

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO 1 : Utilize the basic English grammar and vocabulary to acquire professional communication skills.	Apply
CO 2 : Develop listening and speaking skills through classroom activities based on listening comprehension, recapitulation, interpretation and debate on the same	Apply
CO 3 : Read and write social media posts and comments	Apply
CO 4 : Perform as a member of a team and engage in individual presentation	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO4	-	-	-	-	-	-	-	-	2	3	-	-	-	-

High-3; Medium-2;Low-1

Textbooks:

T1. Jack C. Richards, Jonathan Hull, and Susan Proctor, “Interchange - Student’s book 2”, 5th Edition, Cambridge University Press, South Asia Edition, 2022.

T2. Jack C. Richards, Jonathan Hull, and Susan Proctor, “Interchange - Student’s Book 1”, 5th Edition, Cambridge University Press, South Asia Edition, 2022.

Reference Book(s):

R1. David Bohlke, Jack C. Richards, “Four Corners”, 2nd Edition, Cambridge University Press,2018.

R2. Adrian Doff, Craig Thaine, Herbert Puchta, Jeff Stranks, Peter Lewis-Jones, Graham Burton,Empower B1 – Student’s Book, Cambridge University Press, 2020.

R3. Raymond Murphy, “Intermediate English Grammar” 30th Edition, Cambridge University Press,2022.

Web References:

1. https://speakandimprove.com/
2. https://writeandimprove.com/
3. https://www.cambridgeenglish.org/exams-and-tests/linguaskill/

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 **BOS Chairman**

<table>
<tr><td colspan="2">Course Code: 23MAI102</td><td colspan="2">Course Title: Matrices and Calculus
(Common to AU, EA, EC, EE, EV & ME)</td></tr>
<tr><td colspan="2">Course Category: Minor</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week)
3:0 :2</td><td>Credits: 4</td><td>Total Contact Hours:75</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

The course is intended to impart knowledge on the use of matrix algebra techniques for practical applications, familiarize with differential calculus and acquire knowledge of mathematical tools to evaluate multiple integrals.

Module I **23 Hours**

Matrices

Definitions and examples of symmetric, skew symmetric and orthogonal matrices - Eigenvalues and Eigenvectors – Properties of Eigenvalues and Eigenvectors-Diagonalization of matrices through orthogonal transformation - Cayley-Hamilton Theorem (without proof) – verification problems and properties - Transformation of quadratic forms to canonical forms through orthogonal transformation.

Differential and Integral Calculus

Curvature – Radius of curvature –Centre of curvature- Circle of curvature - Evolutes and Involutes - Evaluation of definite and improper integrals - Beta and Gamma functions – Properties and applications.

Multivariable Differentiation I

Limit – continuity - Mean value theorems and partial derivatives - Taylor's series and Maclaurin's series – Jacobian of functions of several variables.

Module II **22 Hours**

Multivariable Differentiation II

Maxima, Minima and saddle points of functions of several variables - Method of Lagrange's multipliers.

Multiple Integral

Multiple Integration: Double integrals - Change of order of integration in double integrals - Change of variables (Cartesian to polar, Cartesian to spherical and Cartesian to cylindrical) - Triple integrals - Applications: Finding areas and volumes.

Ordinary Differential Equations Of Second and Higher Orders

Second and higher order linear differential equations with constant coefficients – Second order linear differential equations with variable coefficients (Cauchy - Euler equation, Legendre's equation) – Method of variation of parameters – Solution of first order simultaneous linear ordinary differential equations

List of Experiments: **30 Hours**

1. Introduction to MATLAB.
2. Rank of matrix and solution of system of linear algebraic equations.
3. Finding Eigen values and Eigen vectors of a matrix.
4. Solving ordinary differential equation.
5. Gram Schmidt Procedure.
6. Finding Maxima, Minima of a function.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Determine the canonical form of a quadratic form using orthogonal transformation.	Apply
CO2: Identify the evolute of a curve and solve the improper integrals using beta gamma functions.	Apply
CO3: Examine the extreme value of multivariate functions.	Apply
CO4: Evaluate the area and volume using multiple integrals and solve the higher order differential equations.	Apply
CO5: Demonstrate the understanding of calculus concepts through modern tools.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	3	-	-	-	-	-	-	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Erwinkreyzig, Advanced Engineering Mathematics, 9th edition, John Wiley& Sons, 2006.

T2. Veerarajan T., Engineering Mathematics for first year, 3rd edition, Tata McGraw-Hill,

Reference Book(s):

R1. G.B.Thomas and R.L Finney, Calculus and Analytic Geometry, 9th edition, Pearson, Reprint, 2002.

R2. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

R3. P. Sivaramakrishna Das , C. Vijayakumari , Engineering Mathematics, Pearson India, 2017.

Web References:

1. https://nptel.ac.in/courses/111107112
2. https://nptel.ac.in/courses/111104031

Course Code: 23CHI101	Course Title: Chemistry for Electrical Sciences (Common to EC, EE)		
Type of Course: Minor	Course Level: Introductory		
L:T:P (Hours/Week) 3: 0:2	Credits:4	Total Contact Hours:75	Max Marks:100

Course Objectives

The course is intended to impart the knowledge of chemistry involved in Electrochemistry, Corrosion and its control, Spectroscopic technique, Fuels and Nanomaterials.

Module: I **23 Hours**

Electrochemistry and Batteries:

Electrochemistry - Basic terminologies - Potentiometric titration – Nernst equation – Batteries – Types and Characteristics, Construction, working and applications - Lead –Acid battery, Lithium-ion battery – Fuel cells - Construction, working and applications – Hydrogen Oxygen fuel cell.

Corrosion and its Control:

Corrosion – Dry and Wet corrosion – Mechanism of electrochemical corrosion – Galvanic corrosion and Concentration cell corrosion, Factors influencing corrosion. Corrosion Control methods – Cathodic protection methods, Metallic coating – Galvanizing, Tinning – Chrome plating and Electroless plating of Nickel

Spectroscopic Techniques:

Spectroscopy- Electromagnetic spectrum, Absorption and Emission spectroscopy – Relationship between absorbance and concentration – Derivation of Beer-Lambert's law (problems).

Module: II **22 Hours**

Spectroscopic Techniques:

UV - Visible Spectroscopy, Atomic Absorption Spectroscopy, Flame photometry - Principle, Instrumentation, and applications.

Biofuels and Lubricants:

Biomass - Biogas - Constituents, manufacture and uses. General outline of fermentation process - manufacture of ethyl alcohol by fermentation process. Combustion - Calorific values - Gross and Net calorific value - Problems based on calorific value. Lubricants - Classification of lubricants - Properties of liquid lubricants and their significance - Greases - Common grease types and properties. Components of grease – Base oil, additives and thickener.

Synthesis and Applications of Nano Materials:

Introduction - Difference between bulk and Nano materials - size dependent properties. Nano scale materials - Particles, clusters, rods, and tubes. Synthesis of Nanomaterials: Sol-Gel process, Electro deposition, Hydrothermal methods. Applications of Nano materials in Electronics, Energy science and Medicines. Risk and future perspectives of nano materials.

LIST OF EXPERIMENTS: (Any 6 experiments) **30 Hours**

1. Estimation of Fe^{2+} by potentiometric titration.
2. Determination of corrosion rate by weight loss method.
3. Estimation of iron in water by spectrophotometry
4. Determination of Cloud and Pour Point.
5. Green Synthesis of Silver Nanoparticles by Neem leaf.
6. Conductometric titration of strong acid against strong base.
7. Determination of strength of acid by pH metry.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Understand and explain the chemistry involved in Electrochemistry, Corrosion, Spectroscopic techniques, Fuels and Nanomaterials.	Understand
CO2: Apply the acquired knowledge of chemistry to solve the Engineering problems.	Apply
CO3: Analyze the Engineering problems through the concept of Electro chemistry, Spectroscopic techniques, Fuels, and Nanomaterials.	Apply
CO4: Apply the knowledge of chemistry to investigate Engineering materials by volumetric and instrumental methods and analyze, interpret the data to assess and address the issues of Environmental Pollution	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	3	-	-	-	-	-	-	-	-	-	-

Text book(s):

T1. Jain and Jain, Engineering Chemistry, 17th Edition, Dhanpat Rai Publishing Company, New Delhi, 2018.

T2. Wiley Engineering Chemistry, 2nd Edition, Wiley India Pvt Ltd, New Delhi, 2011.

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 **BOS Chairman**

Reference Book(s):

R1. Dara S. S and Umare S. S., A textbook of Engineering Chemistry, 12th Edition, S. Chand & Co Ltd, New Delhi , 2014.
R2. V. R. Gowariker, N. V. Viswanathan and Jayadev Sreedhar, Polymer Science,4th Edition New Age International(P) Ltd, Chennai ,2021.
R3. Jeffery G. H., Bassett. J., Mendham J and Denny R. C., Vogel's Textbook of Quantitative Chemical Analysis, 5th Edition Oxford, ELBS, London, 2012.

Web References:

1. http://nptel.ac.in/courses/122101001/downloads/lec.23.pdf
2. https://nptel.ac.in/courses/104106075/Week1/MODULE%201.pdf
3. https://nptel.ac.in/courses/103102015/

Course Code:23EET101	Course Title: Basics of Electrical Engineering		
Course Category: Major		**Course Level: Introductory**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Course Objectives:

The course is intended to impart the knowledge on basic DC and AC circuits, magnetic and electro-magnetic circuit. Also the course details single phase and three phase system, safety protection and wiring concepts.

Module I **22 Hours**

Electric circuits: Definition, symbol and unit of quantities – Active and Passive elements – Ohm's Law: statement, illustration and limitation – Kirchhoff's Laws: statement and illustration, voltage division rule –current division rule - Method of solving a circuit by Kirchhoff's laws – Star to Delta and Delta to Star transformation - problems.

Magnetic Circuits: Definition of magnetic quantities – Basic Terminology: MMF, field strength, flux density, reluctance – comparison between electric and magnetic circuits – Series and parallel magnetic circuits with composite materials, numerical problems.

Electromagnetic Induction: Faraday's laws, problems, Lenz's law – statically induced and dynamically induced emfs – Self-inductance and mutual inductance, coefficient of coupling.

Module II **23 Hours**

AC Fundamentals: Generation of single phase alternating EMF – Terminology –– Representation of sinusoidal waveforms: frequency, period, Root Mean Square (RMS)Average value of AC – form factor – Phasor representation of alternating quantities – Pure –Resistive, Inductive and Capacitive circuits – Problems .3 Phase System: line and phase values, relation between line and phase values – phase sequence -3 Wire and 4 Wire system.

Electrical Wiring: Connectors and switches, systems of wiring, domestic wiring installation, sub circuits in domestic wiring, simple control circuit in domestic installation, industrial electrification - circuit protection devices, fuses, MCB, ELCB and relays.

Safety and Protection: Safety, electric shock, first aid for electric shock and other hazards, safety rules, use of multi-meters, grounding, importance of grounding, equipment grounding for safety.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the basic engineering fundamentals in solving Electric, Magnetic and Electromagnetic Circuits.	Apply
CO2: Apply the fundamentals of single phase AC circuits in Pure Resistive, Inductive and Capacitive circuits and basics of 3 phase AC system.	Apply
CO3: Understand the fundamental concepts of Three Phase System.	Understand
CO4: Report the financial requirement of installation of electrical wiring, safety standards and protection systems using case studies	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	1	-	-	-	1	-	1	-	-	1	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. R.Muthusubramanian and S.Salivahanan, “Basic Electrical and Electronics Engineering”, McGraw Hill India Limited, New Delhi, 2014.

T2. Kothari DP and I.J Nagrath, “Basic Electrical and Electronics Engineering”, Second Edition, McGraw Hill Education, 2020.

Reference Book(s):

R1. B.L Theraja, “Fundamental of Electrical Engineering and Electronics”, S.Chand Limited – 2006.

R2. J.B. Gupta, “Basic Electrical and Electronics Engineering”, S.K. Kataria & Sons, 2009.

R3. Smarajit Ghosh, “Fundamental of Electrical and Electronics Engineering”, 2nd Edition, PHI Learning Private Limited New Delhi, 2010.

R4. S. K. Sadhev, “Basic Electrical Engineering and Electronics”, Tata McGraw Hill, 2017.

Web References:

1. https://www.nptel.ac.in/courses/108108076/
2. https://www.oreilly.com/library/view/basic-electrical-and/9789332579170/
3. http://www.ait.ac.jp/en/faculty/lab-enginnering/latter/elec-material/
4. http://www.electrical4u.com

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 **BOS Chairman**

Course Code: 23MEL001		Course Title: Engineering Drawing (Common to AD,AM,AU,CS,EA ,EC,EE,EV,IT,ME, SC)	
Course Category: Multidisciplinary		Course Level: Introductory	
L:T:P(Hours/Week) 1: 0: 3	Credits:2.5	Total Contact Hours: 60	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on basic dimensioning. 2D and 3 D drawings such as points, lines,planes and solids on first quadrant.

Module I **8 Hours**

Basics of Engineering Drawing: Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning. Basic Geometrical constructions –Orthographic projection- Free hand Sketching.

Projection of Points, Lines: First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces by rotating object method.

Projection of Solids: Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one of the principal planes by rotating object method. Practicing three dimensional modeling of simple objects by CAD Software (Not for examination).

Module II **7 Hours**

Sectioned Solids: Sectioning of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by cutting planes inclined to one reference plane and perpendicular to the other – Orthographic views of sections of simple solids.

Development of Surfaces: Development of lateral surfaces of simple and truncated solids – Prisms, pyramids, cylinders using straight line and radial line method.

Isometric Projection: Principles of isometric projection – Isometric scale –Isometric projections of simple solids and truncated solids. Practicing three dimensional modeling of isometric projection of simple objects by CAD Software (Not for examination).

List of Experiments **45 Hours**

1. Lettering & Dimensioning
2. Projection of Points & Lines
3. Orthographic projections
4. Projection of Simple Solids
5. Projection of Section of Simple Solids
6. Development of Surfaces
7. Isometric Projections

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO 1: Apply the concepts related to free hand sketching, orthographic and Isometric projection in first quadrant.	Understand
CO2: Apply the concepts and draw projections of points in four different quadrants and lines located first quadrant.	Apply
CO3: Apply the concepts and draw projections and sections of simple solids using rotatingobject method.	Apply
CO4: Apply the concepts and draw lateral surface of simple solids using straight line andradial line development methods.	Apply
CO5: Apply the concepts and draw isometric view of simple solids and truncated solids using principles of isometric projection.	Apply
CO6: Conduct experiments to demonstrate concepts, implement and analyze the drawing concepts using engineering tool : Using AutoCAD.	Analyze

Textbook:

T1. Cencil Jensen, Jay D.Helsel and Dennis R. Short, “ Engineering Drawing and Design”, Tata McGraw Hill India, New Delhi, 3rd edition, 2019.

Reference Book(s):

R1. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill India, New Delhi, 2nd edition, 2014.

R2. Dhananjay A. Jolhe, “Engineering Drawing with an introduction to AutoCAD” Tata McGraw India, New Delhi, 3rd edition, 2010.

R3. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, Gujarat, 54rd edition, 2023.

PUBLICATIONS OF BUREAU OF INDIAN STANDARDS

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
2. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
3. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods. The mode of delivery is like practical.

Web References:

1 http://nptel.ac.in/courses/112103019/

2 https://www.coursera.org/specializations/autodesk-cad-cam-cae-mechanical-engineering

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO6	-	3	-	-	3	-	-	-	1	1	-	1	-	-

High-3; Medium-2; Low-1

Course Code:23EEL101		Course Title:Workshop Practice for Electrical Engineers	
Course Category: Major		**Course Level: Introductory**	
L:T:P(Hours/Week) 0:0:3	**Credits:1.5**	**Total Contact Hours:45**	**Max Marks:100**

Course Objectives

The course is intended to impart knowledge on electrical equipments, basic house wiring, and identification of resistors, capacitors and computers. Also the course provide an insight on soldering ,fitting, carpentry and plumbing experience

List of Exercises:

1. Introduction to switches, fuses, indicators and lamps – Basic switch board wiring with lamp, fan and three pin socket.
2. Staircase wiring.
3. Fluorescent Lamp wiring with introduction to CFL and LED types.
4. Energy meter wiring and related calculations/calibration.
5. Study of Iron Box wiring and assembly.
6. Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac)
7. Study of resistors and capacitors.
8. Soldering simple electronic circuits and checking continuity.
9. Assembly and dismantle of laptop/computer.
10. Inductor Design.
11. Fitting Trade: Demonstration and practice of fitting tools, Preparation of T-Shape, DovetailJoint, Dissembling and Reassembling of Tail Stock, Bench vice etc.
12. Carpentry: Demonstration and practice of carpentry tools, Preparation of Cross Half lap joint/ Mortise Tenon Joint.
13. Plumbing: Demonstration and practice of Plumbing tools, Preparation of Pipe joints with coupling for same diameter and with reducer for different diameters.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Conduct experiment and report the basic house wiring circuit by following professional engineering safety standards.	Apply
CO2: Examine and report the working of different electrical equipment with its technical advancements and sustainable development.	Analyze
CO3: Apply soldering procedure and identify the values of resistors and capacitors in simple circuits and report it.	Apply
CO4: Explain the function of different parts of a computer.	Understand
CO5: Analyze and report fitting, carpentry and plumbing practices.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	1	-	1	-	3	-	-	1	-
CO2	-	2	-	-	-	-	1	-	-	3	-	1	-	-
CO3	2	-	-	-	-	-	-	-	-	3	-	-	1	-
CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	2	-	-	-	-	-	-	-	3	-	-	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Felix W, “Basic Workshop Technology: Manufacturing Process”, Independently Published, 2019.

T2. Bruce J. Black “Workshop Processes, Practices and Materials”, Routledge publishers, 5th Edn. 2015.

T3. Engineering Practices Laboratory Manual, Ramesh Babu.V., VRB Publishers Private Limited, Chennai, Revised Edition, 2013 – 2014.

Reference Book(s):

R1. B.S. Raghuwanshi,”A Course in Workshop Technology” Vol I. & II,Dhanpath Rai & Co., 2015 & 2017.

R2. S. K. Hajra Choudhury,“Elements of Workshop Technology”, Vol. I & Vol. II, Media Promoters and Publishers, Mumbai. 14th Edition, 2007.

R3. T.Jeyapoovan, “Engineering Practices Lab Manua”, Vikas Pub, 4th Edn.2008.

R4. Soni P.M., Upadhyay P.A., Atul Prakashan, “Wiring Estimating, Costing and Contracting”, 2021.

Web References:

1. https://bharatskills.gov.in.

Different Trade E-Books (Fitting, Plumbing, Welding, Carpentry, Foundryman, Turner and House Wiring etc.) developed by National Instructional Media Institute, Chennai. Directorate General of Training, Ministry of Skill Development & Entrepreneurship, Govt. of India.

<table>
<tr><td colspan="2">Course Code: 23VAL102</td><td colspan="2">Course Title: Wellness for Students
(Common to all B.E/B.Tech Programmes)</td></tr>
<tr><td colspan="2">Course Category: VAC</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week)
0: 0 :2</td><td>Credits:1</td><td>Total Contact Hours:30</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:
The course is intended to impart knowledge on setting SMART goals for academic, career and life, applying time management techniques, articulating the importance of wellness for success in life and understanding the dimensions of wellbeing and relevant practices.

Module I **15 Hours**

GOAL SETTING Understanding Vision and mission statements - Writing personal mission statements – 'Focus' as a way of life of most successful people. Clarifying personal values, interests and orientations – Awareness of opportunities ahead – Personal SWOT analysis - Principles driving goal setting: Principle of response and stimuli, Circle of influence and circle of concern, What you see depends on the role you assume. Potential obstacles to setting and reaching your goals - Five steps to goals setting: SMART goals, Inclusive goals, Positive stretch, Pain vs gain, Gun-point commitment.

TIME MANAGEMENT - TOOLS AND TECHNIQUES Importance of planning and working to time. Pareto 80-20 principle of prioritization – Time quadrants as a way to prioritize weekly tasks – The glass jar principle - Handling time wasters – Assertiveness, the art of saying 'NO' – Managing procrastination.

CONCEPT OF WELLNESS – impact of absence of wellness - Wellness as important component to achieve success. Wellbeing as per WHO - Dimensions of Wellbeing: Physical, Mental, Social, Spiritual – indicators and assessment methods

Module II **15 Hours**

Simplified Physical Exercises. Fitness as a subset of Wellness – health related physical fitness - skill related physical fitness. Joint movements, Warm up exercises, simple asanas, WCSC simplified exercises.

PRACTICES FOR MENTAL WELLNESS

Meditation: Mind and its functions - mind wave frequency – Simple basic meditation – WCSC meditation and introspection tables. Greatness of friendship and social welfare – individual, family and world peace – blessings and benefits.
Food & sleep for wellness: balanced diet - good food habits for better health (anatomic therapy) – hazards of junk food - food and the gunas.

PUTTING INTO PRACTICE
Practicals: Using the weekly journal – Executing and achieving short term goals – Periodic reviews.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Set well-articulated goals for academics, career, and personal aspirations	Apply
CO 2: Apply time management techniques to complete planned tasks on time	Apply
CO 3: Explain the concept of wellness and its importance to be successful in career and life	Apply
CO 4: Explain the dimensions of wellness and practices that can promote wellness	Apply
CO 5: Demonstrate the practices that can promote wellness	Valuing

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	1	1	-	1
CO2	-	-	-	-	-	-	-	-	1	-	1	1
CO3	-	-	-	-	-	-	-	-	1	-	-	1
CO4	-	-	-	-	-	-	-	-	1	-	-	1
CO5	-	-	-	-	-	1	1	-	1	-	-	1

High-3; Medium-2;Low-1

Text Book(s):

T1. Reading material, workbook and journal prepared by PS team of the college

Reference Book(s):

R1. Stephen R Covey, “First things first”, Simon & Schuster UK, Aug 1997

R2. Sean Covey, “Seven habits of highly effective teenagers”, Simon & Schuster UK, 2004.

R3. Vethathiri Maharishi Institute for Spiritual and Intuitional Education, Aliyar, “Value education for harmonious life (Manavalakalai Yoga)”, Vethathiri Publications, Erode, I Ed. (2010).

R4. Dr. R. Nagarathna, Dr. H.R. Nagendra, “Integrated approach of yoga therapy for positive health”, Swami Vivekananda Yoga Prakashana, Bangalore, 2008 Ed.

R5. Tony Buzan, Harper Collins, “The Power of Physical Intelligence English”

<table>
<tr><td colspan="2">Course Code: 23VAT101</td><td colspan="3">Course Title: HERITAGE OF TAMILS
(Common to all B.E/B.Tech Programmes)</td></tr>
<tr><td colspan="3">Course Category: VAC</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week)
1: 0 :0</td><td colspan="2">Credit: 1</td><td>Total Contact Hours: 15</td><td>Max Marks:100</td></tr>
</table>

Pre–requisites

- NIL

Course Objectives

மாணவர்கள் இப்பாடத்தை கற்றலின் மூலம்

CO.1 மொழி மற்றும் இலக்கியம், பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை , நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் , திணைக் கோட்பாடுகள் மூலம் தமிழர் மரபை அறிந்து கொள்ள இயலும்.

CO.2இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பை அறிந்து கொள்ள இயலும்.

தமிழர் மரபு

அலகு 1 – மொழி மற்றும் இலக்கியம் 3

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் – சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பெளத்த சமயங்களின் தாக்கம் – பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு 2 – மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை 3

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள் – பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு 3 – நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் 3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு 4 – தமிழர்களின் திணைக் கோட்பாடுகள் 3

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக் கோட்பாடு – சங்க காலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறைமுகங்களும் – சங்க காலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு 5 – இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு 3

இந்திய விடுதலைப் போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறபகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுய மரியாதை இயக்கம் – இந்திய மருத்துவத்தில் சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெ முத்துப் படிகள்– தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL : 15 PERIODS

Course Outcomes		Cognitive Level
மாணவர்கள் இப்பாடத்தை கற்றபின்		
CO.1	மொழி மற்றும் இலக்கியம், பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை , நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் , திணைக் கோட்பாடுகள் மூலம் தமிழர் மரபை அறிந்து கொள்வார்கள்.	அறிதல் (Understand)
CO.2	இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பை அறிந்து கொள்வார்கள்.	அறிதல் (Understand)

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	1	-	-

High–3; Medium–2; Low–1

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 BOS Chairman

TEXT - CUM REFERENCE BOOKS

1 தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே.பிள்ளை
(வெளியீடு. தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி – வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by:
Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 **BOS Chairman**

Course Code: 23VAT101	Course Title: HERITAGE OF TAMILS (Common to all B.E/B.Tech Programmes)		
Course Category: VAC		**Course Level: Introductory**	
L:T:P (Hours/Week) 1: 0 :0	**Credit: 1**	**Total Contact Hours: 15**	**Max Marks:100**

Pre–requisites

- NIL

Course Objectives

The course is intended to:

1. Understand the Heritage of Tamils in terms of Language and Literature, Rock Art Paintings to Modern Art – Sculpture, Folk and Martial Arts, Thinai Concept.
2. Understand the Contribution of Tamils to Indian National Movement and Indian Culture.

HERITAGE OF TAMILS

UNIT I LANGUAGE AND LITERATURE 3

Language Families in India - Dravidian Languages – Tamil as a Classical Language – Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS 3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL : 15 PERIODS

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO.1 Understand the Heritage of Tamils in terms of Language and Literature, Rock Art Paintings to Modern Art – Sculpture, Folk and Martial Arts, Thinai Concept.	Understand
CO.2 Understand the Contribution of Tamils to Indian National Movement and Indian Culture.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	1	-	-

High–3; Medium–2; Low–1

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 **BOS Chairman**

TEXT - CUM REFERENCE BOOKS

1 தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே.பிள்ளை
(வெளியீடு. தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி – வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
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8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
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Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

SEMESTER II

Course Code: 23ENI201		Course Title: Communication Skills II (Common to all B.E/B.Tech Programmes)	
Course Category: AEC		Course Level: Introductory	
L:T:P(Hours/Week) 2:0:2	Credits: 3	Total ContactHours:60	Max Marks:100

Course Objectives

The course is intended to impart effective and accurate language in business correspondence on par with B2 level of CEFR Scale.

Module I **20 Hours**

Grammar: Linking Words - Collocations –Sentence Completion - Articles –Adverbs– Indefinite Pronoun

Listening: Listening to short conversations - Listening for gist and summarizing - Listening for detail - Responding to straightforward questions.

Speaking: Making statements of facts - Agreeing and disagreeing to opinions - Respond to queries - Group Discussion.

Reading: Read and select (phrasal verbs & relative clause)- Cloze Test - Gapped sentences - Multiple- choice gap-fill

Writing: Paragraph Writing: Descriptive, narrative, persuasive and argumentative - Emails: Giving information - Making enquiries - Responding to enquiries - Power Point Presentation

Module II **20 Hours**

Grammar: Expressions of cause and result – Concord - Error Spotting (Parts of Speech & Indian English) - Prepositions

Listening: Listening for identifying main points - Responding to a range of questions about different topics - Listening to identify relevant information

Speaking: Empathetic Enunciation – Situation handling – Visual Interpretation - - Short presentations

Reading: Intensive Reading: Comprehending business articles, reports and proposals and company websites-- Open gap-fill - Extended reading

Writing: – Report Writing - Memo – Complaint letter - Business Letters (Seeking permission & Providing Information)

List of Experiments: **20 Hours**

1. Listening to Monologue and Extended Listening Activity I
2. Listening to Monologue and Extended Listening Activity II
3. Expressing Opinions and Situational based speaking
4. Mini Presentation and Visual Interpretation
5. Reading Comprehension
6. Writing letter, email and report

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO1: Identify the common errors in written and spoken correspondence.	Apply
CO2: Develop listening, reading and speaking skills through task based activities in listening, reading comprehension, recapitulation, interpretation and discussion.	Apply
CO3: Read business correspondences like memo, Email, letter, proposals and write reports and website entries and product launches.	Apply
CO4: Perform as an individual and member of a team and engage effectively in group discussion and individual presentation.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO4	-	-	-	-	-	-	-	-	2	3	-	-	-	-

High-3; Medium-2;Low-1

Textbooks:

T1. Guy Brook- Hart, "Business Benchmark Upper Intermediate", 2nd Edition, South Asian, Cambridge University Press, 2020.

T2. Norman Whitby, "Business Benchmark pre-intermediate to Intermediate", 2nd Edition, South Asian, Cambridge University Press, 2014.

Reference Book(s):

R1. Hewings Martin - Advanced Grammar in use Upper-intermediate Proficiency, CUP,3rd Edition,2013.

R2. Clark David – Essential BULATS (Business Language Testing Service), CUP, 2006.

R3. Adrian Doff, Craig Thaine, Herbert Puchta, Jeff Stranks, Peter Lewis-Jones, Rachel Godfrey,Gareth Davies, Empower B1+ – Student's Book, Cambridge University Press,2015.

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 **BOS Chairman**

Web References:

1. https://speakandimprove.com/
2. https://writeandimprove.com/
3. https://www.cambridgeenglish.org/exams-and-tests/linguaskill/

<table>
<tr><td colspan="2">Course Code:23FLT201</td><td colspan="3">Course Title: Foreign Language - Japanese
(Common to all B.E/B.Tech Programmes)</td></tr>
<tr><td colspan="3">Course Category: AES</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours:45</td><td>Max. Marks:100</td></tr>
</table>

Course Objectives:

The course objectives intended to:

1. Express a basic exposure on Japanese language and culture
2. Express thoughts and communicate in the beginner level of Japanese with native Japanese speaker
3. Identify the kanji etymology as well as use it in basic vocabulary required for the JLPT / NAT 5 examination level
4. Read and write 100 kanji of the official JLPT N5
5. Choose the appropriate verb forms for learning and practicing the Japanese language

UNIT I Introduction to Japan and greetings 9 Hours

Japan : Land and culture - Introduction to Japanese language – Greetings – Seasons - Days of the week - Months of the year – Dates of the month - Self introduction – Numbers (Upto 99,999) – Expressing time – Conversation audio and video.

Listening: Listening to Greetings - Listening for Specific Information: Numbers, Time. Speaking: Self-Introduction

UNIT II Building vocabulary 9 Hours

Family relationships - Colours - Parts of body - Profession - Directions - Time expressions (today, tomorrow, yesterday, day before, day after) - Japanese housing and living style - Food and transport (vocabulary) - Stationery, fruits and vegetables

Listening: Listening for Specific Information: Directions, Family Members, Parts of body Speaking: Introducing one's family.

UNIT III Writing systems 9 Hours

Hiragana Chart 1 - vowels and consonants and related vocabulary – Hiragana Charts 2&3, double consonants, vowel elongation and related vocabulary – Introduction to Kanji – Basic Vocabulary – Basic Conversational Phrases.

Listening: Listening to Japanese Alphabet Pronunciation, Simple Conversation. Speaking: Pair Activity (Day to day situational conversation)

UNIT IV Kanji and preposition 9 Hours

Katakana script and related vocabulary – Basic kanjis: naka, ue, shita, kawa , yama , numbers (1- 10, 100, 1000, 10,000 and yen) , person, man, woman, child, tree , book , hidari, migi, kuchi , 4 directions - Usage of particles wa, no, mo and ka and exercises - Usage of kore, sore, are, kono, sono, ano, arimasu and imasu - Particles – ni (location) and ga , donata and dare - Particles ni (time), kara, made , ne , koko, soko, asoko and doko - Directions : kochira, sochira, achira and dochira , associated vocabulary (mae, ushiro, ue, shita, tonari, soba, etc.)

Listening: Listening to conversation with related particles

UNIT V Verb forms 9 Hours

Introduction to Verbs - Verbs –Past tense, negative - i-ending and na-ending adjectives introduction - ~masen ka, mashou - Usage of particles de, e , o, to, ga(but) and exercises - Adjectives (present/past – affirmative and negative) – Counters - ~te form

Listening: Listening to different counters, simple conversations with verbs and adjectives.

Speaking: Pair Activity (Explaining one's daily routine by using appropriate particles and verbs)

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1: Recognize and write Japanese alphabet	Understand
CO2: Comprehend the conversation and give correct meaning	Understand
CO3: Apply appropriate vocabulary needed for simple conversation in Japanese language	Apply
CO4: Apply appropriate grammar to write and speak in Japanese language	Apply
CO5: Speak using words of the Japanese language	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	1	-	-
CO4	-	-	-	-	-	-	-	-	-	3	-	1	-	-
CO5	-	-	-	-	-	-	-	-	2	3	-	1	--	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Genki 1 Textbook: An Integrated Course in Elementary Japanese by Eri Banno, Yoko Ikeda, Yutaka Ohno, Yoko Sakane, Chikako Shinagawa, Kyoko Tokashiki published by The Japan Times

T2. Genki 1 Workbook: An Integrated Course in Elementary Japanese by Eri Banno published by The Japan Times

Reference Book(s):

R1. Japanese for Everyone: Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007

R2. Japanese for Everyone: Elementary Main Textbook1-2, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007

Web References:

1. www.japaneselifestyle.com
2. www.learn-japanese.info/
3. www.learn.hiragana-katakana.com/typing-hiragana-characters/
4. www.kanjisite.com/

<table>
<tr><td colspan="2">Course Code:23FLT202</td><td colspan="3">Course Title: Foreign Language - German
(Common to all B.E/B.Tech Programmes)</td></tr>
<tr><td colspan="3">Course Category: AEC</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours:45</td><td>Max. Marks:100</td></tr>
</table>

Course Objectives:

The course is intended to:

1. Listen and understand numbers, names and dialogues of a native speaker on par with A1 level.
2. Speak and introduce self in simple sentences to convey their opinion and ideas on par with A1 level.
3. Read simple passages and given text on par with A1 level.
4. Write letter and simple sentences on par with A1 level.

UNIT I Basic Introduction to German Scripts 9 Hours

Theme and Text (Introduction to German - German script, Deutsche Namen, Daily Greetings and Expressions) – Grammar ('wh' questions, das Alphabet)– Speak Action (Buchstabieren, sich und andere vorstellen nach Namen und Herkunft fragen, internationale Wörter auf Deutsch verstehen, jemanden begrüßen)– pronunciation (Buchstabieren J,V,W,Y, - Long vowels A,E,I,O,U - Pronunciation of Ä,Ü,Ö) – To learn (internationale Wörter in Texten finden, Wörter sortieren)

Theme and Text (Gespräche im caf'e, Getränkekarte, Telefon-buch, Namen, Rechnungen) – Grammar (Frägesatze mit wie, woher, wo, was Verben in präsens Singular und Plural, das Verb Sein, Personalpronomen und Verben)– Speak Action (eine Gespräch beginnen sich und andere vorstellen zählen, etwas bestellen und bezhalen Telefonnummern und verstehen)– pronunciation (Wortakzent in Verben und in Zahlen) – To learn (Grammatiktabelle ergänzen, mit einem Redemittelkasten arbeiten)

UNIT II Numbers and Nominative Case 9 Hours

Theme and Text (Numbers – 1 to 12 (Eins bis Zwolf) – 20, 30, 40, 90 (zwanzig-Neunzig) – All Numbers (1-10000) – German Currency (Euro) – Basic Mathematics (plus, Minus, Malen, Geteilt durch)) – Grammar (Introduction of verbs –Have Verb – To Come, To Speak, To Read, To Drive, To Fly, To write, To Eat, To sleep, To take etc.,)

Theme and Text (Communication in course) – Grammar (Singular and Plural, Artikel: der,das,die/ ein,eine, verneinung: kein, keine, Komposita: das Kursbuch) – Speak Action (Gegenständen fragen/ Gegenstände benennen im kurs:) – pronunciation (word accent Marking, Umlaute ö ä ü hören und sprechen) – To learn (Lernkarten schreiben, Memotipps, eine Regel selbst finden)

Theme and Text (City, Town, Language: Nachbar, Sprachen, Sehenswürdigkeiten in Europa) – Grammar (Past tense for Sein, W-Frage, Aussagesatz und Satzfrage) – Speak Action (about city and siteseeing) – pronunciation (Satzakzent in Frage- und Aussagesätzen) – To learn (eine Regel ergänzen, eine Grammatiktabelle erarbeiten, Notizen machen)

UNIT III Akkusative Case and Prepositions 9 Hours

Theme and Text (Menschen und Hauser, Furniture catalogue, E-Mail, House information) – Grammar (possesivartikel im Nominativ, Artikel im Akkusativ, Adjektive im satz, Graduierung mit zu)– Speak Action (Whonung bescreiben about perons and things)– pronunciation (consonant - ch) – To learn (wortschatz systematisch)

Theme and Text (Termine - Appointment and punctuality in Germany) – Grammar (questions with wann?, Preposition (am, um, von... bis), verneinung mit nicht, trennbare verben, präteritum von haben) – Speak Action (Daily plan making, time commitment, excuse for late coming) – pronunciation (consonants- p,b,t,d / k,g) – To learn (Rollenkarten arbeiten)

Theme and Text (orientation in working area, go for work, floor plan city plan, office and computer) – Grammar (preposition: in,neben, unter, auf, vor, hinter, an, zwischen, bei und mit + Datic)– Speak Action (work place, work, giving appointments)– pronunciation (consonants: f,w und v) – To learn (Making notice in calender)

UNIT IV Dativ Case and Prepositions 9 Hours

Theme and Text (Holiday and Party, holiday plan, party plan in Germany) – Grammar (regular and iregular verbs) – Speak Action (holiday speak, accident, Ich-Text schreiben) – pronunciation (lange und kurze vokale markieren) – To learn (Text Order)

Theme and Text (organising an Excursion to Berlin through city orientation, Bus plan, City plan, post card, Excursion programme) – Grammar (preposition: in, durch, über + Akkusativ: zu, an... vorbei + Dativ, Modalverb wollen) – Speak Action (Tourism, culture, postcard preparation, travel description) – pronunciation (r and l)– To learn (plaket making)Theme and Text (Beruf und all Tag, Visiten karten, wörterbuch) – Grammar – Speak Action (profession, statistic speaking) – pronunciation (n,ng and nk)– To learn (wörterbuch , text information in tabel)

UNIT V Adjectives and Pronunciation 9 Hours

Theme and Text (Haushaltstipp, kochrezept, maße und gewichte, Mahlzeiten und Gerichte) – Grammar (jeden Tag, manchmal, nie, Question - welche, Comparison – viel, gut, gern) – Speak Action (about eat, drink question and answers) – pronunciation (e,en,el,er) – To learn (Text auswerten und zusammenfassen)

Theme and Text (Clothing , colour, weather) – Grammar (Adjecktive im Akkusativ, unbestimmer Artikel) – Speak Action (weather, dress and colour understanding) – pronunciation (e-o- ö and ie-u- ü) – To learn (wetter and Farben interkulturelle)

Theme and Text (in super market,purchase, House Maintainence, Emotion, Sports, Body parts) – Grammar (Modal Verb) – Speak Action (Body parts) – To learn (Rollenkarten arbeiten)

Total:45 Hours

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Recognize and write German alphabet, numbers.	Understand
CO2: Comprehend the conversation and give correct meaning	Understand
CO3: Apply appropriate grammar and vocabulary to write and speak.	Apply
CO4: Apply appropriate cases and texts to listen, write and speak.	Apply
CO5: Speak and read using words of the German language	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	1	-	-
CO4	-	-	-	-	-	-	-	-	-	3	-	1	-	-
CO5	-	-	-	-	-	-	-	-	2	3	-	1	--	-

High-3; Medium-2;Low-1

Text Book(s)

T1. Netzwerk, “Deutsch als Fremdsprache” by Stefanie Dengler, Paul Rusch, Helen Schmitz published by Goyal Publishers & Distributors Pvt Ltd;

T2. Funk, Kuhn, Demme, “Studio D A1 Deutsch als Fremdsprache” published by Goyal Publishers & Distributors Pvt Ltd;

Reference Book(s)

R1. Hueber, “Fit for Goethe- Zertifikat A1 (Start Deutsch 1)” by Goyal Publishers and Distributors; 2016

Course Code: 23MAI202	Course Title: Complex Variables and Transforms (Common to AU, EC, EE, EV & ME)		
Course Category: Minor		**Course Level: Introductory**	
L:T:P(Hours/Week) 3:0 :2	**Credits: 4**	**Total Contact Hours:75**	**Max Marks:100**

Course Objectives:
This course is intended to enable the student to acquire the knowledge on the calculus of functions of complex variables and continuous, discrete transforms.

Module I **23 Hours**

Vector Calculus
Gradient – Divergence – Curl – Line integrals – Surface integrals – Volume integrals – Theorems of Green, Gauss and Stokes (without proof) and their applications.

Complex Variables (Differentiation)
Cauchy-Riemann equations – Analytic functions – Properties – Harmonic functions – Finding harmonic conjugate – Conformal mapping (w=z+a, w= az, w=1/z,) – Mobius transformation and their properties.

Complex Variables I (Integration)
Cauchy Integral formula – Cauchy Integral theorem – Taylor's series – Singularities of analytic functions – Laurent's series.

Module II **22 Hours**

Complex Variables II (Integration)
Residues – Cauchy Residue theorem – Contour integrals – Evaluation of real definite integrals around unit circle and semi-circle (Excluding poles on the real axis).

Laplace Transform
Laplace Transform – Properties of Laplace Transform – Laplace transform of derivatives and integrals – Laplace transform of periodic functions -Inverse Laplace transforms - Convolution theorem – Solution of ordinary differential equations by Laplace Transform method.

Fourier Series
Dirichlet's condition -Fourier series – Even and odd functions- Half range sine and cosine series - Parseval's identity--Harmonic Analysis.

List of Experiments(Using Python):	30 Hours
1. Find gradient of a given scalar function, divergence and curl of a vector function. 2. Verify Green's theorem in a plane. 3. Graphically plot time and frequency domain of standard functions and compute Laplace transform of In- built functions. 4. Find the Fourier series of a periodic function. 5. Compute Inverse Laplace transform of In- built functions.	

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain the concepts of Vector Differentiation and Integration.	Apply
CO2: Using the concept of complex variables to construct analytical functions and evaluate definite integrals.	Apply
CO3: Apply Laplace transform techniques to solve ordinary differential equations.	Apply
CO4: Compute the Fourier series expansion for given periodic functions.	Apply
CO5: Develop programs using Complex Variables and Transforms concepts through modern tool.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	3	-	-	-	-	-	-	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Erwinkreyzig, Advanced Engineering Mathematics, 10^{th} edition, John Wiley& Sons, 2011.

T2. Veerarajan T., Engineering Mathematics for first year, 3^{rd} edition, Tata McGraw-Hill, New Delhi, 2019.

Reference Book(s):

R1. G.B.Thomas and R.L Finney, Calculus and Analytic Geometry, 9^{th} edition, Pearson, Reprint, 2002.

R2. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, 36^{th} Edition, 2010.

R3. P. Sivaramakrishna Das , C. Vijayakumari , Engineering Mathematics, Pearson India, 2017.

Web References:

1. https://nptel.ac.in/courses/111107112
2. https://nptel.ac.in/courses/111104031

<table>
<tr><td colspan="2">Course Code: 23PHI201</td><td colspan="2">Course Title: Physics for Electrical Sciences
(Common to EA, EC, EE)</td></tr>
<tr><td colspan="2">Course Category: Minor</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 2</td><td>Credits: 4</td><td>Total Contact Hours:75</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

The course is intended to impart knowledge on the fundamental laws and relations in electricity, magnetism, electromagnetism and electromagnetic waves.

Module I **22 Hours**

Electrostatics: Definition of electric charge-Coulomb's Law – Electric field intensity – Field intensity due to point and line charges – Electric flux density -Gauss's law- Application of Gauss's law: Determine the field due to a line charge and a plane sheet of charge – Electric potential-Equipotential surfaces-Potential gradient.

Magnetostatics: Definition of magnetic flux- magnetic field intensity-Lorentz Law of force- Biot – Savart law, Ampere's Law- Application of Ampere's Law: Magnetic induction due to a long linear conductor and solenoid - Magnetic field due to straight conductors- circular loop – Magnetic flux density (B) - Magnetic potential.

Electric Fields in Materials: Dielectrics: An atomic view - Dielectric Polarization- Dielectrics and Gauss's law- Dielectric Strength- Energy stored in a dielectric medium - Capacity of a condenser - Capacitance - coaxial, Spherical capacitor- Poisson and Laplace Equation.

Module II **23 Hours**

Magnetic Fields in Materials: Magnetic susceptibility and permeability- properties of dia, para and ferro magnetic materials-hysteresis loop.

Electromagnetic Induction: Faraday's law – Lenz's law – Time varying magnetic field - self Inductance - self Inductance of a solenoid- Mutual inductance- Mutual inductance of two solenoids. Charge conservation law - continuity equation- displacement current- Maxwell's equations.

Electromagnetic Waves: Electromagnetic waves in free space - Poynting vector - Propagation of electromagnetic waves in dielectrics – Phase velocity- Propagation of electromagnetic waves through conducting media- penetration or skin depth.

List of Experiments (Any six) **30 Hours**

1. Verification of Ohms' law.
2. Test the Faraday's hypothesis of magnetic field induction.
3. Determination of specific resistance of the given material using Carey foster's bridge.
4. Measurement of capacitance using Schering Bridge.
5. Measurement of inductance using Maxwell Bridge.
6. Determination of wavelength of the given light source using spectrometer.
7. Determination of Dielectric constant of a given Material.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: **Apply** the concepts of static electric and magnetic fields to obtain the electric and magnetic characteristics of the materials.	Apply
CO2: **Interpret** the behavior of materials in electric and magnetic fields.	Apply
CO3: **Apply** the concept of time-varying electric and magnetic fields to obtain the propagation characteristics of electromagnetic waves in different media.	Apply
CO4: **Conduct, analyze and interpret** the data and results from the physics laboratory experiments.	Evaluate

Course Articulation Matrix

CO Vs PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	3	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2; Low-1

Textbooks:

T1. R.K.Gaur and S.L.Gupta, "Engineering Physics", Dhanpat Rai publications, New Delhi, 8th Edition, 2011.

T2. W. H. Hayt and John A. Buck, "Engineering Electromagnetics", Tata McGraw Hill, New Delhi, 6th Edition, 2014.

Reference Book(s):

R1. David Griffiths, "Introduction to Electrodynamics", Pearson Education, 4th Edition, 2013

R2. K. A. Gangadhar and P. M. Ramanathan, " Electromagnetic Field Theory", Khanna Publishers, New Delhi, 5th Edition, 2013.

R3. Mathew. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Press, 4th Edition, 2009.

Web References:

1. http://nptel.iitm.ac.in
2. http://openems.de/start/index.php
3. https://bop-iitk.vlabs.ac.in/List%20of%20experiments.html

Course Code: 23EET201		Course Title: Solid State Devices	
Course Category: Major		Course Level: Introductory	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge about the diodes, and transistors in electronic circuits.

Module I **22 Hours**

Formation of energy bands, Fermi level, energy- band models, direct and indirect band gap, electrons and holes, doping, intrinsic and extrinsic semiconductors, elemental and compound semiconductor, generation, recombination and injection of carriers, Drift and Diffusion of carriers, basic governing equations in semiconductors.

PN Junctions, Formation of Junction, Physical operation of diode, Contact potential and Space Charge phenomena, I - V Characteristics,

Special diodes- Zener diode Tunnel diode, LED, Varactor diode and Photo Diode. I - V Characteristics

DC Analysis – Small Signals and Large signal models of PN junction diode and AC equivalent circuit. Problems using diode circuits.

Module II **23 Hours**

Bipolar Junction Transistor: Device structure and physical operation, I-V characteristics. Field Effect Transistor JFET-MOSFET- Device Structure and Mode of operation, I- V Characteristics, Threshold Voltage.

DC Analysis of BJT Circuits, CB, CE and CC Configuration.

Field Effect Transistor (FET): DC Analysis of MOSFET Circuits, MOSFET CS, CG and Source Follower Circuits- Problems

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO 1: Define, understand and explain the concepts related to semiconductors	Understand
CO 2: Apply the knowledge of engineering fundamentals in construction and working of diodes and transistors	Apply
CO3: Model and analyze the characteristics of PN junction diode, Zener diode and Special diodes report the inference for the datasheet specification using hardware and software tool	Analyze
CO4: Design and Implement the hobby project using the transistors to provide simple solutions in societal and environmental contexts and relate the chosen application with its construction and working.	Create

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	1	-	-	-	-	1	-	-	-	-
CO4	-	-	3	-	-	1	1	-	-	-	-	1	-	-

High-3; Medium-2;Low-1

Textbooks:

T3. Adel S. Sedra, Kenneth C. Smith & Arun N. Chandorkar, Microelectronic Theory and Applications, 5th Edition, Reprint, Oxford University press, New York, USA, 2013.

T4. B G.Streetman and S.Banerjee, Solid State Electronic Education 7th Edition, New Delhi, India, 2015.

Reference Book(s):

R1. Anil K Maini, Varsha Agarwal, “Electronic Devices and Circuits”, Wiley India Private Limited, New Delhi, 1st Edition, 2015.

R2. Salivahanan. S, Suresh Kumar. N, Vallavaraj.A, “Electronic Devices and circuits”, Tata McGraw Hill, New Delhi, 4th Edition, 2016.

R3. R. Muthusubramanian and S Salivahanan, “ Basic Electrical and Electronics Engineering”, McGraw Hill India Limited, New Delhi, 2014

R4. Robert L Boylestad and Louis Nashelsky, “Electron Devices and Circuit Theory”, Pearson Prentice Hall, New Delhi, 11th Edition, 2014.

Web References:

1. https://nptel.ac.in/courses/108108122
2. https://nptel.ac.in/courses/108108122
3. https://nptel.ac.in/courses/108108122
4. https://archive.nptel.ac.in/courses/108/102/108102145/

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 **BOS Chairman**

Course Code: 23CSI201		Course Title: Problem Solving using Python Programming	
Course Category: Multi-Disciplinary		Course Level: Introductory	
L:T:P(Hours/Week) 3:0:2	Credits: 4	Total Contact Hours: 75	Max Marks:100

Course Objectives:

The course is intended to develop problem solving skills and knowledge in computer programming.

Module I **22 Hours**

Programming Constructs: Python interpreter and interactive mode – Python Basics: Data Types – Variables – Keywords – Literals – Usage of Operators – Comments – Indentation – Python standards in Coding.

Control structures: Sequential Statements – Selection Statements: conditional (if), alternative (if-else), chained conditional (if elif- else) – Iterative Control statements: while, for, nested loops, break, continue, pass.

Functions: Functions: Built-in and User defined functions - Defining and Calling function - Return values - Passing arguments to functions - Lambda Functions - Different types of arguments – Recursion - Scope of variables.

Module II **23 Hours**

Strings and Files: String – Creating String – String operations: Concatenation, Repetition, Indexing, Splitting, Slicing – String conversion – Looping through a string – String Methods. Files: Open, Close, Write, Read.

List, Tuple, Dictionary, Set: Mutable & Immutable Data Types – Lists: List operations – List slicing – List methods – Looping through a list; Tuples: Tuple assignment – Indexing – Tuple Methods; Dictionaries: Operations – Iterating Dictionary – Dictionary Methods; Sets: Operations on set – Frozen set – Set Methods.

List of Exercises

1. Implement data types, operators and expressions.
2. Implementation of branching statements and looping constructs.
3. Implementation of recursive and non-recursive functions.
4. Implementation of string methods.
5. Implementation of list and tuple.
6. Implementation of Dictionary and set.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO 1: Implement basic programming constructs in python for solving simple problems.	Apply
CO2: Examine the usage of control structures and functions for solving a given problem.	Analyze
CO3: Create programs using the string operations ,mutable and immutable data types for solving real time applications.	Create
CO4: Conduct experiment with appropriate IT tools in modeling the Programming Constructs, Control structures, functions, Strings, Files, List, Tuple, Dictionary, and Set.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	3	1	-	-	-	1	1	-	1	-	-

High-3; Medium-2; Low-1

Textbooks:

T1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
T2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem-Solving and programming", 1st Edition, BCS Learning & Development Limited, 2017.

Reference Book(s):

R1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
R2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
R3. Eric Matthes, "Python Crash Course, A Hands – on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.

Web References:

1. Python for Data Science: https://onlinecourses.nptel.ac.in/noc22_cs32
2. https://ekumbh.aicte-india.org/allbook.php?id=97
3. https://www.coursera.org/learn/python-crash-course?specialization=google-it-automation

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 **BOS Chairman**

Course Code: 23EEL201	Course Title: Introduction to Programming with IoT		
Course Category: Major		Course Level: Introductory	
L:T:P (Hours/Week) 0:0:3	Credits:1.5	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to discuss the basics of electronics components and their connections, the basics of Python programming for the Raspberry Pi, and the sensor interface with the Raspberry Pi. Also the course includes smart system technologies and their role in real-time applications.

List of Experiments:

1. **Electronic components and connections outline**

   List of Experiments

   a) Simple circuit using LED, resistor and breadboard
   b) Pushbutton and its connections
   c) LCD display and its connections
   d) Relay and its driver circuit
   e) Common mistakes when using breadboard to make connections
   f) Demonstration of all the above components

2. **Introduction to Raspberry pi outline**

   List of Experiments

   a) Blink the LED using python programming
   b) Control the blinking of tricolor LED using Pushbutton using python programming
   c) Display a count on the LCD. Count is increased whenever the pushbutton is pressed using python programming.
   d) Control the speed and direction of a DC motor using python programming

3. **Sensor interfacing**

   List of Experiments

   a) Detect the real time temperature and humidity values using DHT11 sensor by interfacing with Raspberry pi module. .
   b) Design the line following robot using IR sensors, ultrasonic sensor and DC motor.

4. **Wireless connectivity and Programming with IoT**

List of Experiments

a) Control the lamp using webserver.
b) Monitor the real time temperature and humidity values from the webserver.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1:Apply the concept of engineering fundamentals in LCD,LED, Relay, Sensor and Push Button by interfacing with Raspberry pi using python programming	Apply
CO2:Design the line following robot by applying the management principles and budget analysis	Create
CO3: Investigate and Report the technical advancement in wireless connectivity by building simple hobby project as an individual or team.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	3	-	-	-	-	-	-		1	-	-	-
CO3	-	-	-	3	-	-	-	-	1	2	-	2	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1.Maneesh Rao," Internet of Things with Raspberry Pi 3: Leverage the power of Raspberry Pi 3 and JavaScript to build exciting IoT projects", Packt Publishing,2018

T2. Arsheep Bahga &Vijay Madisetti,"Internet of Things - A Hands-On Approach" 1st Edition, Orient Blackswan Private Limited - New Delhi 2015.

Reference Book(s):

R1: "Introduction to Programming with IoT " Manual prepared by Department of Electrical and Electronics Engineering, MCET, Pollachi.

Web References:

1.https://onlinecourses.nptel.ac.in/noc22_cs53

2.https://archive.nptel.ac.in/noc/courses/noc20/SEM2/noc20-cs66

Course Code: 23EEL202	Course Title: Electron Devices Laboratory		
Course Category: Major		Course Level: Introductory	
L:T:P (Hours/Week) 0:0:3	Credits:1.5	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to designate the characteristics of the basic electronic devices using hardware implementation, CAD tools and programming.

List of Experiments:

1. PN Junction diode and Zener diode Characteristics
2. Voltage Regulator using Zener diode
3. Input and Output Characteristics of Common Emitter Configuration.
4. Input and Output Characteristics of Common Base Configuration.
5. JFET and MOSFET characteristics.
6. Simulation of PN diode circuits and its characteristics using CAD tool
7. Simulation of transistor circuits and its characteristics using CAD tool
8. Program the characteristics of a diode using its datasheet
9. Program the characteristics of a transistor using its datasheet
10. Measure the operating regions of LED.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Estimate the concept of engineering fundamentals in diodes and transistors using hardware implementation and report the inference	Evaluate
CO2: Model the diodes and transistor circuits using appropriate simulation tools and programming.	Analyse
CO3: Conduct experiment to analyse the operating regions of LED and Photodiode	Analyse
CO4: Identify and list the safety/safety standards applied in LED	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	3	-	-	-	-	-	1	-	-	-	-
CO2	-	-	-	-	3	-	-	-	-	1	-	1	-	-
CO3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	1	-	-	-	-	-	-

High-3; Medium-2;Low-1

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 **BOS Chairman**

Text Book(s):

T1.Millman J. , Halkias C. C. "Electronic Devices and Circuits ", Tata McGraw Hill, New Delhi, 2011.

T2. Salivahanan.S, Suresh kumar.N and Vallavaraj.A, “Electronic Devices and Circuits”, 2nd Edition, TMH, New Delhi, 2008.

Reference Book(s):

R1. “Electron Devices” Manual prepared by Department of Electrical and Electronics Engineering, MCET, Pollachi.

Course Code: 23ESL201		Course Title: Professional Skills 1:Problem solving skills & Logical Thinking 1 (Common to all B.E/B.Tech Programmes)	
Course Category: SEC		Course Level: Introductory	
L:T:P(Hours/Week) 0: 0: 2	Credits: 1	Total Contact Hours:30	Max Marks:100

Course Objectives:

The course is intended to enhance the students' numerical, analytical and logical reasoning ability.Also course focus to make learners prepare for various public and private sector exams and placement drives.

Module I Quantitative Ability 20 Hours

Number System and LCM & HCF- Percentage- Ratio and Proportion - Average- Progressions- Ages-Partnership- Mixture & Allegation - Profit and loss- Interest calculation- Data

Module II Reasoning Ability 10 Hours

Seating Arrangement- Linear, circular and Complex – Direction Problems- Blood Relation- Puzzles- Crypt arithmetic- Venn diagrams- Statement and conclusion- Statement and argument- Causes and effects- Self-Learning.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Build the competence in numerical, analytical and logical reasoning ability	**Apply**

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	3	-	-

High-3; Medium-2; Low-1

Textbook(s):

T1: Dr. R. S. Aggarwal. "Quantitative Aptitude for Competitive Examinations" Sultan Chand & Sons Pvt. Ltd, New Delhi, 2018.

T2: Dr. R. S. Aggarwal. "A Modern Approach to Logical Reasoning", Sultan Chand & Sons Pvt. Ltd, New Delhi, 2018.

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 **BOS Chairman**

Reference Book(s):

R1: R. V. Praveen. "Quantitative Aptitude and Reasoning" 2nd Revised Edition, Prentice-Hall of India Pvt.Ltd, 2013.

R2: Arun Sharma. "Quantitative Aptitude for Common Aptitude Test", McGraw Hill Publications, 5th Edition, 2020.

R3: Arun Sharma. "Logical Reasoning for Common Aptitude Test", McGraw Hill Publications, 6th Edition, 2021.

Web References:

1 https://www.indiabix.com/aptitude/questions-and-answers/

2 https://www.geeksforgeeks.org/aptitude-questions-and-answers/

Course Code: 23VAT201	Course Title: TAMILS AND TECHNOLOGY (Common to all B.E/B.Tech Programmes)		
Course Category: VAC		Course Level: Introductory	
L:T:P (Hours/Week) 1: 0 :0	Credit: 1	Total Contact Hours: 15	Max Marks:100

Pre–requisites

- NIL

Course Objectives

மாணவர்கள் இப்பாடத்தை கற்றலின் மூலம்

CO.1 நெசவு மற்றும் பானைத் தொழில்நுட்பம், வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம், உற்பத்தித் தொழில்நுட்பம், வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம் ஆகியன குறித்து அறிந்து கொள்ள இயலும்.

CO.2 அறிவியல் தமிழ் மற்றும் கணினித் தமிழ் குறித்து அறிந்து கொள்ள இயலும்.

தமிழரும் தொழில்நுட்பமும்

அலகு 1 – நெசவு மற்றும் பானைத் தொழில்நுட்பம் **3**

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்

அலகு 2 – வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம் **3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் ஷ சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு – சங்க காலத்தில் கட்டுமானப் பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் – மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள், பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ – சாரோசெனிக் கட்டிடக் கலை.

அலகு 3 – உற்பத்தித் தொழில்நுட்பம் **3**

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத் துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு 4 வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம் 3

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன் வளம் – முத்து மற்றும் முத்துக் குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு 5 – அறிவியல் தமிழ் மற்றும் கணினித் தமிழ் 3

அறிவியல் தமிழின் வளர்ச்சி – கணினித் தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின் பதிப்பு செய்தல் – தமிழ் மென் பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக் கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

Course Outcomes மாணவர்கள் இப்பாடத்தை கற்றபின்	**Cognitive Level**
CO.1 நெசவு மற்றும் பானைத் தொழில்நுட்பம், வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம், உற்பத்தித் தொழில்நுட்பம், வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம் ஆகியன குறித்து அறிந்து கொள்வார்கள்.	அறிதல் (Understand)
CO.2 அறிவியல் தமிழ் மற்றும் கணினித் தமிழ் குறித்து அறிந்து கொள்வார்கள்.	அறிதல் (Understand)

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	1	-	-

High–3; Medium–2; Low–1

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 BOS Chairman

TEXT - CUM REFERENCE BOOKS

1 தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே.பிள்ளை (வெளியீடு. தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி – வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 **BOS Chairman**

Course Code: 23VAT201	Course Title: TAMILS AND TECHNOLOGY (Common to all B.E/B.Tech Programmes)		
Course Category: VAC		Course Level: Introductory	
L:T:P (Hours/Week) 1: 0 :0	Credit: 1	Total Contact Hours: 15	Max Marks:100

Pre–requisites

- NIL

Course Objectives

The course is intended to:

1. Understand Weaving and Ceramic Technology, Design and Construction Technology, Manufacturing Technology, Agriculture and Irrigation Technology.
2. Understand the Scientific Tamil & Tamil Computing.

TAMILS AND TECHNOLOGY

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY 3

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL : 15 PERIODS

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO.1 Understand Weaving and Ceramic Technology, Design and Construction Technology, Manufacturing Technology, Agriculture and Irrigation Technology.	Understand
CO.2 Understand the Scientific Tamil & Tamil Computing.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	1	-	-

High–3; Medium–2; Low–1

TEXT - CUM REFERENCE BOOKS

1 தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே.பிள்ளை (வெளியீடு. தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி – வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

Course Code: 23CHT202		Course Title: Environmental Sciences (Common to all B.E/B.Tech Programmes)	
Course Category: Multidisciplinary		Course Level: Introductory	
L:T:P(Hours/Week) 1: 0: 0	Mandatory Non-Credit	Total Contact Hours: 15	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on sustainable utilization of natural resources, prevention of pollution, disaster management and environmental issues & public awareness on ecosystem.

Module I **8 Hours**

Natural Resources

Role of individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.

Environmental Pollution and Disaster Management

Role of an individual in prevention of pollution; Disaster management : floods, earthquake, cyclone and landslides.

Environmental Ethics and Legislations

Environmental ethics : Environment Protection Act; Air Act; Water Act ; Wildlife Protection Act; Forest Conservation Act; Issues involved in enforcement of environmental legislation.

Module II **7 Hours**

Environmental Issues and Public Awareness

Public awareness - Environment and human health.

Environmental Activities

(a) Awareness Activities:

i. Small group meetings about water management, promotion of recycle use, generation of less waste, avoiding electricity waste.
ii. Slogan making event.
iii. Poster making event.

(b) Actual Activities:

i. Plantation.
ii. Cleanliness drive.
iii. Drive for segregation of waste.
iv. To know about the different varieties of plants.
v. Shutting down the fans and ACs of the campus for an hour or so.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO 1: Explain the use of natural resources for a sustainable life as an individual in prevention of pollution.	Understand
CO 2: Apply the environmental ethics and legislations for various environmental issues.	Apply
CO 3: Create the public awareness on environment and human health as an individual or team through various activity based learning.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	3	3	-	-	-	-
CO3	3	-	-	-	-	3	3	-	3	3	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Benny Joseph, “Environmental Studies‟, Tata McGraw Hill, New Delhi, 2006.

T2. Mackenzie Davis and Susan Masten, “Principles of environmental engineering and science”, Mc-Graw Hill, 3rd Edition, 2014.

Reference Book(s):

R1. Trivedi R.K. “Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards‟, Vol.I and II, Enviro Media.

R2. Cunningham, W.P.Cooper, T.H. Gorhani, “Environmental Encyclopedia‟, Jaico Publishing House, Mumbai, 2001.

Web References:

1. https://onlinecourses.nptel.ac.in/noc23_hs155/preview.
2. https://en.wikipedia.org/wiki/Environmental_science.

SEMESTER III

<table>
<tr><td colspan="2">Course Code: 23MAT303</td><td colspan="2">Course Title: Numerical Methods And Linear Algebra (Common to EC, EE & EV)</td></tr>
<tr><td colspan="2">Course Category: Minor</td><td colspan="2">Course Level : Intermediate</td></tr>
<tr><td>L:T:P(Hours/Week) 3:1:0</td><td>Credits: 4</td><td>Total Contact Hours:60</td><td>Max Marks:100</td></tr>
</table>

Course Objectives: This course is designed to give an overview of numerical methods and linear algebra to provide knowledge and skills needed to apply in solving decision making problems in various fields of science and engineering.

Module I **22+8 Hours**

Solution of System of Linear Equations and Eigen value: Solution of system of linear equations– Direct methods: Gaussian elimination method – Indirect methods: Gauss Jacobi method, Gauss-Seidel method– sufficient conditions for convergence –Solution of nonlinear equations: Newton Raphson method –Power method to find the dominant Eigen value and the corresponding Eigen vector. Application of Eigen value and the corresponding Eigen vector.

Interpolation, Numerical Differentiation and Integration: Interpolation – Newton's forward, backward interpolation – Lagrange's interpolation. Numerical Differentiation and Integration – Trapezoidal rule – Simpson's 1/3 rule – Double integration using Trapezoidal rule.

Numerical Solution of Ordinary Differential Equation: Numerical solution of first order ordinary differential equation-Single step method: Taylor's series- Euler's method – Runge-Kutta method of fourth order – Multi step method: Milne's predictor corrector methods for solving first order differential equations.

Module II **23+7 Hours**

Vector Spaces: Vector spaces- Subspace of a vector space- basis and dimension of vector space – linear combination and spanning sets of vectors – linear independence and linear dependence of vectors – Row space, Column space and Null space – Rank and nullity of subspaces.

Orthogonality and Inner Product Spaces: Inner product of vectors: length of a vector, distance between two vectors, and orthogonality of vectors – Orthogonal projection of a vector – Gram-Schmidt process to produce orthogonal and orthonormal basis – Inner product spaces.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the knowledge and skills of numerical methods to solve algebraic and trascedental equations.	Apply
CO2: Apply the basic knowledge of various numerical methods in solving interpolation with equal and unequal interval problems, numerical differentiation and integration.	Apply
CO3: Solve first order ordinary differential equation by single step and multi step methods.	Apply
CO4: Apply the concept of vector spaces and Inner product spaces to produce orthogonal and orthonormal basis.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	1	-	1	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	1	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	1	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	1	1	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Grewal, B.S. and Grewal, J. S., “Numerical Methods in Engineering and Science”, 11th Edition, Khanna Publishers, New Delhi, 2013.

T2. Curtis F. Gerald, Patric.O. Wheatley, “Applied Numerical Analysis”, 7th Edition, Pearson Education, Asia, New Delhi, 2009.

Reference Book(s):

R1. Steven Chopra, Raymond.P. Canale, “Numerical Methods for Engineers”, Seventh Edition, 2015.

R2. Jain M.K, Iyengar.S.R. K and Jain.R. K, “Numerical Methods for Scientific and Engineering Computation”, Sixth Edition, New Age Publishers, 2012.

R3. Gilbert Strang, “Linear algebra and its Applications”, Fourth Edition, Cengage Learning (RS), 2012.

Web References:

1 http://nptel.ac.in/courses/122104018/node2.html
2 http://nptel.ac.in/courses/111105038

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 BOS Chairman

Course Code: 23EET301		Course Title: DC Machines and Transformers	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

This course aims to impart knowledge on DC machines, Transformer fundamentals, andMachine parts. The course also equips students with ability to analyze the equivalent circuits of DC machines and Transformers.

Module I **22 Hours**

Block Diagram –Constructional features of a DC machine – Principle of operation – EMF equation – Methods of excitation: Self and separately excited generators – Characteristics: series, shunt and compound generators - applications – armature reaction - commutation

Principle of operation of DC Motor –Types- Back EMF and torque equation – Electrical and Mechanical Characteristics of series, shunt and compound motors – applications – losses and efficiency

Speed control of DC series and shunt motors –Testing of DC Machines: Brake Test, Swinburne’s test and Hopkinson’s test.

Module II **23 Hours**

Constructional details of core and shell type transformers – Principle of operation – EMF equation – Transformation ratio –Transformer on no load – Transformer on load - Equivalent circuit – Regulation – Losses and efficiency – Condition for maximum efficiency – All day efficiency - Parallel operation of single phase transformers – Auto transformer – Comparison with two winding transformers. Three phase transformer constructional features – Three phase transformer connections.

Testing of transformers: Polarity and voltage ratio tests, Load test, Open circuit and short circuit test, Sumpner’s test and Separation of No load losses.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Apply the concept of an EMF theory in construction, characteristics and performance of DC Generator.	Apply
CO2: Analyze the importance of back EMF, operation, construction, characteristics, performance and applications of DC motor.	Analyze
CO3: Compare the speed control methods and testing methods of DC machines.	Analyze
CO4: Analyze the theory of single phase and three phase transformers.	Analyze
CO5: Evaluate the performance of static machine using equivalent circuits and phasor diagrams under various operating conditions through testing and case studies.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	3	-	-	-	-	1	1	-	1	1	-

High-3; Medium-2; Low-1

Textbooks:

T1.D P Kothari,Nagrath I.J, “Electric Machines”, Tata McGraw Hill Publishing Company Ltd, 5th Edition, 2017.

T2. Dr P.S. Bimbhra, Electrical Machinery, Khanna Publications, Fully Revised Edition, 2021.

Reference Book(s):

R1. Murugesh Kumar.K, “Electrical Machines Volume - I”, Vikas Publishing House Pvt. Ltd, 1st Edition, 2010.

R2. Gupta. J.B, “Theory and Performance of Electrical Machines”, S.K.Kataria and 4th Edition, 2013.

R3 S.K. Bhattacharya, “Electric Machines”, Tata McGraw Hill Publishing Company Ltd 4th Edition, 2017.

Web References:

1. http://www.nptelvideos.in/2012/11/electrical-machines-i.html
2. http://www.nptelvideos.com/electrical_engineering/
3. https://nptel.ac.in/courses/108/105/108105155/
4. https://nptel.ac.in/courses/108/105/108105017/
5. https://nptel.ac.in/courses/108/106/108106071/

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 BOS Chairman

Course Code: 23EET302		Course Title: Electric Circuits	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 3:1: 0	Credits: 4	Total Contact Hours: 60	Max Marks:100

Course Objectives: At the end of this course, students will be exposed to basic terminologies in electric circuits and be able to recognize nonlinear circuit problems. Students can predict the behavior of any electrical circuits. Students can analyze the fundamental concept terminologies of alternating current, phase & phase difference, representation of ac quantities by phasor.

Module I **22+8 Hours**

Network Analysis: Ideal voltage and current sources, Dependent sources, Source Transformation, Mesh Current Analysis and Nodal Voltage Analysis for AC and DC circuits;

Network Theorems for DC and AC Circuits: Thevenin's, Norton's, superposition and maximum power transfer theorems; reciprocity and Tellegen's theorems for DC circuits (only).

Transient Networks: Coupled circuits and Dot conversion, Transient Response of RL, RC and RLC networks using Laplace Transform method for DC and AC excitation - unit step, impulse, ramp and sinusoidal inputs.

Module II **30 Hours**

AC networks: Series and Parallel Resonance for RLC circuits, two port networks – Z, Y, h and T parameters (conceptual)

Three-Phase A.C. Circuit Analysis: Relationship of Line, Phase Voltages and Currents in a Delta and Star-connected System, Analysis of balanced and unbalanced three-phase networks;
Three phase power calculation and power measurement using two wattmeter method; complex power and power factor in ac circuits.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO 1: Apply network theorems and laws to solve electric circuits involving both passive and active elements.	Apply
CO2: Solve linear transient circuit problems involving second order systems using Laplace transform techniques.	Apply
CO3: Solve the electric circuits with coupled inductors and analyze the various parameters of two port networks.	Apply
CO4: Quantify the resonant frequency, band width and Q factor for AC circuits with passive elements.	Apply
CO5: Calculate the power and analyze the three phase AC system under balanced and unbalanced load conditions.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO5	-	3	-	-	-	-	-	-	-	-	-	-	1	-

High-3; Medium-2; Low-1

Textbooks:

T1. Dr. Abhijit Chakrabarti, Circuit Theory Analysis & Synthesis (Revised New Edition), Dhanpat Rai & Co (P) Ltd, Edition/Reprint: 2023.

T2. Robert L. Boylestad, Electronic Devices and Circuit Theory, Pearson Education, 11th Edition, 2015

Reference Book(s):

R1. Sudhakar A, Shyam mohan S. Palli, Circuits and Networks: Analysis and Synthesis, 5th edition McGraw Hill Education l, 2017.

R2. William H. Hayt, Jack E. Kemmerly, Jamie D. Phillips, Steven M. Durbin , Engineering circuit analysis, 9th edition, McGraw Hill, 2020.

Web References:

1. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-071j introduction-to electronics-signals-and-measurement-spring-2006/lecture-notes/
2. https://onlinecourses.nptel.ac.in/noc20_ee64/
3. https://www.edx.org/learn/circuits
4. https://www.udemy.com/topic/electrical-circuits/
5. AICTE e-KUMBH (aicte-india.org)

Course Code: 23EET303		Course Title: Digital Electronics	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours:45	Max Marks:100

Course Objective: The course is intended to acquire the skills to design, analyze, and optimize digital circuits, encompassing combinational and sequential logic and memory components.

Module I **22 Hours**

Review of number systems; Binary arithmetic, One's and two's complements, Boolean Algebra: Basic theorems, Simplification of Boolean functions, Representation of Boolean function in canonical and standard forms-Simplification of Boolean expressions using K maps and Quine-Mc-cluskey method.

Basic Gates, Universal gate implementation. Relation between switching and logic operation; Concept of noise margin, fanout, propagation delay; TTL, Schottky TTL, Tristate; CMOS Logic, Interfacing TTL with CMOS.

Combinational Circuits: Adder, Subtractor, Carry look ahead adder, Comparators, Code converters, Encoders, Decoders, Multiplexers, De-multiplexers- Boolean function realization using multiplexer.

Module II **23 Hours**

Flip Flops: SR, JK, T, D- Level and Edge Triggering-Maser –Slave flip flop.

Design of synchronous sequential circuit using Mealy model and Moore model, state transition diagram, State reduction technique, Algorithm State Machine (ASM) chart;. Synchronous counters; Counter design- Up and down counter, Register, Shift register, Universal shift register. Ripple (asynchronous) counters; Races, Cycles and Hazards: Static, Dynamic, Essential, Hazards Elimination.

ROM, PROM, PAL, PLA-FPGA.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Design the basic combinational circuits.	Apply
CO2: Design the synchronous and asynchronous sequential circuits.	Apply
CO3: Analyze the synchronous and asynchronous sequential circuit.	Analyze
CO4: Categorize the different memory organization techniques and transistor level realization of digital circuits and report a presentation as a team or individual.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO2	-	-	3	-	-	-	-	-	-	-	-	-	1	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	1	-
CO4	-	-	-	3	-	-	-	-	1	1	-	-	1	-

High-3; Medium-2; Low-1

Textbooks:

T1. A.Anandkumar, Fundamentals of digital circuits, 4th Edition, PHI Learning Pvt Ltd, 2022

T2. Donald P. Leach, Albert P. Malvino and GoutamSaha, “Digital Principles & Applications 8e”, McGraw Hill, 2017.

Reference Book(s):

R1. Malvino and Leach, Digital Principles and Applications, Tata McGraw Hill, New Delhi, 8th Edition, 2014.

R2. Morris Mano. M. Michael D Ciletti, —Digital Design‖, Pearson Education, 6th Edition, 2018.

Web References:

1. https://onlinecourses.nptel.ac.in/noc22_ee55/preview
2. https://onlinecourses.nptel.ac.in/noc23_ee115/preview

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 BOS Chairman

Course Code: 23CST304	Course Title: Programming in C		
Course Category: Multidisciplinary		Course Level: Intermediate	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course helps to understand the structured and procedural programming skills. The major objective is to provide students with understanding of code organization and functional hierarchical decomposition using complex data types.

Module I **22 Hours**

Basics of Computer Organization: Generation and Classification of Computers – Basic Organization of a Computer — Software development life cycle – Problem Solving Techniques, Algorithm, Pseudo code and Flow Chart.

Introduction to C Programming: Overview of C – Structure of C program – C Character set – keywords - Identifiers – Variables and Constants – Data types – Operators and Expressions – Managing formatted and unformatted Input & Output operation– Decision statements – Loop control statements.

Arrays and Strings: Arrays**:** Characteristics – One-dimensional array - Two-dimensional arrays. Strings: Declaration and Initialization of string – String handling functions.

Module II **23 Hours**

Functions and Pointers: Functions: Declaration & Definition of function – Classification of functions – Call by value & reference - Recursion. Pointers: Features – Null and Void Pointers - Operations on pointers – Pointers and Arrays - Array of Pointers

Structures and Union: Structures: Declaration & Initialization of Structures – Structure within Structure - Array of structures –Pointers to Structures – Unions.

Files and Preprocessor directives: Files: Introduction to Files – File Types and operations (Open, close, read, write) – Command line arguments. Preprocessor Directives: Macro Expansion, File Inclusion, Conditional Compilation.

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO1: Apply problem solving skills to design and develop solutions for real-world applications.	Apply
CO2: Apply knowledge of C programming constructs to write simple programs that demonstrate fundamental syntax and semantics.	Apply
CO3: Analyze the role of functions in improving code readability and maintainability.	Analyze
CO4: Demonstrate various features to manipulate memory addresses and access data, ensuring proper memory management practices using	Apply

an oral presentation..	
CO5: Examine the ability to access and manipulate structure and Union members through appropriate accessing methods.	Analyze
CO6: Develop programs that involves file handling and preprocessor directives.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	2	-	-	-	-	1	-	-	-	-	-	-	-
CO4	2	-	-	-	-	-	-	-	2	2	-	-	-	-
CO5	-	-	-	2	-	-	-	-	-	-	-	-	-	1
CO6	-	-	3	-	-	-	-	-	-	-	-	-	-	1

High-3; Medium-2; Low-1

Text Book(s):

T1. Ashok N.Kamthane, Amit.N.Kamthane, “Programming in C”, 3rd Edition,Pearson Education, 2015.

Reference Book(s):

R1. Ajay Mittal, “Programming in C-A Practical Approach”, 3rd Edition, Pearson Education,2010.

R2. Yashavant P.Kanetkar,” Let Us C” , 19th Edition, BPB Publications, 2022.

R3. Brian W.Kernighan and Dennis M.Ritchie,”The C Programming Language” 2nd Edition, Pearson Education, 2015

Web References:

1. NPTEL course content on Introduction To Programming: Inhttps://onlinecourses.nptel.ac.in/noc22_cs40
2. Complete guide on Learn C programming: http://www.cprogramming.com/

Course Code: 23EEL301		Course Title: DC Machines and Transformers Laboratory	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 0:0:3	Credits: 1.5	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The main objective of the course is to give the students an insight into the constructional details of dc machines and transformers with a view for better understanding of their working principles. The course also equips the students to test and evaluate the performance of various DC Machines and Single-phase transformers by conducting appropriate experiments.

List of Exercises

1. Open circuit and load characteristics of separately excited DC shunt generators.
2. Load characteristics of DC compound generator with differential and cumulative connection
3. Load characteristics of DC shunt and series motor by brake test.
4. Speed control of DC shunt motor using armature and field control method.
5. Predetermination of efficiencies as Generator and Motor from Swinburne's test.
6. Hopkinson's test on DC motor-generator set.
7. Load test on single phase transformer.
8. Open circuit and short circuit tests on single phase transformer
9. Sumpner's test on transformers.
10. Separation of no-load losses in single phase transformers.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Analyze the characteristics of DC Generators and Motor.	Analyze
CO2: Analyze the various speed control and braking techniques for DC motors.	Analyze
CO3: Predict the performance of single phase transformer by direct test and indirect testing	Analyze

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 BOS Chairman

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	3	-	-	-	-	-	-	-	-	-	-	1	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	1	-
CO3	-	-	-	3	-	-	-	-	-	-	-	-	1	-

High-3; Medium-2; Low-1

Textbooks:

T1.D P Kothari, Nagrath I.J, “Electric Machines”, Tata McGraw Hill Publishing Company Ltd, 5th Edition, 2017.

T2 Murugesh Kumar.K, “Electrical Machines Volume - I”, Vikas Publishing House Pvt. Ltd, 1st Edition, 2010.

Reference Book(s):

R1. Bimbhra. P.S, “Electric Machines”, Khanna Publishers, 2nd Edition, 2017.

R2 Gupta. J.B, “Theory and Performance of Electrical Machines”, S.K.Kataria and 4th Edition, 2013.

R3 S.K. Bhattacharya, “Electric Machines”, Tata McGraw Hill Publishing Company Ltd 4th Edition, 2017.

Web References:

1. https://ems-iitr.vlabs.ac.in/List%20of%20experiments.html
2. www.ee.iitkgp.ac.in/faci_em.php
3. www.eee.griet.ac.in/.../2014/12/DC-Machines-Lab-Manual.pdf
4. http://iitg.vlab.co.in/?sub=61&brch=168.
5. NPTEL : Electrical Engineering - NOC: Electrical Machines – I
6. https://nptel.ac.in/courses/108105155

Course Code:23CSL302	**Course Title: Programming in C Laboratory**		
Course Category Multidisciplinary		**Course Level: Intermediate**	
L:T:P(Hours/Week) 0:0:3	**Credits:1.5**	**Total Contact Hours:45**	**Max Marks:100**

Course Objectives

The course introduces students to the practical knowledge of programming using C programming language as an implementation tool. It aims at providing students with understanding of programming essentials used within the framework of imperative and structural programming paradigms.

List of Experiments:

1. Develop Algorithm, Flowchart and Pseudo code for given problem.
2. Develop C programs using data types, I/O statements, Operators and Expressions.
3. Develop C programs using Decision-making statements.
4. Implement C programs using looping statements.
5. Design C programs to implement the concept of arrays.
6. Design C programs to implement the concept of strings
7. Develop C programs using functions.
8. Develop C programs using pointers.
9. Implement the concept of structures using C.
10. Implement C programs to perform file operations.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Demonstrate proficiency in using development environments, compilers, and debugging tools for C programming**.**	Apply
CO2: Develop C Programs using programming construct for simple scenarios.	Apply
CO3: Analyze the importance of code efficiency and optimization in C programming.	Analyze
CO4: Demonstrate the design and implementation of complex data structures and file handling mechanisms with an oral presentation.	Apply

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 BOS Chairman

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	3	-	-	-	-	-	-	-	1	-
CO2	-	-	3	-	-	-	-	-	-	-	-	-	1	-
CO3	-	2	-	-	-	-	2	-	-	-	-	-	1	-
CO4	-	-	3	-	-	-	-	-	3	3	-	-	1	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Ashok N.Kamthane, Amit.N.Kamthane, "Programming in C", 3rd Edition,PearsonEducation, 2015.

Reference Book(s):

R1. Ajay Mittal, "Programming in C-A Practical Approach", 3rd Edition, Pearson Education,2010.

R2. Yashavant P.Kanetkar," Let Us C", 19th Edition, BPB Publications, 2022.

R3. Brian W.Kernighan and Dennis M.Ritchie, "The C Programming Language" 2nd Edition, Pearson Education, 2015.

Web References:

1. NPTEL course content on Introduction To Programming: https://onlinecourses.nptel.ac.in/noc22_cs40
2. Complete guide on Learn C programming: http://www.cprogramming.com/

Course Code: 23VAT301	Course Title: Universal Human Values 2: Understanding Harmony		
Course Category: VAC		Course Level: Intermediate	
L:T:P (Hours/Week) 2:1: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Strengthening of self-reflection
3. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
4. Development of commitment and courage to act
5. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.

Unit I Introduction to Value Education 9 Hours

Need for the Value Education; Self -exploration as the process for value education; Continuous Happiness and Prosperity: A look at basic Human Aspirations; Right understanding: Relationship and Physical Facilities; Happiness and Prosperity: current scenario; Method to fulfill the Basic human aspirations

Unit II Harmony in Human Being 9 Hours

Human being as a co-existence of self ('I') and the material 'Body'; needs of Self ('I') and 'Body'; The Body as an instrument of 'I'; Harmony in the self ('I'); Harmony of the self ('I') with body; Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Swasthya.

Unit III Harmony in the Family and Society 9 Hours

Harmony in the Family the basic unit of human interaction; Values in human to human relationship; Trust as the foundational values of relationship; Respect as the right evaluation ;Understanding harmony in the society (society being an extension of family); Vision for the universal human order.

Unit IV Harmony in the Nature 9 Hours

Understanding the harmony in the Nature Interconnectedness, self-regulation and mutual fulfillment among the four orders of nature; Existence as Co-existence at all levels; Holistic perception of harmony in existence.

Unit V Harmony on Professional Ethics 9 Hours

Natural acceptance of human values; Definitiveness of Ethical Human Conduct; Basic for Humanistic Education, Humanistic Constitution and Humanistic Universal Order; Competence in professional ethics; Case study: holistic technologies, management models and production systems; Strategy for transition towards value-based life and profession

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO.1	Reflect on values, aspiration, relationships and hence identify strengths and weaknesses.	Responding
CO.2	Appraise physical, mental and social wellbeing of self and practice techniques to promote wellbeing.	Responding
CO.3	Value human relationships in family and society and maintain harmonious relationships.	Valuing
CO.4	Respect nature and its existence for survival and sustainable of all life forms and hence practice conservation of nature	Valuing
CO.5	Appreciate ethical behaviour as a result of value system in personal and professional situations	Receiving

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	1	2	2	-	-	2	-	-
CO2	-	-	-	-	-	1	2	2	2	1	-	2	-	-
CO3	-	-	-	-	-	2	2	2	2	1	-	2	-	-
CO4	-	-	-	-	-	2	2	2	2	-	-	2	-	-
CO5	-	-	-	-	-	1	2	2	2	-	-	2	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 BOS Chairman

Reference Book(s):

R1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.

R2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.

R3. The story of stuff, Annie Leonard, Free Press, New York 2010.

Web References:

1. https://aktu.ac.in/hvpe/ResourceVideo.aspx
2. http://hvpenotes.blogspot.com/
3. https://nptel.ac.in/courses/109/104/109104068/

Course Code: 23ESL301		Course Title: Professional Skills 2: Problem solving skills & Logical Thinking 2 (Common to all B.E/B.Tech Programmes)	
Course Category: SEC		**Course Level: Intermediate**	
L:T:P(Hours/Week) **0: 0: 2**	**Credits: 1**	**Total Contact Hours:30**	**Max Marks:100**

Course Objectives:

The course is intended to enhance the students' numerical, analytical and logical reasoning ability. Also course focus to make learners prepare for various public and private sector exams and placement drives.

Module I **20 Hours**

Quantitative Ability

Time and work –Pipes and cisterns- - Time Speed Distance-Problems on Trains-Boats and Streams- Permutation and Combination-Probability, Mensuration- Heights and distance- Logarithms- Clocks and Calendars – Data Sufficiency

Module II **10 Hours**

Reasoning Ability

Number & Alpha series- Odd man out-Coding and Decoding-Syllogisms- -Problems on Cubes and Dices- Logical Venn diagram -Visual Reasoning- Element & logical series- Analogies

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Enhance their problem solving skills & Logical thinking Skills	**Apply**

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 BOS Chairman

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	3	-	-

High-3; Medium-2; Low-1

Textbook(s):

T1: Dr. R. S. Aggarwal. “Quantitative Aptitude for Competitive Examinations” Sultan Chand & Sons Pvt. Ltd, New Delhi, 2018.

T2: Dr. R. S. Aggarwal. “A Modern Approach to Logical Reasoning”, Sultan Chand & Sons Pvt. Ltd, New Delhi, 2018

Reference Book(s):

R1: R. V. Praveen. “Quantitative Aptitude and Reasoning” 2nd Revised Edition, Prentice-Hall of India Pvt.Ltd, 2013

R2: Arun Sharma. “Quantitative Aptitude for Common Aptitude Test”, McGraw Hill Publications, 5th Edition, 2020

R3: Arun Sharma. “Logical Reasoning for Common Aptitude Test”, McGraw Hill Publications, 6th Edition, 2021.

Web References:

1 https://www.indiabix.com/aptitude/questions-and-answers/

2 https://www.geeksforgeeks.org/aptitude-questions-and-answers/

SEMESTER IV

Semester IV

Course Code: 23MAT401	Course Title: Probability and Statistics (Common to EC, EE, ME, AU, CS, AM, SC, IT & EV)		
Course Category: Minor		Course Level: Intermediate	
L: T: P (Hours/Week) 3:1:0	Credits: 4	Total Contact Hours:60	Max Marks:100

Course Objectives:

This course aims at helping the students to gain knowledge on random variables, probability distributions and hypothesis testing for data.

Module I **22+8 Hours**

Probability and Random Variables: Axioms of Probability- Conditional Probability- Total Probability -Baye's Theorem- Random Variables-One Dimensional Random variables- Probability Mass Function- Probability Density Functions- Properties - Moments- Moment generating functions and their properties-Two Dimensional Random Variables - Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression using least square method – Transformation of random variables.

Standard Distributions: Discrete Distributions - Binomial- Poisson- Properties, Moment generating functions -Continuous Distributions - Uniform –Exponential- Normal Distributions and their properties.

Module II **23+7 Hours**

Testing of Hypotheses: Sampling distributions, Estimation of parameters, Statistical hypothesis, Large sample test based on Normal distribution for single mean and difference of means, Tests based on t-test, Chi-square distributions and F distributions for mean, variance and proportion, Contingency table (test for independent), Goodness of fit.

Design of Experiments: Analysis of Variance (ANOVA) - One-way Classification – Completely Randomized Design (CRD) – Two-way Classification – Randomized Block Design (RBD) – Latin square.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Demonstrate the concepts of probability theory to engineering problems.	Understand
CO2: Calculate the expected values, variances and correlation coefficient of random variables	Apply
CO3: Use the theoretical discrete and continuous probability distributions in the relevant application areas.	Apply
CO4: Apply the concepts of testing the hypothesis and design of experiments to solve real life problems.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	-	-	-	-	1	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Veerajan T, "Probability, Statistics and Random process", 3rd Edition, Tata McGraw-Hill, New Delhi, 2017.

T2. Dr.J.Ravichandran, "Probability and Statistics for Engineers", 1st Edition, Wiley India Pvt. Ltd., 2010.

Reference Book(s):

R1. R.E. Walpole, R.H. Myers, S.L. Myers, and K Ye, "Probability and Statistics for Engineers and Scientists", 9th Edition Pearson Education, Asia, 2013.

R2. M.R. Spiegel, J. Schiller and R.A. Srinivasan, "Schaum's Outlines Probability and Statistics", 4th Edition Tata McGraw Hill edition, 2012.

R3. Morris DeGroot, Mark Schervish, "Probability and Statistics", Pearson Educational Ltd, 4th Edition, 2014, India.

Web References:

1https://archive.nptel.ac.in/courses/111/105/111105090/

2.https://archive.nptel.ac.in/courses/111/105/111105041/

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 **BOS Chairman**

Course Code: 23EET401		**Course Title: Synchronous and Induction Machines**	
Course Category: Major		**Course Level: Intermediate**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

To give exposure to the students about the concepts of alternating current machines including the constructional details, principle of operation, performance analysis, characteristics and to learn how it can be employed for various applications.

Module I **22 Hours**

Synchronous Machines

Alternators: Construction – Types - stationary armature - EMF equation – armature reaction – voltage regulation – pre-determination of regulation by EMF, MMF, and ZPF methods. Load characteristics – parallel operation – synchronizing torque, reactance and reluctance power – load sharing – alternator on infinite bus bar – two reaction theory – predetermination of voltage regulation for salient pole machines-PMSG.

Synchronous Motors: Theory of operation – phasor diagrams - variations of current and power factor with excitation –selection of starting methods – hunting and methods of suppression – power angle relations – V and inverted V curves – applications - synchronous condenser- PMSM.

Module II **23 Hours**

Three Phase Induction Motors

Constructional details – types of rotors – principle of operation – production of RMF – torque equation – torque slip characteristics – maximum torque – slip for maximum power – effect of rotor resistance – losses and efficiency - induction generators - performance calculation: equivalent circuit, testing – load test – no load and blocked rotor tests, circle diagram – separation of no load losses - applications.

Selection of starting methods: DOL, rotor resistance and star–delta starters. Selection of speed control methods: Speed control by change of frequency, V/F ratio, number of poles and change of slip – Cogging – crawling - Electrical Braking: - plugging - regenerative and dynamic braking.

Single Phase Motors

Constructional details of single phase induction motor – double field revolving theory – equivalent circuit. Self-starting methods: Types of Single phase induction motor - capacitor start, capacitor start capacitor run – applications.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Construct the phasor diagrams and equivalent circuits to analyze the performance of the Synchronous machines.	Apply
CO 2: Examine the performance of the induction machines and select appropriate AC machine based on application.	Analyze
CO 3: Appraise the principle of operation and performance of single-phase induction motors.	Apply
CO 4: Select appropriate AC machine for any application and report its significance using case study.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	3	-	-	-	-	1	1	-	1	-	-

High-3; Medium-2; Low-1

Textbooks:

T1. Nagrath I.J Kothari D.P, "Electric Machines", Tata McGraw Hill publishing company Ltd, New Delhi, 5th Edition,2017.

T2. Murugesh Kumar, K, "Electric Machines – Volume II", Vikas publishing house Pvt.Ltd.,Noida, 1st Edition, 2010.

Reference Book(s):

R1. Bimbhra. P.S., "Electrical Machinery", Khanna Publishers, New Delhi, 1st Edition, 2021.

R2. Gupta. J.B., "Electrical Machine - II", S.K. Kataria& Sons, New Delhi, Reprint, 2020.

R3. Theraja. B.L., Theraja. A.K., "A Textbook of Electrical Technology, Volume II(AC & DC Machines", S.Chand& Company Ltd, New Delhi, 5th Edition, 2022.

R4. A.E.Fitzgerald, Charles Kingsley, Stephen .D. Umans, "Electric Machinery", TataMcgraw Hill, New Delhi, 7thEdition, 2013.

R5. V K Mehta &Rohit Mehta, "Principle of Electrical Machines", S. Chand Publishing, 2nd Edition, 2019.

Web References:

1. https://nptel.ac.in/courses/108106072
2. https://nptel.ac.in/courses/108102146
3. https://nptel.ac.in/courses/108105131
4. https://nptel.ac.in/courses/108102372

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 **BOS Chairman**

Course Code:23EET402		Course Title: Electronic Circuits	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart the knowledge on rectifiers, transistor amplifiers and their frequency response with emphasis on low signal and large signal amplifiers and wave shaping circuits

Module I **22 Hours**

Rectifiers and Filters: Half wave, Full wave and Bridge Rectifiers using diodes, Harmonic components in a Rectifier Circuit, Inductive Filters, Capacitive Filters, π- Section Filters. Design of Isolated Power Supply.

Transistor Biasing and Stabilization: Operating Point, DC and AC Load lines, Need for Biasing, Types of BJT Biasing - Fixed Bias, Feedback Bias, Voltage Divider Bias, Bias Stability, Stabilization Factors, Thermal Runaway. FET Biasing

Transistor amplifiers: Differential amplifier – Common mode and Difference mode analysis, Small signal analysis of BJT using h-parameters, Amplifier frequency response, Multistage amplification; R-C coupled amplifiers, Cascode and Darlington configurations

Module II **23 Hours**

Power Amplifiers : Class A and Class B power amplifiers, Tuned amplifiers –Neutralization method

Feedback Amplifiers: Introduction to Feedback, Basic Feedback Concepts, Ideal Close−Loop Gain, Effect of negative feedback on input and output resistances, gain, gain stability, distortion and bandwidth; Feedback Topologies.

Oscillators & Multivibrators: Conditions for oscillations-Phase shift, Wien bridge, Hartley, Colpitts and Crystal oscillators. Astable, Monostable and Bistable Multivibrators using BJT

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply the active and passive components in the construction and operation of rectifiers and filter circuit.	Apply
CO2: Analyze the DC bias circuitry of BJT and FET.	Analyze
CO3: Analyze transistor amplifiers, encompassing small signal analysis, frequency response, multistage configurations, and diverse applications using Case Studies	Analyze
CO4: Analyze the operation of power amplifiers and tuned amplifiers.	Analyze
CO5: Design the Oscillators and Multivibrators for the given specification.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	1	-
CO3	-	-	-	3	-	-	-	-	1	1	-	-	1	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	1	-
CO5	-	-	3	-	-	-	-	-	-	-	-	-	1	-

High-3; Medium-2; Low-1

Text Book(s)

T1. Robert L Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education, 11th Edition, 2015.

T2. S. Salivahanan, N. Suresh Kumar and A. Vallavaraj, "Electronic Devices and Circuits" by, Tata McGraw Hill, New Delhi, 2nd Edition 2008.

Reference Book(s)

R1. David A. Bell, "Electronic Devices and Circuits", Oxford, 5th Edition, April 2008.

R2. Anil K.Maini, Varsha Agarwal, "Electronic Devices and Circuits", Wiley India Private Ltd, New Delhi, 1st Edition, 2015.

R3. Millman.J, Halkias.C and SatyebrantaJit, "Electronic Devices & Circuits", TMH, New Delhi, 2nd Edition,2008.

R4. Jacob Millman, Christos C.Halkias, "Integrated Electronics - Analog and Digital circuits system", Tata McGraw Hill, 2003

Web References

1. https://nptelvideos.com/video.php?id=1322
2. https://nptel.ac.in/courses/117101106

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 **BOS Chairman**

Course Code:23CSI402	Course Title: Data Structures and Algorithms		
Course Category: Multidisciplinary	Course Level: Intermediate		
L:T:P(Hours/Week) 2: 0: 2	Credits:3	Total Contact Hours:60	Max Marks:100

Course Objectives:

The course is indented to introduce the concepts of elementary data structures and their implementation. It also discusses the appropriate data structures to solve problems.

Module I Linear data structures 15 hours

LIST: Data Structures - Abstract Data Types (ADT) - List ADT: Array Implementation and Linked List Implementation - Application: Polynomial Addition

Stack ADT: Array and Linked List implementation of Stack - Application: Infix to Postfix Conversion - Postfix Expression Evaluation

Queue ADT – Array and Linked List implementation of Queue

Searching &Sorting: Linear Search- Binary search Bubble sort - Quick sort – Merge sort

Module II Non Linear Data Structure 15 hours

Trees: Binary Trees – Binary Tree Traversals – Expression Trees – Binary Search Tree

Graphs: Representation of Graphs – Graph Traversals: Depth first and Breadth first traversal - Topological Sort

Shortest Path Algorithms: Unweighted Shortest Paths–Dijkstra's Algorithm – Floyd's Algorithm.

Minimum Spanning Tree: Prim's Algorithm- Kruskal's Algorithm

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Solve problems using Linear data structures	Apply
CO2: Apply the concept of nonlinear data structures Trees and Graphs for various applications	Apply
CO3:Demonstrate the use of standard sorting and Hashing Techniques	Analyze
CO4:Make use of data structures to develop solutions to the real time scenario	Analyze

LIST OF EXPERIMENTS / EXERCISES:

1. Implementation of linked list and its operations
2. Implementation of stack & queue using array and linked list
3. Implementation of Binary search tree operations
4. Implementation of Dijkstra's Algorithm
5. Quick Sort and Bubble Sort
6. Merge Sort.

7. **Course Articulation Matrix**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	--	-	-	1	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	1	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	1	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	1	-	-	-	-	-	-	-	-	-

High-3; Medium-2; Low-1

Text Books:

T1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education Asia, New Delhi, 2015.

Reference Books:

R1. Horowitz Sahni, Andreson Freed, "Fundamentals of Data Structures in C", 2nd Edition, Universities Press, Hyderabad, 2011.

R2. Seymour Lipschutz, "Data Structures with C", McGraw Hill, 2014

R3. Thomas H Cormen, Charles E Leiserson, Ronald L Revest, Clifford Stein, "Introduction to Algorithms" 3rd ed., The MIT Press Cambridge, 2014.

Web References:

1. https://www.coursera.org/specializations/data-structures-algorithms
2. https://onlinecourses.nptel.ac.in/noc24_cs45/preview
3. https://onlinecourses.swayam2.ac.in/cec21_cs02/course

Course Code: 23EET403		Course Title: Measurement and Instrumentation	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to infer the fundamental concepts of transducers with characteristics and applications .The course focus on the methods of measurement of low voltage and high voltage electrical quantities, DC and AC bridges for measurements, overall measurement and instrumentation with the knowledge on digital instrumentation principles.

Module I **23 Hours**

Basic Blocks of measurement system – Instrument standards

Construction, Working and Errors: PMMC, MI and D Arsonval Galvanometer Instruments Construction and Working: Potentiometers, Induction type and dynamometer type wattmeters – Energy meter - Power factor meter – Megger.

Instrument transformers: CT and PT.

Digital DC & AC Voltmeter – True & RMS responding Voltmeter – Digital Multimeter.

DC & AC Bridges: Wheatstone's bridge, Kelvin's bridge, Maxwell bridge, Schering bridge and Wein bridge - Errors and compensation in A.C. bridges.

Module II **22 Hours**

Transducers– Characteristics of transducers – Errors and Error analysis – Resistive, capacitive and inductive transducers – RTD – Strain gauge – LVDT – Capacitive and Inductive Proximity sensors – Piezo electric transducers – ultrasonic transducers - Magnetic pickups – Optical transducers – Digital encoders – Smart Transducer -Selection of transducers-Measurement of Temperature, Pressure, Level, Displacement, Angular velocity and Torque.

Signal Generators and Analyzer: Sine, Pulse, and square wave generators – Function generators- Wave Analyzer and Spectrum Analyzer.

Oscilloscopes: CRO and DSO

Basic blocks of Data Acquisition System and PC based instrumentation.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Describe the working of different measuring instruments in electrical and physical quantity measurements.	Understand
CO2: Analyze the characteristics and errors in measuring instruments and transducers	Apply
CO3: Select the instruments and bridges for high power and low power electrical quantity measurements.	Analyze
CO4: Select the transducers for various physical quantity measurement applications	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	--	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2; Low-1

Textbooks:

T1. Ernest O. Doebelin. Measurement system Application and Design. McGraw Hill International Editions, 1990

Reference Book(s):

R1. A.K. Sawhney, PuneetSawhney ‘A Course in Electrical & Electronic Measurements & Instrumentation’, DhanpatRai and Co, New Delhi, Edition 2011.

R2. H.S. Kalsi, ‘Electronic Instrumentation’, Tata McGraw-Hill, New Delhi, 2010

R3. R. K. Rajput, “Electrical and Electronics Measurements and Instrumentation”, Chand Pub, 2016

Web References:

1. NPTEL:Transducers For Instrumentation By Prof. Ankur Gupta, IIT-Delhi.
2. NPTEL:Electrical Measurement and Electronic Instruments, Prof. AvishekChatterjee Department of Electrical Engineering, IIT-Kharagpur.

Course Code: 23EEL401		Course Title: Synchronous and Induction Machines Laboratory	
Course Category: Major		**Course Level: Intermediate**	
L:T:P(Hours/Week) 0:0:3	**Credits: 1.5**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

To demonstrate the tests and analyze the performance of synchronous and induction machines

List of Exercises

1. Load test on three phase Alternator
2. Regulation of three phase alternator by EMF & MMF method
3. Regulation of three phase alternator by ZPF method
4. Regulation of three phase salient pole alternator by slip test
5. Determination of V and Inverted V curves of Synchronous Motor
6. Demonstrate the working of different types of starters.
7. Load test on single phase induction motor
8. Load test on three phase Squirrel cage and Slip-ring induction motor
9. No load and blocked rotor test on a three phase induction motor – Equivalent Circuit and Circle Diagram
10. Parallel operation of three phase alternators

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1:Compare the performance of an alternator by direct and indirect method.	Analyze
CO2:Demonstrate the parallel operation of alternator and control of induction motor.	Apply
CO3:Identify the performance curves of the synchronous motor.	Apply
CO4:Identify the performance of single and three phase Induction motor.	Apply
CO5:Evaluate the performance of different types of AC motors.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	3	-	-	1	-	-	-	-	-	-	-	1	-
CO2	3	-	-	-	1	-	-	-	-	-	-	-	1	-
CO3	3	-	-	-	1	-	-	-	-	-	-	-	1	-
CO4	3	-	-	-	1	-	-	-	-	-	-	-	1	-
CO5	-	-	-	3	1	-	-	-	-	-	-	-	1	-

High-3; Medium-2; Low-1

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 **BOS Chairman**

Textbooks:

T1. Gupta. J.B., "Electrical Machine - II", S.K. Kataria & Sons, New Delhi, Reprint, 2020.

T2. "Synchronous And Induction Machines Laboratory Manual" prepared by Department of Electrical and Electronics Engineering, Dr.Mahalingam College of Engineering and Technology.

Reference Book(s):

R1.Bimbhra. P.S., "Electrical Machinery", Khanna Publishers, New Delhi, 1st Edition, 2021.

R2. Nagrath I.J Kothari D.P, "Electric Machines", Tata McGraw Hill publishing company Ltd, New Delhi, 5th Edition,2017.

Web References:

1. https://em-coep.vlabs.ac.in/List%20of%20experiments.html

Course Code:23EEL402		Course Title: Analog and Digital Electronics Laboratory	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 0:0:3	Credits: 1.5	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on the design and implementation of basic analog and digital circuit.

List of Exercises

1. Design and implementation of code converters.
2. Design of combinational circuits using multiplexer and de- multiplexer.
3. Design and implementation of counters and shift registers.
4. Verilog implementation of Full Adder and Full Subtractor.
5. Verilog implementation of Flip-Flop.
6. Design and implementation of synchronous sequential circuits.
7. Design and Implementation of Half-Wave and Full-Wave Rectifier with and without Capacitor Filter.
8. Frequency response of tuned amplifiers.
9. Design and verification of RC Oscillators.
10. Design and Verification of Power Amplifiers.
11. Design and implementation of multivibrators.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1:Design the basic combinational and sequential circuits	Apply
CO2: Experiment the Half-Wave and Full-Wave Rectifier with and without Capacitor Filter.	Apply
CO3:Design the amplifiers, oscillators and multivibrators for the given application	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	1	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	1	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	1	-	-	-	-	-	-	-	-	-

High-3; Medium-2; Low-1

Passed in 17th Board of Studies Meeting held on 05.01.2024

Approved in 18th Academic Council Meeting held on 23.03.2024 **BOS Chairman**

References:

T1.Lab manual prepared by the Department of Electrical and Electronics Engineering, Dr.Mahalingam College of Engineering and Technology, Pollachi.

Course Code: 23ESL401		Course Title:Professional Skills 3 : Professional Development and Etiquette (Common to all B.E/B.Tech Programmes)	
Course Category: SEC		Course Level: Introductory	
L:T:P(Hours/Week) 0: 0: 2	Credits: 1	Total Contact Hours:30	Max Marks:100

Course Objectives:

The course is intended to cultivate students' appropriate etiquette across various personal and professional contexts, fostering professionalism and effective communication.

Module I **15 Hours**

Emotional Intelligence

Intrapersonal Skill: Goal Setting- Self-management- Emotional Intelligence: Understanding & Developing EI for Effective Communication and Relationships – Enhancing Social Skills

Professional Development

Introduction to Professional Development - Career State Assessment - Set Career Goals- Stay on Industry Trends - Self & Lifelong learning – Creativity - Problem Solving Skills - Strong Fundamentals – Using/ Creating Opportunities – Work & Life Balancing - Revisiting Goals

Teamness and Interpersonal skills

Paraphrasing: Techniques for Active Listening -Paraphrasing as a Tool for Effective Understanding and Communication – Collaboration and Team Building: Building Trust and Rapport - Self-paced learning.

Module II **15 Hours**

Effective Communication

Effective Verbal Communication - Assertive Communication - Elements of Effective Communication - Barriers to Effective Communication - Persuasion Skills -Effective Presentation: Oral and visual presentation – Drafting formal reports.

Professional Etiquette

Introduction - Types of professional Etiquette- Personal Grooming: Importance of Personal Grooming in Professional Settings- Dress Codes and Professional Appearance Guidelines- Body language - Social – Email – Telephonic – Dining – Classroom - Business.

Activities:

- Emotional Intelligence: Scenario based role play, Debate
- Paraphrasing: Listening, Reading
- Effective Presentation:
    - Oral Presentation: Self-Introduction, JAM , Extempore speech
    - Visual presentation: Email Writing, Power Point Presentation, Vlog

Professional Etiquette: Demonstrate required Professional Etiquette in all the above activities.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Communicate effectively and exhibit Professional etiquettes in various social forums.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	2	2	3	-	1	-	-

High-3; Medium-2; Low-1

Textbook(s):

T1. Sabina Pillai, Agna Fernandez, "Soft Skills & Employability Skills", Cambridge University Press2018.

T2.Peggy Post &Peter Post, "The Etiquette Advantage in Business: Personal Skills for Professional Success", 2nd edition (May 3, 2005), William Morrow.

Reference Book(s):

R1. Ashraf Rizvi, "Effective Technical Communication" 2nd Edition, McGraw-Hill India, 2018.

R2. Maithry Shinde, Jyotsna Sreenath, "Life Skills & Personality Development", Cambridge University Press 2022.

Web References:

1. https://www.indeed.com/career-advice/career-development/etiquette-at-work
2. https://www.skillsyouneed.com/interpersonal-skills.html

SEMESTER V

Course Code: 23EET501		Course Title: Control Systems	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3:1:0	Credits: 4	Total Contact Hours: 60	Max Marks:100

Course Objectives:

This course aims to equip students with the skills to develop mathematical models of physical systems and analyze their behavior through time-domain and frequency-domain approaches. Through analytical insights, students will gain the ability to predict system behavior and design effective control mechanisms.

Module I **30 Hours**

Introduction to Control Systems: Introduction, classification of control systems.

Mathematical models of physical systems: Modeling of mechanical system elements, electrical systems, Analogous systems, Transfer function of Armature Control and Field Control of DC motor.

Block Diagram: Procedure for drawing block diagram and block diagram reduction to find transfer function.

Signal Flow Graphs: Signal flow graphs, Basic properties of signal flow graph, Construction of signal flow graph for control systems.

Time Domain Analysis: Standard test signals, time response of first order systems, time response of second order systems, time domain specifications - steady state errors and error constants.

Controllers: Effects of P, PI, PD and PID Controllers on the system's response.

Module II **30 Hours**

Frequency domain analysis: Frequency domain specification, Bode plot, Polar plot – phase margin and gain margin - Nyquist stability criterion, Correlation between time and frequency response.

Stability analysis: Stability, Routh-Hurwitz Criterion, Concept of Root Locus Technique, Construction of Root Locus, Effect of adding pole and zero on Root locus.

Design of compensator: Compensation, Lead compensator, Lag compensator, Lag-Lead compensators, Compensator design using Bode plot.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Possess in-depth knowledge on modeling of electrical and mechanical systems using transfer function.	Apply
CO2. Analyze the time domain specifications and frequency domain specification of first order and second order systems.	Analyze
CO3: Analyze the stability of control system using techniques such as the Routh-Hurwitz Criterion and Root Locus analysis, and independently solve simple problems and report inferences.	Analyze
CO4: Design compensator using bode plot technique. (Assignment Component only using MATLAB)	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2		3			1									
CO3				3					1	1				
CO4			3											

High-3; Medium-2; Low-1

Textbook(s):

T1. J. Nagrath and M. Gopal, 'Control Systems Engineering', New Age International Publishers, sixth Edition, 2018.

T2. Benjamin C. Kuo, 'Automatic Control systems', 10 edition Pearson Education, New Delhi, tenth Edition, 2017.

Reference Book(s):

R1. Norman S. Nise, 'Control Systems Engineering', John Wiley, New Delhi, 6th Edition, 2010.

R2. Samarajit Ghosh, 'Control systems Theory and Applications ', Pearson Education, New Delhi, 2nd Edition 2012.

R3. M. Gopal, 'Control Systems, Principles and Design', Tata McGraw Hill, New Delhi, 4th Edition 2012.

R4. K. Ogata, 'Modern Control Engineering', Pearson Education India, New Delhi, 5th Edition 2015.

R5. Richard C.Dort and Robert H.Bishop, "Modern Control Systems ", Pearson Prentice Hall, 13th Edition 2016.

Web References:

1. https://nptel.ac.in/courses/107106081/
2. https://www.tutorialspoint.com/control_systems/control_systems
3. http://lpsa.swarthmore.edu/Root_Locus/RLocusExamples.html
4. https://in.mathworks.com/help/control/examples/compensator-design-for-systems

Course Code: 23EET502		Course Title: Embedded Controller	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

This course covers microprocessor and microcontroller architectures, focusing on PIC and ARM systems, including programming, interfacing, peripherals, and system design. It also explores ARM7 and LPC2148 features for embedded system development.

Module I **22 Hours**

Microprocessor Architecture

Introduction to Microprocessor and Microcontroller – Evolution – Von Neumann and Harvard architecture- RISC Vs CISC

PIC Microcontroller and Programming

PIC18FX Pin connection – File register – Data type and Time delay in C - Logical operation – Data conversion - Program ROM Allocation - Data RAM allocation

On-Chip Peripherals of PIC Microcontroller

I/O Ports- Timer0/counter – UART– Interrupts –CCP- ADC - SPI - I2C

System Design Using PIC18FX

LED and Switch interfacing-LCD Interfacing – Keyboard Interfacing- Relay interfacing – Sensor Interfacing - Stepper Motor Interfacing - DC Motor Interfacing.

Module II **23 Hours**

Architecture of ARM

ARM7 data flow model - architecture, flag register - CPSR, ARM7 programmer's register model, pipelining, operating modes, interrupts - exceptions, addressing modes, ARM7 instruction set- Memory Management.

On-chip peripherals of LPC2148

LPC2148-Functional description-GPIO-Timers-UART-PWM-RTC-ADC-DAC-Overview on ARM Cortex Mx.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Analyze the programming and interfacing of the PIC18FX microcontroller, focusing on the utilization of on-chip peripherals (I/O ports, timers, UART, ADC, SPI, and I2C) in embedded system design.	Analyze
CO2: Analyze and design embedded systems using PIC18FX, focusing on interfacing various components such as LEDs, switches, LCDs, keyboards, relays, sensors, stepper motors, and DC motors.	Analyze

CO3: Analyze the ARM7 architecture, focusing on its data flow model, pipelining, flag registers, and instruction set, to evaluate and design efficient embedded systems.	Analyze
CO4: Develop embedded systems using the LPC2148 microcontroller, integrating peripherals like GPIO, timers, PWM, RTC, ADC, and DAC.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2		3											1	
CO3		3					1						1	1
CO4			3	3									1	

High-3; Medium-2; Low-1

Textbook(s):

T1. Muhammad ALI Mazidi, RolinD. Mckinlay, Danny Causery,"PIC Microcontroller and Embedded systems using assembly and C PIC18", Second edition Pearson international edition, 2021.

T2. Andrew N. Sloss, Dominic Symes, Chris Wright "ARM System Developer's Guide Designing and Optimizing System Software" Elsevier Inc., 2005.

Reference Book(s):

R1. R.S.Gaonkar,"Microprocessor Architecture, Programming and Applications with the 8085", Sixth Edition, Prentice Hall, 2013.

R2. Steve Furber, "ARM System-on-Chip Architecture" Pearson Education Limited, 2012

R3. Krishna Kant, "Microprocessor and Microcontroller Architecture, Programming and System Design using 8085, 8086, 8051 and 8096", PHI, 2011.

R4.Myke Predko,"Programming and Customizing the PIC Microcontroller"3rd Edition Tata McGraw hill 2008.

R5. A.K Ray, K.M.Bhurchandi, "Advanced Microprocessors and Peripherals" 3rd Edition McGraw Hill Education 2017.

Web References:

1. https://www.nxp.com/docs/en/user-guide/UM10139.pdf
2.http://www.microchip.com/design-centers/microcontrollers
3.https://electrosome.com/category/tutorials/pic-microcontroller/hi-tech-c/
4.https://ww1.microchip.com/downloads/en/devicedoc/39582b.pdf

Course Code:23EET503		Course Title: Linear Integrated Circuits	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart the knowledge on Op-Amp, its characteristics and application and few other linear integrated circuits.

Module I **22 Hours**

IC classification - Fundamentals of monolithic ICs –Basic Planar Processes - Construction of a typical Integrated circuit–Block Diagram of Op-amp - Current mirror and Current source - Widlar current source -Wilson current source - Ideal Op-amp characteristics and its equivalent circuit – DC characteristics - AC characteristics – Concept of frequency compensation-methods of improving slew rate. Ideal Inverting and Non-inverting amplifier - Voltage Follower - Adder– Subtractor - Instrumentation Amplifier - Integrator – Differentiator – Precision rectifiers - Fundamentals of Log and Antilog Amplifiers. Active filters: Low pass, High pass, Band pass and Band Reject filters

Module II **23 Hours**

Wave form- generators: Triangular, and Sine-RC-phase shift oscillator, Wein bridge oscillator - Basic Comparators – Zero crossing detectors – Schmitt trigger– Window detector – DAC: specifications - weighted resistor type, R-2R Ladder type. ADC: Specifications - Successive Approximation type - Dual Slope type-Delta sigma ADC- A/D Converter using Voltage-to-Time Conversion and Integrated Circuit ADC.

Voltage regulators-IC 78XX, IC79XX, IC LM317, general purpose regulator IC 723.

Timer IC 555 – Astable and Monostable multivibrators - Voltage Controlled Oscillator (VCO) - PLL IC 565: Principle of operation.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Apply the concept of basic planar process in construction of a simple circuit.	Apply
CO2: Design the various analog arithmetic circuits, amplifiers, oscillators, multivibrators, wave-shaping circuits using different linear ICs.	Apply
CO3: Analyze the different voltage regulator using the line and load regulation characteristics.	Analyze

CO4: Make use of timer, delay, pulse generation, and oscillator applications.	Analyze
CO5: Work as team or engage in independent study and make an effective oral presentation of Linear ICs and its application to solve various environmental and societal needs following the engineering standards	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2			3										1	
CO3		3											1	
CO4		3											1	
CO5				3			1		1	1			1	1

High-3; Medium-2; Low-1

Text Book(s)

T1.D. Roy Choudhery, Sheil B. Jain, "Linear Integrated Circuits," Second Edition, New Age Publishers, 2010.

T2.Ramakant A. Gayakwad, "Op-Amps and Linear Integrated Circuits," fourth Edition, Pearson Education, 2024.

Reference Book(s)

R1.Robert F.Coughlin, Fredrick F. Driscoll, ‘Op-amp and Linear ICs’, PHI Learning, Sixth Edition, 2012

R2.Jacob Millman, Christos C. Halkias, "Integrated Electronics - Analog and Digital Circuits Systems," Second Edition, Tata McGraw-Hill, 2017.

R3.James M. Fiore, Op Amps and Linear Integrated Circuits Concepts and Applications, Second Edition, Cengage Learning 2012.

R4.S. Franco, "Design with Operational Amplifiers and Analog Integrated Circuits," Fourth Edition, McGraw-Hill, 2015.

R5.David A. Bell, “Op-Amps & Linear ICs,” Third Edition, Oxford University Press, 2011.

R6. M. H. Rashid, Microelectronic Circuits: Analysis and Design. Cengage Learning, 4th ed., 2016.

Web References

1.http://www.nptel.ac.in/courses/Webcourse-contents/IIT ROORKEE /Analog %20 circuits/html

2. http://www.555-timer-circuits.com

3. http://www.technologystudent.com/elec1/elecex.htm

4.http://freevideolectures.com/Course/2915/Linear-Integrated-Circuits#

Course Code: 23EEL501		Course Title: Embedded Controller Laboratory	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 0: 0: 3	**Credits: 1.5**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

This course aims to provide students with the skills to design and implement microcontroller-based systems for real-time applications.

LIST OF EXPERIMENTS **45 Hours**

1. Interface LED and switch using PIC16F877A microcontroller.
2. Lamp control using Timer/Counter using PIC16F877A microcontroller.
3. Transmission and Reception of a byte using on chip serial port using PIC16F877A microcontroller.
4. Data Transmission using I2C protocol using PIC16F877A.
5. Read the temperature sensor value using ADC and display it in LCD using PIC16F877A microcontroller.
6. Controlling the LED via external interrupt using STM32 microcontroller.
7. Controlling PWM period with analogue input (POT) using STM32 microcontroller.
8. Data Transmission using CAN protocol using STM32 microcontroller.
9. Direction control of DC motor using STM32 microcontroller.
10. Waveform generation using 10 Bit DAC using STM32 microcontroller.
11. Conduct an experiment to compare the power consumption of PIC and STM32 microcontrollers in active and low-power modes. Analyze their suitability for extended battery applications based on measured energy efficiency.(Optional)

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply programming techniques for interfacing LEDs, switches, sensors, and motors with microcontrollers.	Apply
CO2: Implement communication protocols to transmit and receive data between microcontrollers and external devices.	Apply
CO3: Analyze the microcontroller-based systems and evaluate their impact on system performance as a team or individual.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				1								1	
CO2			3		1								1	
CO3				3	1							1	1	

High-3; Medium-2; Low-1

Reference books:

"Microprocessor and Microcontroller Lab" Manual prepared by Department of Electrical and Electronics Engineering, MCET, Pollachi.

Course Code: 23EEL502		Course Title: Integrated Circuits Laboratory	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 0:0:3	Credits: 1.5	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to design the op-amp circuits for open and closed loop applications and analyze the application of PLL. Additionally analyze the output of amplifiers, multi-vibrators and power supplies

List of Exercises

1. Inverting, Non inverting and differential amplifiers
2. Integrator and Differentiator
3. Instrumentation amplifier.
4. Simulation of Comparator applications.
5. Simulation of Active low-pass and High-pass filters.
6. Simulation of RC Phase shift and Wien bridge oscillators using op-amp.
7. Design of DC power supply using LM723.
8. Weighted resistor and R-2R ladder type DACs.
9. Astable and Monostable multivibrators using NE555 Timer.
10. Design a 8 bit Flash type ADC using IC741.
11. Design of Frequency Multiplier using PLL IC565.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO 1: Analyze analog amplifiers and filters to achieve desired performance parameters.	Analyze
CO 2: Implement specialized analog systems such as instrumentation amplifiers, RC phase shift oscillators, and Wien bridge oscillators.	Apply
CO 3: Implement digital-to-analog conversion systems using weighted resistor and R-2R ladder designs, and evaluate the performance.	Evaluate

CO4:Design timing circuits and power supply systems, including astable and monostable multivibrators using NE555 Timer IC and DC power supplies using LM723 and evaluate the performance.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3			1								1	
CO2	3				1								1	
CO3				3	1								1	
CO4				3	1								1	

High-3; Medium-2; Low-1

Reference Book(s)

1. "Linear Integrated Circuits Laboratory" Manual prepared by Department of Electrical and Electronics Engineering, MCET, Pollachi.

Web References

1. D.Roy Choudhry, Shail Jain, Linear Integrated Circuits, New Age International Pvt. Ltd., 2000.
2. Sergio Franco, Design with operational amplifiers and analog integrated circuits, McGraw-Hill, 2002.

Course Code: 23ESL501		Course Title: Professional Skills 4: Communication Skills and Interview Essentials (Common to all B.E/B.Tech Programmes)	
Course Category: SEC		Course Level: Introductory	
L:T:P(Hours/Week) 0: 0: 2	Credits: 1	Total Contact Hours:30	Max Marks:100

Course Objectives:

The course is intended to equip students with the necessary skills to effectively communicate in various professional settings and excel in the interview process

Module I **15 Hours**

Resume Building & Portfolio Management

Importance of a Strong Resume - Resume Content Development & Core Components – Formatting and Design - Tailoring and Customization – Proofreading - Portfolio Content, design and Structure : Components & Efficient portfolios – Preparing and Maintaining documents for interview – maintaining repositories - Enhancing Personal Brand - Digital Tools and Platforms

Interview - Dress code, Body Language and Grooming

Dress Code Essentials - Body Language – Facial expression, eye contact, gesture, posture, touch behavior & space- Personal Grooming

Effective Communication

Communication in Diverse Contexts - Presentations – Individual and group presentations - Public Speaking - Visual Aids and Presentation Tools

Module II **15 Hours**

Group Discussion

Introduction & types of Group Discussion – Prerequisites of GD – Techniques and tips of GD - Role of GDs in various professional contexts – GD Etiquettes – Strategies to enhance GD – Mock GD.

Interview Skills

Purpose of an interview - Types of Interviews –Interview Techniques – Interview Etiquette - Planning and Preparation - Mock Interviews with Feedback - Post-Interview Etiquette and Follow-Up

Activities:

Building Portfolio: Resume Building, Updating LinkedIn, Maintaining Repositories.

Effective Presentation:

Oral Presentation: Impromptu speech, Mini Presentation, Picture Perception (Both Speaking and Writing)

Visual presentation: Power Point Presentation, Vlog

Group Discussion: General, Technical

Mock Interview: General, Technical

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Communicate effectively and exhibit required competency in various professional environments and demonstrate proficiency in interview process.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	1	3	3	-	1	-	-

High-3; Medium-2; Low-1

Textbook(s):

T1. Ashraf Rizvi, "Effective Technical Communication" 2nd Edition, McGraw-Hill India, 2018

T2. Pease, Allan, and Barbara Pease. "The Definitive Book of Body Language." Bantam, 2006.

Reference Book(s):

R1. Cheryl Hamilton, “Communicating for Results: A Guide for Business and the Professions”, 11th edition (1 January 2017), Wadsworth Publishing Co Inc.

R2. Whitcomb, Susan Britton. Resume Magic: Trade Secrets of a Professional Resume Writer. JIST Works, 2010.

R3. Carnegie, D. (2009). The Quick and Easy Way to Effective Speaking. Pocket Books.

Web References:

1 https://www.linkedin.com/pulse/interview-etiquette-dos-donts-interviews-brian-vander-waal-fmy8e/

2 https://www.simplilearn.com/group-discussion-tips-article

Course Code: 23EEP501		Course Title: Reverse Engineering Project	
Course Category: Project		**Course Level: Higher**	
L:T:P(Hours/Week) 0:0:6	**Credits: 3**	**Total Contact Hours: 90**	**Max Marks:100**

Course Objective:

This course is designed as a hands-on, project-based learning component that enables students to understand the structure, function, and design principles of existing products or systems. Through disassembly, functional analysis, and modelling, students gain insights into real-world engineering challenges.

Module 1 **30 Hours**

Introduction to Reverse Engineering – Ethics and Case Studies- Selection and Approval of Product/System- Disassembly and Physical/Logical Mapping of Components- Functional Analysis

Module 2 **60 Hours**

System Interaction, Data Flow- Modelling & Simulation using CAD/EDA/Software/Hardware Tools- Redesign / Optimization

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Identify and analyze the functional structure of real-world products.	Analyze
CO 2: Document and map system components through manual and digital methods.	Apply
CO 3: Create accurate models and simulations using appropriate tools.	Create
CO 4: Propose feasible improvements or alternative designs.	Evaluate
CO5: Present comprehensive reports and defend their analysis with clarity and professionalism.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3											1	1
CO2	3													
CO3					3									
CO4				3										
CO5								3		3				

High-3; Medium-2; Low-1

Web References

1.https://innovationspace.ansys.com/product/reverse-engineering-in-metal-additive-manufacturing/

Semester VI

Course Code: 23EET601		Course Title: Generation, Transmission and Distribution	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course aims to provide a comprehensive understanding of power generation by delving into the principles and technologies associated with diverse energy sources. It further focuses on the analysis of transmission line parameters, emphasizing the efficient transfer of electrical energy over extended distances.

Module I **22 Hours**

General structure of power system - types of generation: conventional- thermal power plant, hydro power plant, nuclear power plant-concept of distributed generations- Renewable Energy Sources.

Feeders, distributors and service mains - radial and ring main systems - calculation of voltage in distributors with concentrated and distributed loads in DC Distribution, A.C. single phase and three phase distribution systems- Introduction to Substation.

Load capacity factor - connected load - load curve and load duration curve - economics of power generation- types of tariff.

Module II **23 Hours**

Parameters of single and three phase transmission lines with single and double circuits: Introduction to Zebra and Panther conductors, resistance, inductance and capacitance of solid. Stranded and bundled conductors- symmetrical and unsymmetrical spacing transposition- application of self and mutual GMD- skin and proximity effects.

Transmission lines: types –short line, medium line and long line- equivalent circuits, surge impedance - transmission efficiency and voltage regulation - Ferranti effect and corona effect.

Insulators: types, voltage distribution in insulator string, improvement of string efficiency underground cables: constructional features of LT and HT cables, capacitance, dielectric stress and grading.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Understand the various generation schemes and analyze the various parameters in power generation.	Understand
CO 2: Compute the transmission line parameters	Apply
CO 3: Compute the voltage distribution in insulator and dielectric stress in cables.	Apply
CO 4: Determine the voltage at various load points of AC and DC distributors.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1							1					1	1	
CO2	3						1	1				1	1	
CO3	3						1	1				1	1	
CO4	3						1	1				1	1	

High-3; Medium-2; Low-1

Textbooks:

T1. Wadhwa,C.L.,“ Electrical Power Systems'',6th Edition, New age International, 2014.

T2. M.L.Soni, Gupta, Bhatnagar, Chakrabarthy, ‘A Text book on Power Systems Engineering’, Danpat Rai & Sons, 1st Edition, 2010.

T3. V.K.Mehta, Rohit Mehta," Principles of Power System”, S Chand & Co Ltd, 4th Edition, 2011.

Reference Book(s):

R1. S.N. Singh, "Electric Power Generation, Transmission and Distribution", Prentice Hall of India Pvt. Ltd, 2nd Edition, 2010.

R2. B.R. Gupta, “Generation of Electrical Energy”, S. Chand & Company Ltd, 4th edition, 2014.

R3. Leonard L. Grigsby, “Electric Power Generation, Transmission and Distribution”, CRC Press, 3rd Edition, 2012.

R4. Haadi Saadat, “Power System Analysis”, TATA Mcgraw Hill, 3rd Edition, 2010.

Web References:

1. https://archive.nptel.ac.in/courses/108/102/108102047
2. https://www.classcentral.com/course/youtube-electrical-power-system-generation-transmission-and-distribution-47683
3. https://nptel.ac.in/courses/108/108/108108034/
4. https://cea.nic.in/installed -capacity-report/

Course Code: 23EET602		Course Title: Power Electronics	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The objective of this course is to explore the role of Power Electronics as a key enabling technology in industrial automation, energy conservation, renewable energy integration, and transportation electrification. It also focuses on its significance in utility-related applications, including smart grids, HVDC systems, and power quality improvement for modern energy networks.

Module I **22 Hours**

Solid State Power Devices: Principle of operation of SCR, dynamic characteristic of SCR during turn ON and turn OFF, parameters of SCR, dv/dt and di/dt protection, snubber circuit, commutation circuits; Principle of operation of MOSFET, IGBT their operating characteristics.

Single-phase Converter: Half wave converter, 2-pulse midpoint converter, half controlled and fully controlled bridge converters, input current and output voltage waveforms, effect of load and source impedance, expressions for input power factor, displacement factor, harmonic factor and output voltage, effect of free-wheeling diode.

Three-phase Converter: Half wave, full wave, half controlled and fully controlled bridge converters, effect of load and source impedance, expressions for input power factor, displacement factor, harmonic factor and output voltage.

Module II **23 Hours**

DC-DC Converters: Introduction, Basic principles of step-down and step-up operation, chopper classification study of Buck, Boost and Buck-Boost regulators, Introduction to forward and fly back converters.

Inverters: Introduction, principle of operation, performance parameters, single phase bridge inverters with R and RL loads, 3-phase bridge inverters- 180 and 120 degrees mode of operation, Voltage control of single phase inverters -single pulse width modulation, multiple pulse width modulation, sinusoidal pulse width modulation.

A.C. Regulator: Introduction, principle of operation of single phase voltage controllers for R &R-L loads and its applications.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Analyze and Evaluate the performance of given power electronic converter	Analyze
CO2: Design the DC-DC Converter for the given specifications.	Create
CO3: Design the DC-AC Converter for the given specifications.	Create
CO4: Simulate and design single-phase AC-AC and DC-AC Converters.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	3	3	-	-	-	1	1	-	1	-	-

High-3; Medium-2;Low-1

Textbooks:

T1.Muhammad H. Rashid, Power Electronics - Circuits, Devices and Applications, Pearson, 4th Edition, 2018.
T2. Mohan Undeland Robin, Power Electronics - Converters, Applications and Design, John Wiley & Sons, 3rd Edition, 2002.

Reference Book(s):

R1.P.S.Bimbhra, Power Electronics, Khanna Publishers, 6th Edition, 2016.
R2 L Umanand, Power Electronics, Wiley India Pvt Ltd.

Web References:

1.https://nptel.ac.in/courses/108/101/108101038/

2. https://nptel.ac.in/courses/108/102/108102145/

3. https://nptel.ac.in/courses/108/101/108101126/

Course Code: 23EEL601		Course Title: Power Electronics Laboratory	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 0:0:3	Credits: 1.5	Total Contact Hours: 45	Max Marks:100

Course Objectives:

This course focuses on modeling and verifying the outputs of various converters, including AC-DC and DC-DC converters, as well as DC-AC converters. Additionally, it covers the design and analysis of PCB circuits for a full bridge inverter using simulation tool, providing comprehensive skills in power electronics and circuit simulation.

List of Experiments:

1. Determine the turn on and turn off time of MOSFET, SCR and also draw it's characteristics.
2. Determine the turn on and turn off time of IGBT and also draw it's characteristics.
3. Simulate the Single phase half and full converter and verify using hardware.
4. Simulate the Three phase full converter and validate the result using hardware.
5. Model the Single phase inverter and validate the result using hardware.
6. Simulate the Three phase inverter and validate the result using hardware.
7. Simulate the BUCK and BOOST converter and validate the result using hardware.
8. Model the Four quadrant chopper using simulation and validate the result using hardware.
9. Simulate the single phase AC voltage controller and validate the result using hardware.
10. Design a Single phase full bridge inverter and verify it into a PCB hardware model.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Simulate ac-dc, dc-dc, dc-ac, and ac-ac converters using MATLAB.	Analyze
CO2: Evaluate the results of various converters using hardware.	Evaluate
CO3: Design and implement the full bridge inverter using PCB model as a mini project	Create

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1					3									
CO2				3										
CO3			3		1									

High-3; Medium-2; Low-1

Reference Book(s):

R1. ”Power Electronics Lab Manual” prepared by Department of Electrical and Electronics Engineering, MCET, Pollachi.

R2. Muhammad H. Rashid” Power electronics Hand book”, Elsevier Inc.2018.

Web References:

1. https://nptel.ac.in/courses/108/102/108102145/
2. https://nptel.ac.in/courses/117103148
3. https://nptel.ac.in/courses/108101126
4. http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/power_electronics/labs/index.php

Course Code: 23EEL602		Course Title: Embedded Software Laboratory	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 0:0:3	**Credits: 1.5**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

This course focuses on hands-on experience in embedded systems programming using C/C++ on Ubuntu OS. Students will learn dynamic memory handling, pointer operations, multithreading with Free RTOS, and communication protocols. Additionally the course enables simulation of real-time embedded applications without hardware, concluding with a mini-project.

List of Exercises

1. Dynamic Memory Allocation in Embedded Systems
2. Pointer Manipulation for Peripheral Access
3. Modular Programming with Pointer-based Argument Passing
4. Recursive Functions and Stack Analysis
5. Debugging: GDB Revision & Core Dump Analysis.
6. Communication Protocol Programming: UART, I2C, SPI
7. Task-Based Multi-threading in Embedded Systems Using Free RTOS
8. CPU Scheduling
9. Concepts of uP/uC Architecture Connecting Memory/Peripherals,
10. Mini-Project

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Apply dynamic memory allocation, pointer manipulation, and modular programming techniques essential for embedded software development.	Apply
CO2 Analyze and implement recursive functions, stack usage, and debugging skills using GDB and core dump analysis to troubleshoot embedded applications.	Analysis
CO3: Develop and simulate communication protocols (UART, I2C, SPI) and real-time multitasking applications using Free RTOS on a Linux-based environment.	Evaluate
CO4: Apply concepts of microprocessor/microcontroller architecture, CPU scheduling, and peripheral interfacing through hands-on experiments and a comprehensive mini-project.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				1									
CO2		3												
CO3				3										
CO4			3		1	1	1						1	

High-3; Medium-2; Low-1

Reference Book(s)

1. “Embedded Software Laboratory” Manual prepared by Department of Electrical and Electronics Engineering, MCET, Pollachi.

Course Code:23ESL601		Course Title: Professional Skills 5: Ace and Elevate : Aptitude and Soft Skills (Common to all B.E/B.Tech Programmes)	
Course Category: SEC		Course Level:Higher	
L:T:P (Hours/Week) 0: 0: 2	Credits: 1	Total Contact Hours: 30	Max Marks: 100

Course Objectives:

To enhance students' problem-solving skills in the aptitude segment while also equipping them with effective communication skills for professional settings and success in the interview process.

Module I Verbal Ability & Effective Communication **15 Hours**

Verbal Ability

Parts of Speech – Tenses – Subject Verb Agreement – Synonyms – Antonyms – Idioms and Phrases - One Word Substitution – Reading Comprehension – Cloze test – Error Spotting.

Verbal Enhancement

Self-Introduction – Just A Minute- Picture Perception - Writing Skills: Sentence Types (Simple, Compound, Complex), Email drafting.

Campus to Corporate

Professional Grooming –Group Discussion – Impromptu – Interview.

Module II Quantitative & Reasoning Ability **15 Hours**

Quantitative Ability

Simplification & Approximation, Number System, Percentage, Averages, Ratios and Proportion, Ages, Profit & Loss, Interest Calculation, Time and work, Time, speed and distance, Clocks and Calendar, Mixtures and alligation, Permutations and Combinations, Probability, Mensuration, Data Interpretation, Data Sufficiency

Reasoning Ability

Seating Arrangement, Blood relations, Directions Problems, Syllogisms, Number & Alpha Series, Coding and Decoding, Non Verbal Reasoning, Analogies, Cubes and Dices.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Exhibit strong problem-solving skills in the aptitude segment while enhancing their communication abilities for professional settings, enabling them to excel in interviews and placement processes.	**Apply**

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	-	-	-	-	-	-	2	3	3	-	1	-	-

High-3; Medium-2; Low-1

Textbook(s):

T1: Technical Communication, 3E: Principles and Practice book. Authors. Meenakshi Raman, Sangeeta Sharma, 2006

T2: Pease, Allan, and Barbara Pease. "The Definitive Book of Body Language." Bantam, 2006.

T3: Dr. R. S. Aggarwal. "Quantitative Aptitude for Competitive Examinations" Sultan Chand & Sons Pvt. Ltd, New Delhi, 2024

T4: Dr. R. S. Aggarwal. "A Modern Approach to Verbal and Non-Verbal", Sultan Chand & Sons Pvt. Ltd, New Delhi, 2024

Reference Book(s):

R1: Cheryl Hamilton, "Communicating for Results: A Guide for Business and the Professions",

R2: Whitcomb, Susan Britton. Resume Magic: Trade Secrets of a Professional Resume Writer. JIST Works, 2010.

R3: Carnegie, D. (2009). The Quick and Easy Way to Effective Speaking. Pocket Books.

R4: Arun Sharma. "Quantitative Aptitude for Common Aptitude Test", McGraw Hill Publications, 5th Edition, 2020

R5: Arun Sharma. "Logical Reasoning for Common Aptitude Test", McGraw Hill Publications, 6th Edition, 2021.

Web References:

1. https://www.linkedin.com/pulse/interview-etiquette-dos-donts-interviews-brian-vander-waal-fmy8e/
2. https://www.simplilearn.com/group-discussion-tips-article
3. https://talentbattle.in
4. https://www.geeksforgeeks.org/aptitude-questions-and-answers/

Semester VII

Course Code: 23EET701		Course Title: Power System Analysis and Stability	
Course Category: Major		Course Level: Advanced	
L:T:P(Hours/Week) 3:1:0	Credits: 4	Total Contact Hours: 60	Max Marks:100

Course Objectives:
This course focuses on power system analysis, including bus admittance and bus impedance matrix construction and numerical methods for power flow analysis. The course also emphasis on fault analysis under both balanced and unbalanced conditions and examines system stability during faults.

Module I **22+8 Hours**

Introduction: Need for system planning and operational studies - Power scenario in India - Power system components, Representation - Single line diagram - per unit quantities - p.u. impedance diagram - p.u. reactance diagram, Formation of bus admittance matrix – Direct inspection method, Bus Impedance matrix building algorithm (without mutual coupling).

Power Flow Analysis: 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.

Module II **23+7 Hours**

Fault Analysis: Assumptions in short circuit analysis - Symmetrical short circuit analysis, Symmetrical fault analysis through bus impedance matrix - Post fault bus voltages - Fault level.

Unsymmetrical fault Analysis: 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.

Stability Analysis: Classification of power system stability – Rotor angle stability - Power-angle equation – Steady state stability – Methods to improve stability - Swing equation - Swing curve, Equal area criterion - Critical clearing angle and time- Methods to improve transient stability.
Introduction AVR, Load Frequency Control and Reactive power control.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply p.u. system to model the power system components and network matrices to solve power flow analysis under steady state operating condition.	Apply
CO 2: Apply the concept of network matrices and symmetrical component theory to analyze the various faults in power systems.	Analyze
CO 3: Analyze the stability of power system using different methods.	Analyze
CO4: Simulate the power flow analysis using simulator and develop the MATLAB program to analyze the various power system model.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2		3											1	
CO3		3											1	
CO4				2	1				1	1			1	1

High-3; Medium-2; Low-1

Textbooks:

T1. John J. Grainger, William D. Stevenson, Jr, ‘Power System Analysis’, Mc Graw Hill Education (India) Private Limited, New Delhi, 2017.

T2. Kothari D.P. and Nagrath I.J., ‘Power System Engineering’, Tata McGraw-Hill Education, 3rd edition 2019.

T3. Hadi Saadat, ‘Power System Analysis’, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.

Reference Book(s):

R1. Pai M A, ‘Computer Techniques in Power System Analysis’, Tata Mc Graw-Hill Publishing Company Ltd., New Delhi, Second Edition, 2007.

R2. J. Duncan Glover, Mulukutla S.Sarma, Thomas J. Overbye, ‘Power System Analysis & Design’, Cengage Learning, Fifth Edition, 2012.

R3. P. Venkatesh, B. V. Manikandan, A. Srinivasan, S. Charles Raja, “Electrical Power Systems: Analysis, Security and Deregulation” Prentice Hall India (PHI), second edition - 2017 R4. Gupta B.R., ‘Power System - Analysis and Design’, S. Chand Publishing, Reissue edition 2005.

R5. Kundur P., ‘Power System Stability and Control’, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2013

Web References:

1. https://nptel.ac.in/courses/108/105/108105067/
2. https://nptel.ac.in/courses/108/105/108105067/
3. https://uom.lk/sites/default/files/elect/files/EE423_%20Fault_Analysis_Notes.pdf
4. https://www.iitp.ac.in/~siva/2022/ee381/Per_Unit.pdf
5. https://www.iitp.ac.in/~siva/2022/ee381/Network_Matrices.pdf

Course Code: 23EET702	Course Title: Electric Drives and Control		
Course Category: Major		Course Level: Advanced	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on basics of electric drives, different control techniques of DC&AC drives, realize the operation and control of advanced electric drives and applications.

Module I **23 Hours**

Electric drives: Parts of Electrical drives – Classification of electric drives - Dynamics of Electrical drives-fundamental torque equations-concept of steady state Stability-Typical load torque characteristics – Selection of motor power rating - Thermal model of motor for heating and cooling - Classes of duty cycle – Multi quadrant operation

DC Drives: Single and three phase controlled rectifier fed separately excited DC motor drives – Chopper fed DC drives: Class A, B, C, D and E – Closed loop chopper control of separately excited DC Motor-Applications: DC traction using chopper- BLDC Motor Drives.

Module II **22 Hours**

AC Drives - I: Stator side Control: Stator voltage - frequency and v/f control - CSI fed induction motor drives - VSI fed induction motor drives.
AC Drives II: Rotor side Control of Induction motor – vector controlled induction motor drives– Synchronous motor drives: Scalar control of synchronous motor drive: True synchronous mode and self-control mode of operations– VSI and CSI fed Synchronous motor Drives-Load commutated CSI fed Synchronous motor – Closed loop operation of synchronous motor drives-Marginal angle control and power factor control - PMSM Drives- Applications.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Analyse the dynamic and steady state characteristics of electrical drives, their nature and classification	Analyze
CO2: Demonstrate the various modes of operation of power converter fed DC Motor drives.	Apply
CO3: Demonstrate the functions of converters for induction motor drives and other advanced drives	Apply
CO4: Analyze different control techniques for Synchronous and BLDC motor drives	Analyze

CO5: Submit a report by conducting a case study on drive applications in Textile industry, Paper industry, Electric vehicles and Steel rolling mills.	Analyze

Textbooks:

T1.Dubey.G.K, “Fundamental of Electrical Drives”, Narosa publishing House, New Delhi, 2nd Edition, 2020.
T2.BimalK. Bose. "Modern Power Electronics and AC Drives", Pearson Education, 1st Edition,2015.

Reference Book(s):

1. Vedam Subrahmanyam “Thyristor control of Electrical Drives”, Tata McGraw Hill Publishers, 2017.
2. R.Krishnan,“ Electric motor drives: Modelling, analysis and control”, Pearson Education, New Delhi, 2015.
3. P.S.Bhimbra,‘Power Electronics’, Khanna Publications, 5th edition, 2018.
4. P.S.Bhimbra,‘Electric Drives: Concepts and Applications” Tata McGraw Hill Publishers, 2017, 2nd edition.
5. Ned Mohan, “Advanced Electric Drives: Analysis, Control, and Modeling Using MATLAB / Simulink”, Wiley, 2014

Web References:

1. https://nptel.ac.in/courses/108/104/108104140/
2. https://epd.wisc.edu/courses/introduction-to-electric-machines-and-drives/
3. http://www.nptelvideos.in/2012/11/industrial-drives-power-electronics.html
4. https://nptel.ac.in/courses/108102046

Course Code: 23EEL701		Course Title: Power System Laboratory	
Course Category: Major		**Course Level: Advanced**	
L:T:P(Hours/Week) 0:0:3	**Credits: 1.5**	**Total Contact Hours:**	**Max Marks:100**

Course Objectives:
This course offers a thorough understanding of power system analysis and protection techniques. It covers load flow analysis, fault current calculations, and dynamic behavior of power systems. Students gain practical skills by simulating faults and protection mechanisms in generators, transformers, and circuit breakers using hardware simulators, linking theory with real-world applications.

List of Exercises

1. Load flow analysis by Gauss Seidel method.
2. Load flow analysis by Newton Raphson method.
3. Scheduling economic dispatch in power system.
4. Load frequency dynamics of single area and two area system.
5. Simulation of generator protection.
6. Simulation of transformer protection.
7. Simulation of Vacuum circuit breaker.
8. Determination of power angle characteristics of a synchronous machine.
9. Reactive power compensation using capacitor bank.
10. Harmonic analysis for Incandescent lamp, Fluorescent lamp and LED lamp.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Evaluate the performance of power systems under different loading conditions using Gauss-Seidel and Newton-Raphson load flow techniques.	Evaluate
CO2: Create an optimal power scheduling strategy by applying economic dispatch methods to minimize operating cost while meeting load demands.	Create
CO3: Evaluate load frequency control in single-area and two-area systems to maintain system stability and reliability under varying load conditions.	Evaluate
CO4: Simulate protection systems for generators and transformers, and test vacuum circuit breakers to assess their effectiveness in fault conditions.	Evaluate
CO5: Apply practical techniques to analyze the power angle characteristics of synchronous machines, implement reactive power compensation using capacitor banks, and perform harmonic analysis on different lamps.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3			2								1	
CO2				3	2								1	
CO3			3		2								1	
CO4				3	2								1	
CO5				3	2								1	

High-3; Medium-2; Low-1

References:

T1. “Power System Simulation Lab” Manual prepared by Department of Electrical and Electronics Engineering, MCET, Pollachi.

Course Code: 23EEL702		Course Title: Electric Drives and Controls Laboratory	
Course Category: Major		Course Level: Advanced	
L:T:P(Hours/Week) 0:0:3	Credits: 1.5	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to develop a Simulink model for speed control of dc motor, induction motor drives and SRM drives using suitable converters. Also, it aims to control the speed of dc motor and ac motor drives using suitable converters and DSP and FPGA.

List of Exercises

1. Simulation of closed loop control of converter fed DC motor.
2. Simulation of closed loop control of chopper fed DC motor.
3. Simulation of VSI fed three phase induction motor drive.
4. Simulation of three - phase synchronous motor drive.
5. Simulation of closed loop speed control of Switched Reluctance motor
6. Speed control of DC motor using three phase controlled rectifier.
7. Speed control of DC motor using four quadrant chopper.
8. Speed control of 3 Phase induction motor using PWM inverter.
9. Speed control of 3 Phase induction motor using DSP.
10. Speed control of stepper motor using PLC.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Develop simulation model for speed control of dc motor drives using suitable converters	Apply
CO2: Develop simulation model for speed control of induction motor and synchronous motor drives using suitable converters	Apply
CO3: Develop simulation model for speed control of SRM motor drives using suitable converters	Apply
CO4: Demonstrate the speed control of concepts on dc motor and ac motor drives using suitable converters	Apply
CO5: Apply the programming knowledge on FPGA and DSP for speed control of induction motor drives	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				1								1	
CO2	3				1								1	
CO3	3				1								1	
CO4	3				1								1	
CO5	3				1				1	1		1	1	

High-3; Medium-2; Low-1

References:

T1. “Electric Drives and Controls Lab” Manual prepared by Department of Electrical and Electronics Engineering, MCET, Pollachi.

Course Code: 23EEP701		Course Title: Project Phase - I	
Course Category: Project		Course Level: Advanced	
L:T:P(Hours/Week) 0:0:8	Credits: 4	Total Contact Hours: 120	Max Marks:100

Course Objectives: The objective of the course is to enable students to identify and investigate real-world problems in the field of Electrical and Electronics Engineering, and develop innovative solutions. It focuses on designing and implementing a functional software or hardware prototype.

Module **120 Hours**

Understanding research domains and identifying a relevant problem statement - Conducting a thorough literature survey to study existing solutions and identifying research gaps - Defining clear project objectives and scope based on the problem analysis - Performing requirement analysis, including hardware/software needs and feasibility study - Planning project activities with appropriate time management tools - Designing the system architecture through block diagrams or flowcharts and selecting appropriate tools and technologies - Developing a methodology for implementation, including initial modeling or simulation - Executing partial implementation or subsystem development with a focus on performance analysis - Preparing interim reports with proper documentation, citation, and plagiarism compliance - Delivering an oral presentation to a review committee demonstrating the progress and understanding of the project work.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the knowledge of Electrical and Electronics Engineering to identify real-world problems through literature survey and gap analysis.	Apply
CO2: Analyze the functional and technical requirements to perform feasibility studies and prepare an effective project plan and bill of materials.	Analyze
CO3:Design a suitable system architecture or solution approach using appropriate hardware/software tools and simulation methodologies.	Create
CO4: Evaluate the performance and feasibility of the developed prototype through structured documentation and oral presentation to justify the design choices.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3					1	1						1	1
CO2		3									1		1	1
CO3			3		2								1	1
CO4				3				1	1	3		1	1	1

High-3; Medium-2; Low-1

Semester VIII

Course Code: 23EEP801		Course Title: Project Phase - II	
Course Category: Project		Course Level: Advanced	
L:T:P(Hours/Week) 0:0:12	Credits: 6	Total Contact Hours: 180	Max Marks:200

Course Objectives: The course aims to equip students with the ability to identify and analyze engineering problems through literature review and research in the field of Electrical and Electronics Engineering. It emphasizes developing innovative solutions through theoretical and practical work, including design, modeling, simulation, and prototyping. The course also focuses on enhancing project execution, documentation, and presentation skills for effective technical communication.

Module **180 Hours**

Identifying the project goals and finalizing the problem statement based on societal relevance and feasibility – Designing and developing a complete solution using appropriate hardware, software, or a combination of both – Implementing the system through coding, circuit design, simulation, fabrication, or prototyping – Testing and validating the developed solution through experiments, data collection, and analysis – Evaluating system performance using key parameters such as accuracy, speed, efficiency, and reliability – Making improvements based on test results to enhance functionality and robustness – Documenting the entire process with clear methodology, results, discussions, and conclusions – Ensuring ethical practices, sustainability, and safety compliance in the project – Preparing a professional technical report with references, diagrams, and outcome analysis – Presenting the completed work effectively through oral presentation and demonstration before an expert review panel.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1:Apply appropriate engineering concepts, tools, and technologies to implement a functional solution addressing a complex, real-world problem.	Apply
CO2:Analyze the performance and behavior of the implemented system under various testing conditions to identify limitations and areas for improvement.	Analyze
CO3:Evaluate the effectiveness, efficiency, and sustainability of the developed solution by comparing alternative designs and justifying the	Evaluate
CO4:Create a comprehensive technical report and demonstrate the completed project through a structured presentation, showcasing innovation, interdisciplinary integration, and potential future	Create

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				3	1	1						1	1
CO2		3											1	1
CO3				3									1	1
CO4			3					1	1	1			1	1

High-3; Medium-2; Low-1

Vertical 1: Control and Automation Electives

Course Code: 23EEE010	Course Title: Digital Control Engineering		
Course Category: Major		**Course Level: Advanced/Higher**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Course Objectives

The course is intended to study the importance of sample data control system and importance of modeling of discrete systems and stability analysis of discrete data system.

Module I **22 Hours**

Introduction-Discrete time system representation-Mathematical modeling of sampling process-Data reconstruction-Modeling discrete-time systems by pulse transfer function- Z-transform-Mapping of s-plane to z-plane-Pulse transfer function-Pulse transfer function of closed loop system-Sampled signal flow graph-Stability analysis of discrete time systems-Jury stability test-Stability analysis using bi-linear transformation-Time response of discrete systems-Transient and steady state responses-Time response parameters of a prototype second order system-Design of sampled data control systems-Root locus method-Controller design using root locus-Root locus based controller design using MATLAB-Nyquist stability criteria

Module II **23 Hours**

Bode plot-Lead compensator design using Bode plot-Lag compensator design using Bode plot-Lag-lead compensator design in frequency domain-Deadbeat response design-Design of digital control systems with deadbeat response-Practical issues with deadbeat response design-Sampled data control systems with deadbeat response-Discrete state space model-Introduction to state variable model-Various canonical forms-Characteristic equation, state transition matrix-Solution to discrete state equation-Controllability, Observability and stability of discrete state space models

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1.	Analyze signals in both time domain and Z domain.	Analyze
CO2.	Solve the problems on discrete systems.	Apply
CO3.	Analyze and report the inference as an individual or team considering real time problems using discrete data system.	Analyze

CO4.	Distinguish the conventional and state variable approaches, design the discrete-date control systems.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3											1	
CO2	3												1	
CO3				3								1	1	
CO4	3												1	

High-3; Medium-2; Low-1

Text Book(s):

T1. Gopal M, "Digital Control and State Variable Methods", Tata McGraw-Hill Publishing Company Limited, New Delhi, India, Second Edition, 2012.

T2. Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India Private Ltd, 5th edition, 2010

Reference Book(s):

R1. J. Nagrath and M. Gopal, 'Control Systems Engineering', New Age International Publishers, 2010.

R2. Nise S Norman, "Control Systems Engineering", John Wiley & Sons, Inc, Delhi, Third edition, 2010.

Web References:

1. www.goodreads.com/59581
2. nptel.ac.in/courses/108103008/25
3. web.mit.edu/2.14/StateSpace.pdf

Course Code: 23EEE011	Course Title: Industrial Data Communication Networks		
Course Category: Major		**Course Level: Advanced/Higher**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Course Objective

The objective is to enhance process automation, improve operational efficiency, and support smart manufacturing by leveraging advanced protocols, IoT integration, and scalable network architectures.

Module I **23 Hours**

ISO-OSI model – Layers in the OSI model – Peer to Peer Process –TCP/IP Protocol Suite– TCP/IP comparison with OSI model – Types of TCP/IP addressing

Industrial Ethernet: Introduction – IEEE Standards – Ethernet MAC layer – IEEE 802.2 and Ethernet SNAP – OSI and IEEE 802.3 standard. Ethernet transceivers, Ethernet types, switches and switching hubs, 10 Mbps Ethernet, 100 Mbps Ethernet, Gigabit Ethernet..

Communication Protocols: Serial communication Standards: RS232, 422 and 485 – Protocol Structure Overview – Example Function codes. ASCII based protocol - Modbus protocol – Overview. HART Protocol – Overview – Layers

Module II **22 HOURS**

Field bus Technology: AS-i Bus - Protocol Stack - CAN bus – Overview – Layers - Profibus – Overview – Protocol Stack. FIP and World FIP - Foundation Field Bus – Layers – Error Detection and Diagnostics – Redundancy.

Wireless Communication: Wireless LANs – IEEE 802.11 standard – Blue Tooth Communication - Wireless WANs – Cellular Telephony

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO1.	Identify, prevent and troubleshoot industrial data communication problems	Analyze
CO2.	Apply the fieldbus configuration in networking	Apply
CO3.	Analyze the wired and wireless communications used in Process	Analyze
CO4.	Analyze industrial data communication protocol and standards and present a seminar as an individual or team	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3											1	
CO2	3												1	
CO3				3								1	1	
CO4	3												1	

High-3; Medium-2; Low-1

Text Book(s):

T1. Behrouz A Forouzan, 'Data Communications and Networking', Tata McGraw-Hill, 2013.

T2. William Buchanan, 'Computer Buses- Design and Application', CRC Press, 2000.

Reference Book(s):

R1. Theodore S Rappaport, 'Wireless Communications: Principles and Practice', Prentice Hall PTR, Second Edition, 2010.

R2. Stallings,W., "wireless Communication and networks", second Edition, Prentice Hall of India, 2005.

R3. Steve Mackay, Edwin Wright and Deon Reynders, 'Practical Industrial data Networks: Design, Installation and Trouble Shooting', Elsevier International Projects Ltd., 2004.

R4. Nader. F. Mir, "Computer and Communication Networks", Pearson Prentice Hall Publishers, 2010.

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1. http://nptel.ac.in/courses/106105082/
2. http://nptel.ac.in/downloads/106105080/
3. http://sine.ni.com/nips/cds/view/p/lang/en/nid/208382

Course Code: 23EEE012	Course Title: Robotics and Automation		
Course Category: Major		**Course Level: Advanced/Higher**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Course Objective

To design and implement the robotics and automation systems that enhance efficiency, precision, and safety across industries. By integrating cutting-edge technologies and robot programming, these systems aim to streamline operations, reduce human error, and foster innovation for sustainable and scalable solutions in diverse applications as per the industry requirements.

Module I **23 Hours**

Automation and Robotics – Asimov's laws of Robotics – Robot Anatomy – Basic components of Robot System – classification of Robots by configuration – Robot Motion – Precision of movements – End effectors. Actuators – Hydraulic, Pneumatic and Electric drives – Mechanical power transmission system: Bearings, Gears, Belt and Chains – Sensors: Position, Velocity, tactile sensors, Proximity and range sensor – Machine vision: Sensing and digitizing, Image processing and application

Kinematics and Dynamics: Solution for direct and inverse kinematic problem – Robot dynamics – Jacobian work envelop – Robot trajectories – Manipulator path control – Robot cycle time analysis.

Module II **22 HOURS**

Robot Programming: Methods of Robot programming – lead through programming methods – Robot program as a path in space – Motion interpolation – Wait, signal and delay commands – Branching – Capabilities and limitations – Robot programming examples for pick and place application using VAL.

Case Studies: Robots in manufacturing and non-manufacturing application – Robot Cell layout – Selection of Robot – Applications – Material handling, Processing operation, assembly and inspection.

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO1.	Analyze the various parts of robotics and its automation	Analyze

CO2.	Derive kinematics and dynamic equation for functioning the robot	Apply
CO3.	Program a Robot using lead through methods.	Apply
CO4.	Analyze the operations of Robot used in industrial automation and report the standards and codes followed as an individual or team.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3											1	
CO2	3												1	
CO3			3										1	
CO4				3				5				1	1	

High-3; Medium-2; Low-1

Text Book(s):

Mikell P.Groover, Nichols G.Ordy, “Industrial Robotics, Technology, Programming and Applications” McGraw hill, 2005

Fu K.S, Gonzalez and Lee C.S.G, “Robotics Control, Sensing, vision and Intelligence”, McGraw hill, 2000.

Reference Book(s):

Deb.S.R, “Robotics Technology and Flexible Machine Design”, Tata McGraw Hill, 2012

Web References:

https://onlinecourses.nptel.ac.in/noc21_me76

https://www.udemy.com/topic/robotic-process-automation/

https://www.coursera.org/specializations/modernrobotics

Course Code: 23EEE013	Course Title: Smart Sensor Technology		
Course Category: Major		Course Level: Advanced/Higher	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

To advance smart sensor technology by developing innovative, efficient, and reliable sensing solutions that enable real-time data collection, analysis, and decision-making. By integrating the latest technologies, the goal is to enhance system performance, improve resource management, and support intelligent applications across industries for a connected and smarter future.

Module I **23 Hours**

Mechanical to Electronic transition in Sensing – Nature of Sensor – Integration of Micromachining and Microelectronics - Evolution of Smart Sensors - Components of Smart Sensors – General Architecture of Smart Sensors

Data Acquisition: Amplification and Signal Conditioning: Instrumentation amplifier – Sleep mode Circuitry - Rail to Rail operational amplifier - 4-20ma Signal transmitter – Digital conversion: sampling, Quantizing and encoding – MCU control and sensor interface

Smart Sensor Communication: Overview of Communication Organization and standards – Automotive protocols: CAN – LIN – Media Oriented Systems Transport – Flex ray - Industrial usage of CAN – MCU with integrated CAN – LonTalk Protocol – MI bus – Other aspects of Network communications

Module II **22 HOURS**

Wireless Sensing: Introduction of RF and Spread spectrum – Wireless data and communication – Zigbee – ANT+ - 6LoWPAN – NFC – Zwave – Dust networks – RF Sensing: Surface acoustic waves - RADAR – LIDAR – GPS – Remote emission sensing – Intelligent transportation system - RFID - Telemetry

Smart Sensor devices: Sensors in Mobile phones: Accelerometer, Gyroscope, Touch sensor, Proximity Sensor, Ambient light sensor, Hall sensor and Finger print sensor – Sensors in Automotive vehicles: Air flow sensor, Engine speed sensor, Manifold Absolute Pressure Sensor, Spark Knock Sensor, Fuel Temperature Sensor and Voltage Sensor - Sensors in Wearables: Electro-chemical Bio Sensor, Wearable electrodes, Strain, temperature and pressure sensors

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO1.	Describe the data acquisition from sensor to other devices	Analyze
CO2.	Summarize the various communication protocol used for data processing	Apply
CO3.	Analyze the wireless technology used in sensor system for real world applications	Analyze
CO4.	Apply the suitable sensors for various smart devices and report the inference on its usage	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3											1	
CO2	3												1	
CO3				3									1	
CO4	3											1	1	

High-3; Medium-2; Low-1

Text Book(s):

T1. Randy Frank "Understanding Smart Sensors" 3rd Edition, CRC Press, 2014

T2. Krzysztof Iniewski "Smart Sensors for Industrial applications" CRC Press, 2013

Reference Book(s):

R1. Kevin Yallup, Krzysztof Iniewski "Technologies for Smart Sensors and Smart fusion" CRC Press, 2014

R2. Gerard Meijer, Kofi Makinwa, MichielPertijs "Smart Sensor Systems: Emerging Technologies and applications" John wiley and Sons Ltd, 2014

R3. S.C.Mukhopadhyay, G.S.Gupta "Smart Sensors and Sensing Technology" Springer, 2008

Web References:

1. https://new.abb.com/motors-generators/service/advanced-services/smart-sensor
2. https://www.intersil.com/en/applications/industrial/smart-sensor.html
3. http://www.smartsensors.com/

Course Code: 23EEE014	Course Title: Industrial Automation		
Course Category: Major		Course Level: Advanced/Higher	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to cutting-edge technologies such as Programmable Logic Controllers (PLC), Supervisory Control and Data Acquisition (SCADA), and Distributed Control Systems (DCS), students will learn to develop innovative automation solutions. The course emphasizes hands-on experience in designing control logic programs, configuring industrial networks, and exploring real-world applications.

Module I **23 Hours**

Introduction to Factory Automation: History and developments in industrial automation-Vertical integration of industrial automation- Building blocks in Automation: Processing systems, Multi microprocessor systems, LAN, analog and digital I/O modules, remote terminal unit

Programmable Logic Controllers :PLC an Overview- Parts and Architecture of PLC-Principles of Operation - I /O Specifications - Memory types-Programming devices- PLC vs Computers, PLC size and Applications, Advantages of PLC, selection of PLC

Programming of PLC :Program scan - PLC Programming Languages-Simple process control programs using Relay Ladder Logic - Programming Timers : On delay timer, OFF delay timer- Programming counters: Up and Down counter – PLC arithmetic functions – Program Control Instructions-Math Instructions-data transfer operations-Data comparison instructions

Module II **22 HOURS**

Industry Networking and SCADA :PLC Networking- Networking standards & IEEE Standard - Protocols - Field bus - Process bus and Ethernet .SCADA-Channel scanning-conversion to engineering units- data processing –Distributed SCADA systems- HMI introduction

Distributed Control System and Applications : DCS: Evolution – Different architectures – local control unit – Operator interface – Displays – Engineering interface. Applications: Thermal power plant-cement plant-water treatment plant- Solar, windmill substation automation.

Course Outcomes

At the end of this course, students will be able to:		Cognitive Level
CO1.	Apply the principles of automation to identify its necessity in industrial processes.	Apply
CO2.	Analyze the architecture and types of PLCs used in industrial automation to select suitable options.	Analyze
CO3.	Develop PLC-based control logic programs to meet specific industrial requirements.	Apply
CO4.	Analyze industrial networking protocols and SCADA systems to implement effective automation.	Analyze
CO5.	Apply the concepts of DCS to evaluate its applications in power plants and other industrial setups.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3											1	
CO2	3												1	
CO3				3								1	1	
CO4	3												1	
CO5	3												1	

High-3; Medium-2; Low-1

Text Book(s):

T1. Frank D Petruzella "Programmable Logic Controllers", McGraw Hill Education India Private Limited, 6th Edition, 2023.

T2. Bolton.W, "Mechatronics", Pearson Education, Delhi, 7th Edition,2018.

Reference Book(s):

R1. John W Webb & Ronald A Reis, "Programmable logic controllers: Principles and Applications", Prentice Hall India, 5th edition, 2011

R2. Dobrivojie Popovic, Vijay P. Bhatkar," Distributed Computer Control for Industrial Automation", Marcel Dekkar Inc., New York, 1st edition, 2011.

R3. Krishna Kant, „Computer based Industrial Control", Prentice Hall of India, 2nd edition, 2010 .

R4. Rajesh Mehra and Vikrant Vij, "PLCs& SCADA- Theory and Practice",Laxmi Publications, 1st edition, 2019.

Web References:

1. http://www.fieldbus.org
2. www.nptel.ac.in/downloads/108105063/
3. http://nptel.ac.in/courses/108105062/18

<table>
<tr><td colspan="2">Course Code: 23EEE015</td><td colspan="3">Course Title: Industrial Internet of Things</td></tr>
<tr><td colspan="3">Course Category: Major</td><td colspan="2">Course Level: Advanced/Higher</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours:45</td><td>Max
Marks:100</td></tr>
</table>

Course Objectives

To harness the potential of the Industrial Internet of Things (IIoT) by enabling seamless connectivity, real-time data exchange, and intelligent automation across industrial systems. The objective is to optimize operations, enhance productivity, and drive innovation while ensuring scalability, security, and sustainability in modern industrial environments.

Module I **23 Hours**

The Various Industrial Revolutions - Digitalization and the Networked Economy -Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0- Comparison of Industry 4.0 Factory and Today's Factory.

IoT building blocks: IoT Architecture, WoT and M2M - Physical & Logical IoT design Basics - IoT Enabling Technologies - IoT Levels and templates.

Understanding Internet Protocols: Simplified OSI Model, Network Topologies, Standards, Types of Internet Networking - Ethernet, WiFi, Local Networking, Bluetooth, Bluetooth Low Energy (BLE), Zigbee, 6LoWPAN, Sub 1 GHz, RFID, NFC, Proprietary Protocols, Simplicity, Networking Design - Push, Pull and Polling, Network APIs.

Module II **22 HOURS**

IoT Security: Industrial IoT: Security and Fog Computing - Cloud Computing in IIoT, Fog Computing in IIoT,

Case Studies: Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies: Milk Processing and Packaging Industries,Manufacturing Industries.

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO1.	Analyze various industrial revolutions and role of industry4.0	Analyze
CO2.	Apply the communication protocols suitable for IoT	Apply
CO3.	Analyze the opportunities, challenges brought about by Industry 4.0 and how organizations and individuals should prepare to reap the benefits	Analyze
CO4.	Appreciate the smartness in Smart Factories, Smart cities, smart products and other smart services	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3											1	
CO2	3												1	
CO3				3								1	1	
CO4	3												1	

High-3; Medium-2; Low-1

Text Book(s):

T1. Joe Biron, Jonathan Follett, Foundational Elements of an IoT Solution - The Edge, Cloud and Application, Oreilly, 2022

T2. Elizabeth Goodman, Alfred Lui, Martin Charlier, Ann Light, Claire Rowland, Designing Connected Products, 1st Edition,

Reference Book(s):

R1. Lucas Darnell, The Internet of Things (A Look at Real World Use Cases and Concerns), Kindle Edition,2016

R2. Vijay Madisetti and Arshdeep Bahga, “Internet of Things: A Hands-On Approach”, Orient Blackswan Private Limited, New Delhi, 1st Edition 2015

R3. Hands-On Industrial Internet of Things: Create a powerful Industrial IoT by Giacomo Veneri, Published by Packt Publishing, 2018

Web References:

1. www.goodreads.com/59581
2. nptel.ac.in/courses/108103008/25
3. web.mit.edu/2.14/StateSpace.pdf

Vertical 2: Converters and Drives

Electives

Course Code: 23EEE020		Course Title: Power Electronic Applications to Renewable Energy	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course equip students with a comprehensive understanding of both stand-alone and grid-connected systems, focusing on renewable energy sources. It aims to teach the design of various power converters for solar-based systems, along with the classification of different types of Wind Energy Conversion Systems (WECS).

Module I **22 Hours**

Environmental aspects of electric energy conversion, Recent trends in energy consumption - Energy sources and their availability, Global scenario: solar PV, Wind – Solar PV -Basics, Types: Standalone and Grid connected SPPs - Wind: Aerodynamic factors & types of Wind power system.

Introduction to PV-Cells, I-V Characteristics, Block diagram of PV System, components, MPPT tracking components &Controlling algorithms, Factors affecting PV output, Power converters for Solar: DC Power conditioning converters – AC power conditioners line commutated converters (inversion mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing - synchronized operation with grid supply Solar- Economic aspect – Efficiency and performance

Module II **23 Hours**

Fixed speed systems: 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 Variable speed systems: Need of variable speed systems-Power-wind speed characteristics Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modeling - Variable speed variable frequency schemes.

AC voltage controllers, Interleaved boost converters, Two level Voltage source converters, Three level Neutral point clamped converters, multi-input converters, PWM current source Converters, Control of grid connected inverter: Generator-Side Control Grid side Control, Future trends in wind conversion system converters. Wind / Solar PV integrated systems – Need for Hybrid Systems- Types &range of Hybrid system- selection of power conversion ratio – Optimization of system components in hybrid power system.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply modeling techniques to design and analyze different types of PV and Wind energy systems.	Apply
CO 2: Implement and select appropriate components and converters for Photovoltaic (PV) systems.	Apply
CO 3: Apply knowledge of generators and converters to design and optimize Wind Energy Conversion (WEC) systems.	Apply
CO 4: Apply the principles of hybrid systems to compare and integrate their components in real-world energy solutions and report the case study as individual or team.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			3										1	
CO2	3												1	
CO3			3										1	
CO4	4					1				1		1	1	

High-3; Medium-2; Low-1

Textbooks:

T1. Mukund R. Patel —Wind and Solar Power Systems: Design, Analysis, and Operation, third Edition, CRC Press 2021

T2. Neeraj Priyadarshi, P. Sanjeevikumar, Farooque Azam, C. Bharatiraja, Rajesh Singh — Advanced Power Electronics Converters for Future Renewable Energy Systems ", First Edition, Wiley, 2024.

Reference Book(s):

R1. Rashid .M. H —Alternate Energy in power electronics First Edition ,Academic press,2015

R2. Thomas Corke &Robert Nelson—Wind Energy Design ‖, First Edition , CRC Press, 2018.

R3. Haitham Abu-Rub, Mariusz Malinowski, Kamal Al-Haddad, — Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications — First Edition, Wiley, 2014.

Web References:

1. https://onlinecourses.nptel.power converters.ac.in/noc19_ee37/preview
2. https://nptel.hybrid.ac.in/noc20_ee28/preview
3. https://nptel.ac.in/courses/108/107/108107143

Course Code: 23EEE021		Course Title: Control of Power Electronics Circuits	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits:	Total Contact Hours:	Max Marks:100

Course Objectives:

The objective of this course is to provide a comprehensive understanding of linear and nonlinear control theories, feedback controller design, and advanced techniques such as sliding mode control and differential flatness, applied to power converters.

Module I **22 Hours**

Introduction, Review of Linear Control Theory, Linearization of Various Transfer Function Blocks, Feedback Controller Design in Voltage-Mode Control, Peak-Current Mode Control, Feedback Controller Design in DCM.

Introduction, Linear Feedback Control- Pole Placement by Full State Feedback, Pole Placement Based on Observer Design, Reduced Order Observers, Generalized Proportional Integral Controllers Hamiltonian Systems Viewpoint - Application to power converters.

Introduction, Operating Principle of Single-Phase PFCs, Control of PFCs, Designing the Inner Average-Current-Control Loop.

Module II **23 Hours**

Designing the Outer Voltage-Control Loop, Example of Single-Phase PFC Systems

Introduction, Variable Structure Systems, Control of Single Switch Regulated Systems, Sliding Surfaces, Equivalent Control and the Ideal Sliding Dynamics, Accessibility of the Sliding Surface, Invariance Conditions for Matched Perturbations- Application to power converters.

Flatness, the use of the differential flatness property, Controller development using flatness Application to power converters

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply linear control theory, including pole placement and observer design, as well as nonlinear control techniques with a focus on power converter applications.	Apply
CO2: Design feedback controllers for voltage-mode control, peak-current mode control, and discontinuous conduction mode (DCM), demonstrating the ability to stabilize and optimize power converter	Apply

CO3: Analyze and design single-phase PFC systems by developing inner average-current control loops and outer voltage-control loops, ensuring efficient and stable operation of power converters.	Analyze
CO4: Implement advanced control methods, including sliding surface design, equivalent control, and invariance conditions for perturbations, for robust regulation of single-switch systems and other power electronics applications and report the presentation as a team or individual.	Apply
CO5: Apply the differential flatness property to develop controllers for power converters, enabling innovative solutions to complex system dynamics and achieving enhanced system performance.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2			3										1	
CO3		3											1	
CO4	3					1	1			1			1	1
C05	3												1	

High-3; Medium-2; Low-1

Textbooks:

T1. Gerry Moschopoulos,” DC-DC Converter Topologies: Basic to Advanced”, Wiley-IEEE Press, 2023

T2. Marian K. Kazimierczuk and Agasthya Ayachit,”Laboratory Manual for Pulse-Width Modulated DC– DC Power Converters”, Wiley

T3. 2016Hebertt Sira-Ramírez and Ramón Silva-Ortigoza,”Control Design Techniques in Power Electronics Devices “ Springer-Verlag London Limited 2006

Reference Book(s):

R1. Farzin Asadi and Kei Eguchi, Morgan & Claypool,” Dynamics and Control of DC-DC Converters”, 2018

R2. Andre Kislovski, “Dynamic Analysis of Switching-Mode DC/DC Converters”, Springer 1991

R3. Azar, Ahmad Taher, Zhu, Quannmin,” Advances and Applications in sliding mode control systems” Springer, 2015

R4. Neeraj Priyadarshi, Akash Kumar Bhoi, Ramesh C. Bansal, Akhtar Kalam, “DC—DC Converters for Future Renewable Energy Systems” Springer, 2022

Web References:

1. https://onlinecourses.nptel.ac.in/noc21_ee104/preview
2. https://onlinecourses.nptel.ac.in/noc19_ee37/preview
3. https://archive.nptel.ac.in/courses/117/103/117103148/

Course Code: 23EEE022		**Course Title: Switched Mode Power Converters**	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course is intended to provide students with a comprehensive understanding of the principles, design, and control of DC/DC converters, resonant converters, and power converter systems, enabling them to analyze, model, and design efficient power electronic circuits and systems.

Module I **22 Hours**

DC/DC Converters : Basic topologies of buck, boost converters, buck-boost converters, and cuk converter, isolated DC/DC converter topologies—forward, and fly-back converters, half and full bridge topologies, modeling of switching converters.

Current mode and Current Fed Topologies: Voltage mode and current mode control of converters, peak and average current mode control, its advantages and limitations, voltage and current fed converters.

Resonant Converters: Need for resonant converters, types of resonant converters, methods of control, phase modulation technique with ZVS in full-bridge topology, series resonant converter and resonant transition converter.

Module II **23 Hours**

Converter Transfer Functions and Controller Design: Application of state-space averaging to switching converters, derivation of converter transfer functions for buck, boost, and fly-back topologies. Controller Design -Introduction, mechanisms of loop stabilization, shaping E/A gain vs. frequency characteristic, Conditional stability in feedback loops, stabilizing a continuous mode forward converter and discontinuous mode fly-back converter, feed-back loop stabilization with current mode control, the right-half plane zero.

Power Converter Design : Design of filter inductor & capacitor, and power transformer, Ratings for switching devices, current transformer for current sensing, design of drive circuits for switching devices, considerations for PCB layout.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply knowledge of isolated and non-isolated DC-DC converters to analyze their operation in continuous conduction mode and discontinuous conduction mode.	Apply
CO2: Apply current control and voltage control methods to regulate the output power of DC-DC converters.	Apply
CO3: Apply the concept of resonant converters to design and implement a full-bridge topology.	Apply
CO4: Apply techniques to evaluate and ensure controller stability for the given DC-DC converter.	Apply
CO5: Apply design principles to develop a power circuit based on given Standards and Specifications and report the presentation as a team or	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2	3												1	
CO3			3										1	
CO4	3												1	
CO5			3					1		1			1	

Text Book(s):

T1. Gerry Moschopoulos,” DC-DC Converter Topologies: Basic to Advanced”, Wiley-IEEE Press, 2023.

T2. Joe Marrero, Raymond Zhang, Switching Power Supply Design, Harvard Book Store, First Edition, 2020.

T3. Philip T Krein, Elements of Power Electronics‖, Second Edition, Oxford Press, 2014.

Reference Book(s):

R1. Neeraj Priyadarshi, P. Sanjeevikumar, Farooque Azam, C. Bharatiraja, Rajesh Singh ― Advanced Power Electronics Converters for Future Renewable Energy Systems ", First Edition , Wiley, 2024.

R2. Andrzej M. Trzynadlowski, Introduction to Modern Power Electronics, Secon Edition, John Wiley & Sons, 2015.

R3. Christophe Basso, Switch-Mode Power Supplies SPICE Simulations and Practical Designs Second Edition, McGraw Hill, 2014.

Web References:

1. https://onlinecourses.nptel.ac.in/noc21_ee104/preview
2. https://onlinecourses.nptel.ac.in/noc19_ee37/preview
3. https://archive.nptel.ac.in/courses/117/103/117103148/

Course Code: 23EEE023		Course Title: Advanced Electric Drives	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to equip students with the knowledge and skills necessary to model, analyze, and control various types of electric machines, including brushed DC machines, synchronous machines, induction machines, and switched reluctance drive systems, enabling them to design and optimize advanced motor drive applications.

Module I **22 Hours**

Modeling and Control of DC Machines: Modeling of Brushed DC Machines **-** Control of Brushed DC Machines - Operational Drive Boundaries - Use of a Current Source and Voltage Source DC Model with Model Based Current Control - Modeling of a Current and Voltage Source Connected Brushed DC Motor - Current Source Connected Brushed DC Motor with Field Weakening Controller.

Synchronous Machine Modeling Concepts: Symbolic Model of a Non-salient and Machine - Generic Model of Non-salient and salient Synchronous Machines - Rotor-Oriented Model of the Non-salient Synchronous Machine - Dynamic Model of a Non-salient Synchronous Machine - Steady-State Analysis of a Non-salient Synchronous Machine.

Module II **23 Hours**

Induction Machine Modeling Concepts: Induction Machine with Squirrel-Cage Rotor - Zero Leakage Inductance Models of Induction Machines - Machine Models with Leakage Inductances - Parameter Identification and Estimates - Simplified Induction Machine Model - Universal Induction Machine Model.

Switched Reluctance Drive Systems: Basic Machine Concepts - Single-Phase Motor Concept - Torque Production and Energy Conversion Principles - Switched Reluctance Modeling Concepts - Representation of the Magnetization Characteristics - Converter and Control Concepts - Low and High Speed Drive Operation - Analysis of a Linear SR Machine, with Current Excitation - Nonlinear SR Machine, with Voltage Excitation and Hysteresis Current Controller.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Model and control brushed DC machines with current and voltage source models.	Analyze
CO2: Analyze models of non-salient and salient synchronous machines.	Analyze
CO3: Create and evaluate models of induction machines, including parameter identification and report the presentation as a team or individual.	Evaluate
CO4: Design and control switched reluctance drive systems for various speed operations.	Apply
CO5: Implement advanced control techniques for efficient motor performance.	Apply

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3											1	
CO2		3											1	
CO3				3						1		1	1	
CO4			3										1	
CO5	3												1	

Text Book(s):

T1. Rik W. De Doncker , Duco W.J. Pulle and André Veltman, "Advanced Electrical Drives Analysis, Modeling, Control", Second Edition, Springer, 2020.

T2. Ned Mohan, "Power Electronics and Motor Drives", Second Edition, Elsevier, 2020.

Reference Book(s):

R1. Vinod Kumar, Ranjan Kumar Behera, Dheeraj Joshi, Ramesh Bansal, "Power Electronics, Drives, and Advanced Applications",1st edition CRC Press,2020 .

R2. R. Krishnan, "Electric Motor Drives: Modeling, Analysis and Control", Prentice Hall.

R3. Seung-Ki Sul, "Control of Electric Machine Drive Systems", Wiley Publishers, 2011.

R4. Ned Mohan, "Advanced Electric Drives Analysis, Control, and Modeling", Wiley Publishers, 2014.

Web References:

1. https://nptel.ac.in/courses/108104011
2. https://archive.nptel.ac.in/courses/108/104/108104140/
3. https://archive.nptel.ac.in/courses/108/102/108102046/

Course Code: 23EEE024		Course Title: Multilevel Power Converters	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:
The study of multilevel inverter (MLI) topologies begins with understanding the common DC bus link configuration, which serves as a fundamental component in various MLI designs. Key topologies include the cascaded H-Bridge multilevel inverter, known for its modular structure and ease of scalability, and the diode-clamped multilevel inverter, which employs diodes to achieve voltage levels and ensure proper mode transitions.

Module I Multilevel Topologies 22 Hours

Introduction – Generalized Topology with a Common DC bus – Converters derived from the generalized topology – symmetric topology without a common DC link – Asymmetric topology.
Introduction -H-Bridge Inverter, Bipolar Pulse Width Modulation, Unipolar Pulse Width Modulation (PWM).
Multilevel Inverter Topologies, CHB Inverter with Equal DC Voltage, H-Bridges with Unequal DC Voltages – PWM, Carrier-Based PWM Schemes, Phase-Shifted Multicarrier Modulation, Level Shifted Multicarrier Modulation, Comparison Between Phase- and Level-Shifted PWM Schemes - Staircase Modulation

Module II Multilevel Converter Types 23 Hours

Introduction – Converter structure and Functional Description – Modulation of Multilevel converters –Voltage balance Control – Effectiveness Boundary of voltage balancing in DCMC converters- Resonant converter, EMI and EMC standards

Introduction – Flying Capacitor topology – Modulation scheme for the FCMC – Dynamic voltage balance of FCMC - Comparison between diode clamped and flying capacitor based MLI Multilevel inverter with reduced switch count-structures, working principles and pulse generation methods.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Demonstrate the application of different topologies of multilevel inverters (MLIs) with and without understanding the operational principles and report the presentation as a team or individual.	Apply

CO2: Analyze the working principles of Cascaded H-Bridge MLI using Bipolar	Analyze
CO3: Analyze the working principles of diode clamped MLI	Analyze
CO4: Apply the voltage balancing performance of flying capacitor based MLI for real world application	Apply
CO5: Demonstrate the working principles of reduced switch MLI	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3					1	1			1		1	1	1
CO2		3											1	
CO3		3											1	
CO4			3										1	
CO5	3												1	

High-3; Medium-2; Low-1

Textbooks:

T1. Muhammad H. Rashid ,Power Electronics: Devices, Circuits, and Applications, Pearson Education, Fourth Edition, 2017.

T2. Sergio Alberto Gonzalez, Santiago Andres Verne, Maria Ines Valla," Multilevel Converters for Industrial Applications", CRC Press, 22-Jul-2013, 2017.

Reference Book(s):

R1. Ersan Kabalcı, Multilevel Inverters Introduction and Emergent Topologies, First Edition Academic Press Inc, 2021,.

R2. Hani Vahedi, Mohamed Trabelsi, Single-DC-Source Multilevel Inverters, Springer, First Edition, 2019.

R3. Fang Lin Luo, Hong Ye, Advanced DC/AC Inverters: Applications in Renewable Energy, CRC Press, 2017.

Web References:

1. https://archive.nptel.ac.in/courses/108/102/108102157/
2. https://archive.nptel.ac.in/courses/108/107/108107128/
3. https://archive.nptel.ac.in/courses/117/103/117103148/

Course Code: 23EEE025		Course Title: Power Management Integrated Circuits	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is designed to provide a comprehensive understanding of Power Management Integrated Circuits (PMICs) and DC-DC converters, highlighting the differences between linear and switching regulators.

Module I **22 Hours**

Introduction to Power Management - Need, Applications, Types of PMIC - Overview of DC-DC Converters, Linear vs. Switching Regulators - Efficiency, Accuracy, Line and Load Regulation, PSRR - Choosing the Type of Regulator

Bandgap Voltage Reference - Basics of PTAT and CTAT References - Brokaw Bandgap Circuit

Feedback Systems and Stability - Bode Plots - Loop Gain AC Analysis - Stability Criterion, Phase Margin - Stabilizing Linear Regulators - Frequency Compensation Techniques - Dominant Pole and Miller Compensation - Linear Regulator Design - LDO Design - Sources of Error - Offset Correction

Module II **23 Hours**

Basic Concepts and Efficiency - Inductor Volt-Second Balance - Buck Converter - Duty Cycle Calculation - Efficiency Considerations: Conduction Losses, Gate-Driver Switching Loss - Control Techniques - PWM Control: Voltage-Mode and Current-Mode - Compensators: Type-I, Type-II, Type-III

Design Parameters - Inductor and Capacitor Selection - Continuous vs. Discontinuous Conduction Modes - Advanced Control and Design Examples - Design Examples with Simulation - Gate-Driver Design and Current Mode Control - Designing Gate-Drivers - Non-Linear Control Techniques - Hysteretic Control: Voltage-Mode vs. Current-Mode

Buck-Boost and Switched-Capacitor Converters - Switched-Capacitor DC-DC Converter - Digitally-Controlled Techniques and Multi-Phase Converters - Digitally-Controlled DC-DC Converters - Multi-Phase DC-DC Converters - Specialized Applications - DC-DC Converters for LED Lighting - Lithium-Ion Battery Charging

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Apply knowledge of PMICs to analyze their need, classify their types, and demonstrate their applications, including practical implementation of DC-DC converters	Apply
CO2: Analyze feedback systems and stability using Bode plots, loop gain AC analysis, stability criteria, and frequency compensation.	Analyze
CO3: Apply control techniques like PWM control (voltage-mode and current mode) and evaluate efficiency considerations including conduction losses and gate-driver switching loss.	Apply
CO4: Apply the principles of advanced converters such as buck, boost, buck boost, and switched-capacitor converters to design and optimize solutions for LED lighting systems and lithium-ion battery charging applications.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2		3											1	
CO3	3												1	
CO4			3			1	1					1	1	

Textbooks:

T1. Power Management Techniques for Integrated Circuit Design, Ke-Horng Chen, Wiley-IEEE Press, 2016.

Reference Book(s):

R1. Power Management Integrated Circuits, Mona M. Hella, Patrick Mercier, CRC Press, 2017

R2. Switch-Mode Power Supplies: SPICE Simulations and Practical Designs by Christophe P. Basso, McGraw-Hill Professional, Second Edition, 2014.

Web References:

1. https://onlinecourses.nptel.ac.in/noc21_ee25/preview
2. https://onlinecourses.nptel.ac.in/noc21_ee01/preview
3. https://archive.nptel.ac.in/courses/108/108/108108111/

Course Code: 23EEE026		Course Title: Design of Power Electronic Converters	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to equip students with the fundamental knowledge on power electronic converters, covering fundamental principles, design considerations, and practical applications.

Module I **22 Hours**

Analysis of Power Electronic Converters: Introduction to Power Electronics: Applications, benefits, limitations - Power semiconductor devices (overview): Diodes, Thyristors, MOSFETs, IGBTs - DC-DC converters: Buck, Boost, Buck-Boost, Cuk, SEPIC converters - Operating principles and steady-state analysis of DC-DC converters - Continuous conduction mode (CCM) vs. Discontinuous conduction mode (DCM) - Average voltage and power calculations.

Power Converters Control and Applications: Introduction to control techniques for power converters: Pulse Width Modulation - Feedback control systems for DC-DC converters: Voltage mode control, Current mode control - Stability analysis of converter control systems - Applications of DC-DC converters in various power electronic systems.

Module II **23 Hours**

Converter Component Design: Gate driver design: Functions, types, and selection criteria - Snubber design: Principles, configurations, and selection for different switches - Thermal design: Power dissipation analysis, heat sink selection - Magnetics design: Transformers and inductors for power electronics converters - Design considerations for efficiency, power density, and cost.

EMI and Hardware Implementation: Electromagnetic interference (EMI) in power electronics converters: Sources, mitigation techniques - Introduction to power electronic hardware design tools - Practical considerations for PCB layout, component selection, and assembly - Familiarization with power electronic hardware labs and equipment - Hands-on design project: Design, simulate, and build a simple power converter circuit.

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO1: Apply the principles of DC-DC converter operation to evaluate and compare their performance in steady-state conditions.	Apply
CO2: Apply design methodologies to create gate driver circuits for power electronic converters, considering functionality, selection criteria, and performance impact.	Apply
CO3: Apply snubber circuit design techniques to mitigate voltage transients and enhance the reliability of power semiconductor devices.	Apply
CO4: Apply thermal design principles, including power dissipation analysis and heat sink selection, to ensure efficient operation of power electronic converters.	Apply
CO5: Apply appropriate software tools to design, simulate, and evaluate a simple power converter circuit, considering design factors like efficiency, power density, and cost.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2			3										1	
CO3			3										1	
CO4			3										1	
CO5			3		1						1		1	

Text Book(s):

T1. Gerry Moschopoulos," DC-DC Converter Topologies: Basic to Advanced", Wiley-IEEE Press, 2023

T2. Joe Marrero, Raymond Zhang, Switching Power Supply Design, Harvard Book Store, First Edition, 2020.

T3. Philip T Krein, Elements of Power Electronics, Second Edition, Oxford Press, 2014.

Reference Book(s):

R1. P.C. Sen, Modern Power Electronics, Second Edition, S. Chand-2005.

R2. Andrzej M. Trzynadlowski, Introduction to Modern Power Electronics, Second Edition, illustrated Publisher John Wiley & Sons, 2015.

R3. Christophe Basso, Switch-Mode Power Supplies SPICE Simulations and Practical Designs 2 nd Edition, McGraw Hill, 2014.

Web References:

1. https://onlinecourses.nptel.ac.in/noc21_ee104/preview
2. https://onlinecourses.nptel.ac.in/noc19_ee37/preview
3. https://archive.nptel.ac.in/courses/117/103/117103148/

Course Code: 23EEE027		Course Title: Design of Motor and Power Converters for Electric Vehicles	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

To review the drive cycles and requirements of EVs with respect to Mechanical Characteristics and to understand the working operation of electric drive motor implemented in electric vehicle along with its choice of selection of drive motor.

Module I **22 Hours**

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

Module II **23 Hours**

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Analyze the need and mechanical performance of electric vehicle for real time applications and report the presentation	Analyze
CO2: Use appropriate electric machine for electric vehicle application	Apply
CO3: Design buck, boost and buck-boost converter for EV application with help of transfer function.	Apply
CO4: Compute a power stage transfer functions for DC-DC converters	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3					1	1		1			1	
CO2	3												1	
CO3	3												1	
CO4			3										1	

High-3; Medium-2; Low-1

Textbooks:

T1. L. Ashok Kumar, S. Albert Alexander,” Power Converters for Electric Vehicles”, First Edition, Taylor and Francis 2020.

T2. Power Electronic Converters”, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition 2017.

T3. K. T. Chau," electric vehicle machines and drives design, analysis and application ", First Edition, Wiley Publishers, 2015

T3. James Larminie, “Electric Vehicle Technology Explained”, First Edition, Wiley Publishers, 2003

Reference Book(s):

R1. P.C. Krause, O. Wasynczuk, and S. D. Sudhoff, “Analysis of Electric Machinery”, McGrawHill Book Company, 1995.

R2. R. Krishnan, “Electric Motor Drives: Modeling, Analysis and Control”, Prentice Hall, 2015.

R3. P. S. Bhimbra, “Generalized Theory of Electric Machines”, Khanna Publication, 2018.

R4. B. K. Bose, “Modern Power Electronics and AC Drives”, Pearson Education. s, Processes, Methods and Tools, SAE, 2016

Web References:

1.https://nptel.ac.in/courses/108/104/108104011/

2.https://www.nrel.gov/docs/fy19osti/72198.pdf

3.https://onlinecourses.nptel.ac.in/noc23_ee38/preview

4. https://onlinecourses.nptel.ac.in/noc24_ee30/preview

Vertical 3: Electrical Vehicle Technology Electives

Course Code: 23EEE030		Course Title: Electric Vehicle Architecture	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

The course provides an understanding of the structure and operation of Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs), along with an explanation of vehicle mechanics. Additionally, it covers the fundamental concepts and workings of Plug-in Hybrid Electric Vehicles (PHEVs).

Module I **23 Hours**

Electric Vehicle Architectures : Electric vehicle history, Evolution of electric vehicles, Social and environmental importance of hybrid and electric vehicles, Layout of an electric vehicle- Electric drive-train topologies, Transmission types for EV – Power flow control in electric drive train. Mountain Bike - Motorcycle - Electric Cars and Heavy duty EVs.-Details and Specification.

Hybrid Vehicle Architectures: Concepts of hybrid electric drive train, Hybrid vehicle architectures- Series, Parallel and Series parallel Architecture, Micro and Mild architectures. Power flow control in all hybrid vehicle configurations.

Vehicle Mechanics, Power Components and Brakes: Vehicle mechanics- Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire Road mechanics, Propulsion system design. Power train component sizing- Gears, Clutches, Differential, Transmission and vehicle brakes.

Module II **22 Hours**

Hybrid Vehicle Control Strategy: Vehicle supervisory control, Mode selection strategy, Modal Control strategies.

Plug-In Hybrid Electric Vehicle: Introduction-History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV-Block diagram and components-Charging mechanisms-Advantages of PHEVs.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Summarize the history and Evolution of EVs, Hybrid and Plug-In Hybrid EVs	Understand
CO2: Categorize the various architectures of hybrid electric vehicles.	Apply
CO3: Analyze the basics of vehicle mechanics, power components and Brakes.	Analyze
CO4: Describe the hybrid vehicle control strategy	Apply
CO5: Describe the concepts related in the Plug-In Hybrid Electric Vehicles by selecting the suitable societal relevant case study and report the inference.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1												1	
CO2	3												1	
CO3		3											1	
CO4	3												1	
CO5	3					1	1			1		1	1	

High-3; Medium-2; Low-1 Kindly update the table as per new Course Outcomes

Text Book(s):

T1. Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.

T2. Build Your Own Electric Vehicle,Seth Leitman , Bob Brant, McGraw Hill, Third Edition 2013

T3. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, First edition 2017.

T4. Electric Vehicle Technology Explained" by James Larminie and John Lowry, Wiley, 2023

Reference Book(s):

R1. Hybrid Electric Vehicles: A Review of Existing Configurations and Thermodynamic Cycles, Rogelio León , Christian Montaleza , José Luis Maldonado , Marcos Tostado - Véliz and Francisco Jurado, Thermo, 2021, 1, 134–150.

R2.Electric Vehicles Modern Technologies and Trends, Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen Springer, 2020.

R3. The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles,and Bicycles -- Includes EV Components, Kits, and Project Vehicles Mark Warner, HP Books, 2011.

Web References:

1. https://nptel.ac.in/courses/108106170
2. https://archive.nptel.ac.in/courses/108/106/108106182/
3. https://archive.nptel.ac.in/courses/108/103/108103009/

Course Code: 23EEE031		Course Title: Sensors for Electric Vehicle	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is designed to provide a understanding of digital transducers and the evolution of the seven generations of IoT sensors. It introduces sensor technology used in advanced driver assistance systems (ADAS) and disseminates knowledge about sensor networks.

Module I **23 Hours**

Digital Transducers: Digital voltmeter -Ramp type, Integrating type, ADC, Digital frequency meter -Working principle and applications. Frequency meter, Electronic counters - Transducers for the measurement of DC and AC voltages and currents - CTs, PTs for supply frequency as well as high frequency, Hall Effect Current Sensors, High Voltage Sensors.

Seven Generations of IoT Sensors: Industrial sensors –Description and Characteristics–First Generation –Description and Characteristics–Advanced Generation –Description and Characteristics–Integrated IoT Sensors –Description and Characteristics–Polytronics Systems –Description and Characteristics–Sensors' Swarm –Description and Characteristics–Printed Electronics – Description and Characteristics–IoT Generation Roadmap.

Sensor Technology for Advanced Driver Assistance Systems: Basics of Radar Technology and Systems - Ultrasonic Sonar Systems - Lidar Sensor Technology and Systems - Camera Technology - Night Vision Technology - Use of Sensor Data Fusion - Integration of Sensor Data to On-Board Control Systems.

Module II **22 Hours**

Sensor Networks: Introduction to sensor network, Unique constraints and challenges, Localization and Tracking, Networking Sensors, Infrastructure establishment, Sensor Tasking and Control, Sensor network databases, Sensor Network Platforms and tools, Industrial Applications and Research directions.

Intelligent Sensor Systems: Intelligent Sensor Systems- Intelligent pressure, Flow, Level, Temperature Sensors – Intelligent sensor, Complex sensors, biometric sensors - Application of intelligent sensor in electric vehicles.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Analyze the concept digital transducers	Analyze
CO2: Examine the evolution of IoT sensor technology.	Apply
CO3: Make use of the sensor technology for advanced driver assistance systems.	Apply
CO4: Make use of the concepts of sensor networks in different intelligent sensor systems using a simple case study.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3											1	
CO2	3												1	
CO3	3												1	
CO4	3					1				1			1	

High-3; Medium-2; Low-1

Textbooks:

T1. Hybrid Electric Vehicle System Modeling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017

T2. Electric and Hybrid Vehicles, Tom Denton, Taylor & Francis, 2018

T3. Wenping Cao, Siliang Lu, Advanced Sensors and Sensing Technologies for Electric Vehicles, AIP Publishing LLC, 2022.

Reference Book(s):

R1. Robert Bosch Gmbh, Automotive Electrics and Automotive Electronics, Systems and Components, Networking and Hybrid drive, Fifth Edition, Springer Vieweg, Wiesbaden 1998.

R2. Mehrdad Ehsani Yimin Gao Stefano Longo Kambiz M. Ebrahimi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Taylor & Francis Group, LLC, 2018.

R3. Denton.T , Automobile Electrical and Electronic Systems: Automotive Technology: Vehicle Maintenance and Repair, 2012

Web References:

1. https://archive.nptel.ac.in/courses/108/108/108108123/
2. https://nptel.ac.in/courses/108106170
3. https://onlinecourses.swayam2.ac.in/ntr24_ed16/preview
4. https://archive.nptel.ac.in/courses/108/108/108108147/

Course Code: 23EEE032		**Course Title: Automotive Electrical & Electronic Systems**	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course is designed to provide an understanding of the types of batteries, their performance, and the lighting techniques used in automotive systems. It covers the analysis of various ignition systems employed in automobiles and illustrates the components of vehicle charging and starting systems.

Module I **23 Hours**

Batteries and Lighting System: Lead acid and alkaline batteries, construction and working, battery rating, battery charging methods, testing and maintenance. Lighting system: insulated and earth return system, head light and side light, LED lighting system, head light dazzling and preventive methods.

Ignition System: Ignition system- Construction and working of magneto coil and battery coil ignition systems, Centrifugal and Vacuum Advance Mechanism, spark plug types, spark advance mechanisms, electronic ignition systems - Transistorized ignition system, solid state ignition systems, capacitor discharge ignition system and distributor less ignition system.

Starting And Charging System: Requirements of Starter Motor, Starter Motor types, construction and characteristics, Starter drive mechanisms, Starter Switches and Solenoids, Charging system components, Generators and Alternators, types, construction and Characteristics. Voltage and Current Regulation, Cutout relays and regulators. Charging circuits for D.C. Generator.

Module II **22 Hours**

Sensors and Actuators: Sensors - Oxygen Sensors, Throttle Position Sensor, Engine Speed Sensor, Ignition Timing Sensor, Crankshaft Position Sensor, Manifold Absolute Pressure Sensor -Engine Coolant Temperature Sensor, Knock Sensor, Airflow rate sensor. Actuators - Fuel Metering Actuator, Fuel Injector, and Ignition Actuator.

Electronic Engine Control Systems: Comparison indirect and direct injection- mechanical and hydraulic actuated EDC - In-line fuelinjection pumps, helix and port controlled axial piston distributor, solenoid valve control, unit injectors, common rail systems, data processing, lambda closed loop control, torque-controlled EDC systems, control and triggering of actuators, gasoline direct injection systems, air assisted systems, principles and features of Bosch electronic systems, idle speed, knock and spark timing control. Case study of solar powered vehicle.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Discriminate various types of batteries and their testing methods and lightening systems employed in automobiles.	Analyze
CO2: Compare various types of ignition techniques adopted in automobiles	Analyze
CO3: Examine the operating principle of starter motor for starting and generator for charging system.	Apply
CO4: Analyze various types of sensors and actuators, their construction, operating principle and uses	Analyze
CO5: Apply the various electronic control techniques for diesel and gasoline systems.and report a presentation as an individual or team.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3											1	
CO2		3											1	
CO3	3												1	
CO4		3											1	
CO5	3									1		1	1	

High-3; Medium-2; Low-1

Textbooks:

T1. Tony Tranter “Automobile Electrical and Electronic Systems Essential theory & Practice”, Haynes Publishers, 2009.

T2. Tom Denton, Hayley Pells, “Automobile Mechanical and Electrical Systems” CRC Press, 2017.

Reference Book(s):

R1. A W Judge, Modern Electrical Equipment for Automobiles, Chapman & Hall, 2009.

R2. P. L. Kohli, Automotive Electrical Equipment, First Edition, McGraw-Hill, 2017.

R3. Robert Bosch Automotive Hand Book, 9th Edition, Robert Bosch, 2014.

R4. W. H. Crouse, Automotive Electrical Equipment, McGraw-Hill, 2009

Web References:

1. https://nptel.ac.in/courses/107/106/107106088/
2. https://www.ti.com/solution/electrical-and-electronics-automotive-applications
3. https://elearn.nptel.ac.in/product-category/nptel/page/6/?v=c86ee0d9d7ed
4. https://onlinecourses.nptel.ac.in/noc24_ee30/preview

Course Code: 23EEE033		Course Title: Design of Electric Vehicle Charging System	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

This course is to provide comprehensive knowledge of charging stations and the standards associated with them, exploring the fundamental concepts of power converters used in charging systems.

Module I **23 Hours**

Charging Stations and Standards: 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

Power Electronics for EV 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

EV Charging using Renewable and Storage Systems: 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. kW and MW charging system

Module II **22 Hours**

Wireless Power Transfer: 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

Power Factor Correction in Charging System: 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

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Compare charging techniques, Systems and relate with charging standards and regulations	Analyze
CO2: Apply the knowledge of power converters in charging system	Apply
CO3: Apply the concepts of integrating renewable energy sources with EV charging infrastructure	Apply
CO4: Analyze the factors contributing to power factor deviation during charging and implement techniques to improve the efficiency of power usage.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3						1					1	
CO2	3												1	
CO3	3												1	
CO4		3											1	

High-3; Medium-2; Low-1

Textbooks:

T1. Rajiv Singh, Sanjeevikumar Padmanaban, Sanjeet Dwivedi, Marta Molinas and Frede Blaabjerg,"Cable Based and Wireless Charging Systems for Electric Vehicles, Technology and control, management and grid integration", IET, 2021

T2. Miao Wang Ran Zhang Xuemin (Sherman) Shen, "Mobile Electric Vehicles Online Charging and Discharging", Springer, 2016

Reference Book(s):

R1. Ali Emadi, "Handbook of Automotive Power Electronics and Motor Drives", Taylor & Francis, 2005.

R2. James D Halderman, "Electric and Hybrid Electric Vehicles", Pearson, 2022.

R3. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, "Electric Vehicles Modern Technologies and Trends" Springer Publisher, 2021.

Web References:

1. https://link.springer.com/article/10.1007/s42835-020-00547-x
2. https://evreporter.com/category/learning-resources/

Course Code: 23EEE034		Course Title: Testing of Electric Vehicles	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is to explore various standardization procedures and testing procedures relevant to electric vehicles (EVs) and hybrid electric vehicles (HEVs) to ensure performance, reliability, and compliance. Also to study functional safety requirements and investigate the effects of electromagnetic compatibility (EMC) & electromagnetic interference (EMI) in motor drives and DC-DC converter systems.

Module I **23 Hours**

EV Standardization: Introduction - Current status of standardization of electric vehicles, electric Vehicles and Standardization - Standardization Bodies Active in the Field – Standardization activities in countries like Japan. The International Electro Technical Commission - Standardization of Vehicle Components.

Testing of Electric Motors and Controllers for Electric and Hybrid Electric Vehicles: Test Procedure Using M-G Set, electric motor, controller, application of Test Procedure, Analysis of Test Items for the Type Test - Motor Test and Controller Test (Controller Only) -Test Procedure Using Eddy Current Type Engine Dynamometer, Test Strategy, Test Procedure, Discussion on Test Procedure. Test Procedure Using AC Dynamometer.

Fundamentals of Functional Safety: Functional safety life cycle - Fault tree analysis - Hazard and risk assessment – Reliability - Reliability block diagrams -Functional safety and quality – Standards.

Module II **22 Hours**

EMC in Electric Vehicles: Introduction - EMC Problems of EVs, EMC Problems of Motor Drive, EMC Problems of DCDC Converter System, EMC Problems of Wireless Charging System, EMC Problem of Vehicle Controller, EMC Problems of Battery Management System, Vehicle EMC Requirements-Functional safety and EMC.

EMI in Motor Drive and DC-DC Converter System: Overview -EMI Mechanism of Motor Drive System, Conducted Emission Test of Motor Drive System, IGBT EMI Source, EMI Coupling Path, EMI Modelling of Motor Drive System. EMI in DC-DC Converter, EMI Source, The Conducted Emission High-Frequency, Equivalent Circuit of DC-DC Converter System, EMI Coupling Path

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Analyze the status and other details of standardization of EVs	Analyze
CO2: Analyze the testing protocols for EVs and HEV components	Analyze
CO3: Analyze the safety cycle and need for functional safety for EVs	Apply
CO4: Analyze the problems related with EMC for EV components.	Apply
CO5: Evaluate the EMI in motor drive and DC-DC converter system	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3											1	
CO2		3											1	
CO3	3												1	
CO4	3												1	
CO5	3												1	

High-3; Medium-2; Low-1

Textbooks:

T1. Ali Emadi, "Handbook of Automotive Power Electronics and Motor Drives", Taylor & Francis,2005

T2. Li Zhai, "Electromagnetic Compatibility of Electric Vehicle", Springer Nature Singapore, 2022.

Reference Book(s):

R1. Kai Barguest, "EMC and Functional Safety of Automotive Electronics", IET 2018.

R2. Beate Müller, Gereon Meyer, "Electric Vehicle Systems Architecture and Standardization Needs, Reports of the PPP European Green Vehicles Initiative", Springer 2015

R3. Druce Archam beault, colin branch, Omar M.Ramachi , "EMI/EMC Computational Modeling Handbook", Springer 2012.

Web References:

1. http://ri.diva-portal.org/smash/get/diva2:962406/FULLTEXT01.pdf
2. https://dewesoft.com/applications/electric-vehicle-testing

Course Code: 23EEE035		Course Title: Electric Vehicle Design, Mechanics and Control	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The objective is to understand the basics of internal combustion engines, fuel economy, emission control, and compare Electric and Hybrid Electric Vehicles with traditional vehicles. Learning about battery types and management for electric vehicles. To apply emission control techniques, optimize battery usage, and evaluate the benefits of EVs and HEVs.

Module I **22 Hours**

Internal Combustion Engines: IC Engines, Vehicle Fuel Economy, Emission Control Systems, Treatment of Diesel Exhaust Emissions.

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

Battery Modeling, Types and Charging: Batteries in Electric and Hybrid Vehicles - Battery Basics - Battery Parameters. Types- Lead Acid Battery - Nickel-Cadmium Battery - Li-Ion Battery - Li-Polymer Battery, Research and Development for Advanced Batteries. Battery Modelling, Electric Circuit Models. Battery Pack Management, Battery Charging.

Module II **23 Hours**

Control Preliminaries: 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.

Control Of Ac Machines: Introduction- Reference frame theory, basics-modeling of induction and synchronous machine in various frames-Vector control- Direct torque control.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Describe the concepts related with EV, HEV and to compare the same with internal combustion engine vehicles	Apply
CO2: Calculate the gain margin and phase margin for various transfer functions of boost converters to evaluate system stability and	Apply
CO3: Implement control strategies for AC machines, demonstrating the application of vector control and direct torque control.	Apply
CO4: Apply battery modeling techniques and analyze key battery parameters to optimize battery performance and management in electric and hybrid vehicles and report the presentation.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2			3										1	
CO3	3												1	
CO4		3								1		1	1	

High-3; Medium-2; Low-1

Textbooks:

T1. Iqbal Husain, Electric and Hybrid Vehicles, Design Fundamentals, Third Edition, CRC Press, 2021.

T2. Wie Liu, “Hybrid Electric Vehicle System Modeling and Control”, Second Edition, John Wiley & Sons, 2017.

Reference Book(s):

R1. Teuvo Suntio, Tuomas Messo, Joonas Puukko, Power Electronic Converters,Dynamics and Control in Conventional and Renewable Energy Applications, 1st Edition, Wiley - VCH.

R2. Ali Emadi, Mehrdad Ehsani, John M.Miller, “Vehicular Electric Power Systems”, Special Indian First Edition, Marcel dekker, Inc 2003.

R3. C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, First Edition 2001.

Web References:

1. https://archive.nptel.ac.in/courses/108/106/108106170/
2. https://www.mathworks.com/videos/hybrid-electric-vehicle-modeling-and-simulation-81751.html

Course Code: 23EEE036		Course Title: Intelligent Control of Electric Vehicles.	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits:	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The objective is to model BLDC motors, covering structure, drive modes, and dynamic equations. It includes studying speed control techniques like PID, vector control, and fuzzy logic for BLDC applications. It focuses on FPGA architecture, VHDL basics, and their use in real-time BLDC motor control.

Module I **23 Hours**

Mathematical Model of The BLDC Motor: Structure and Drive Modes - Basic Structure, General Design Method, Drive Modes. Mathematical Model, Differential Equations, Transfer Functions, State-Space Equations.

Speed Control for Electric Drives: Introduction -PID Control Principle, Anti windup Controller, Intelligent Controller. Vector Control. Control applied to BLDC motor-. FUZZY LOGIC 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.

Module II **22 Hours**

Fpga and Vhdl Basics: 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.

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Drive the mathematical model of a BLDC motor and to discuss about its characteristics	Understand
CO2: Apply PID control, anti-windup techniques, intelligent controllers, and vector control strategies to effectively regulate the operation of BLDC	Apply
CO3: Design and implement fuzzy logic-based systems for intelligent decision-making and control applications.	Apply
CO4: Develop and utilize VHDL and FPGA for programming and deploying control systems in electric vehicle applications.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2												1	
CO2	3												1	
CO3			3										1	
CO4	3											1	1	

High-3; Medium-2; Low-1

Textbooks:

T1. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Third Edition" CRC Press, Taylor & Francis Group, First Edition 2021.

T2. Jayaram Bhasker, VHDL Primer, A (3rd Edition), Prentice Hall, 1st Edition 2015

Reference Book(s):

R1. 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.

R2. Wei Liu, Hybrid Electric Vehicle System Modeling and Control, Wiley 2017, 2nd Edition

R3. Emanuele Crisostomi, Robert Shorten, Sonja Stüdli, Fabian Wirth, Electric and Plug-in Hybrid Vehicle Networks Optimization and Control, CRC Press, 1st Edition. 2018.

Web References:

1. https://onlinecourses.swayam2.ac.in/ntr24_ed16/preview
2. https://www.mathworks.com/matlabcentral/fileexchange/48250-fuzzy-logic-control-of-electric-vehicle

Course Code: 23EEE037		Course Title: Grid Integration of Electric Vehicles	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

To Learn the basic details of V2G in perspective of definition, History and Development, Auditing and Metering, Electricity Markets with application and Technical Benefits as well Economic Benefits in Grid Integration of EVs. It focuses on Understanding the fundamental details on Technical Challenges, The Economic and Business Challenges, Regulatory and Political Challenges in Grid Integration of EVs.

Module I **22 Hours**

Defining 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. 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.

Module II **23 Hours**

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. Introduction-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.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply the concepts related with V2G.	Apply
CO2: Analyze the benefits of V2G integration, propose strategies for enhancing sustainable energy systems	Analyze
CO3: Analyze the technical, economics. business, regulatory & political challenges related with V2G	Analyze
CO4: Apply the concept of grid integration and management of EVs and report the case study	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2		3											1	
CO3		3											1	
CO4	3									1			1	

High-3; Medium-2; Low-1

Text Books

T1. Vitor Monteiro, João L. Afonso and Sheldon Williamson,” Vehicle Electrification in Modern Power Grids”,Elsevier,2024.

T2. Lance Noel · Gerardo Zarazua de Rubens Johannes Kester · Benjamin K. Sovacool, Vehicle to-Grid A Sociotechnical Transition Beyond Electric Mobility, 2020

T3.ICT for Electric Vehicle Integration with the Smart Grid, Nand Kishor 1; Jesus Fraile-Ardanuy, First Edition IET 2020.

Reference Books

R1. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press First Edition, 2017.

R2. Plug In Electric Vehicles in Smart Grids, Charging Strategies, Sumedha Rajakaruna , Farhad Shahnia and Arindam Ghosh,Springer, First Edition 2015.

R3. Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid, Junwei Lu and Jahangir Hossain, IET 2015, First Edition.

Web Reference

1. https://onlinecourses.swayam2.ac.in/nou24_ec10/preview
2. https://www.coursera.org/learn/bridging-the-gap-ev-grid-integration--v2g-systems

Course Code: 23EEE038		**Course Title: Smart Grid Interface for EV**	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

To explain the smart grids components and architecture in view of its fundamental concepts, its evolution, functions, its opportunities, Standards and challenges, Environment and Economics with automation based energy management system.

Module I **22 Hours**

Introduction - Definitions and Need for Smart Grid -Today's Gird Versus Smart Grid, Rationale for Smart Grid- Evolution of Electric Grid, Smart Grid Concept– Functions – Opportunities – Benefits and challenges, Communication and Standards, Environment and Economics, Shareholders Roles and Function, Architecture, Technology Drivers. Energy Management System - Smart substations - Substation Automation - Feeder Automation, SCADA – Remote Terminal Unit – Intelligent Electronic Devices – Protocols, Phasor Measurement Unit – Wide area monitoring protection and control, Smart integration of energy resources – Renewable, intermittent power sources – Energy Storage.

Module II **23 Hours**

Distribution Management System – Volt / VAR control – Fault Detection, Isolation and Service Restoration, Network Reconfiguration, Outage management System, Customer Information System, Geographical Information System, Effect of Plug in Hybrid Electric Vehicles. Introduction to Smart Meters – Advanced Metering infrastructure, AMI protocols – Standards and initiatives, Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing. Plugin Electric Vehicles and hybrid, Vehicle classes, Vehicle Architecture, Gird to Vehicle Charging, Grid Impacts, Vehicle to Grid.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Analyze the smart grids components and architecture based on application	Analyze
CO2: Analyze the functions of energy management systems	Analyze
CO3: Analyze the modern power distribution system functions	Analyze
CO4: Make use of the smart meter in applications and standards	Apply
CO5: Identify the role of smart grid in Electric Vehicles in real world applications and report the presentation as an individual or team.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3											1	
CO2		3											1	
CO3		3											1	
CO4	3												1	
CO5	3									1		1	1	

High-3; Medium-2; Low-1

Text Books

T1.Mehdi Rahmani Andebili,"Planning & Operation of Electric Vehicles in Smart Grids", Green Energy and Technology, Springer, 2023.

T2. Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.

T3. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012.

Reference Books

R1. James Momoh, "Smart Grid: Fundamentals of design and analysis", John Wiley & sons Inc, IEEE press 2012.

R2. Yokoyama, "Smart Grid: Technology and Applications", John Wiley & Sons Inc, 2012.

R3. Lars.T.Berger, K.Iniewski, "Smart Grid: Applications, Communications & Security" Wiley India Pvt. Ltd, Reprint 2015.

R4. Fereidoon P. Sioshansi, "Smart Grid: Integrating Renewable, Distributed & Efficient Energy", Academic Press, 2012.

Web Reference

1. https://onlinecourses.nptel.ac.in/noc18_ee42/preview
2. https://www.energy.gov/oe/services/technology-development/smart-grid-future-electricgrid

Passed in 20th Board of Studies Meeting held on 26.04.2025

Approved in 20th Academic Council Meeting held on 04.07.2025 BOS Chairman

Vertical 4: Power Engineering Electives

Course Code: 23EEE040		**Course Title: Advanced Power System Protection**	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:
To provide the basic concepts of static relay and its design principles of phase and amplitude comparators and the application of static relays in over current protection scheme, static relays in differential protection scheme and distance relaying schemes and static relays and Microprocessor based program protection system for the power system network.

Module I **22 Hours**

Static Relays and Comparators - Advantages of static relays - Basic construction of static relays-Level detectors - Replica impedance - Mixing circuits - General equation for two input phase and amplitude comparators- Amplitude comparator: Circulating current type and opposed voltage type- rectifier bridge comparators- Phase comparator: Coincidence circuit type- block spike phase comparator. Static over Current Relays - Instantaneous over-current relay-Time over-current relays-basic principles - definite time and Inverse definite time over-current relays. Static Differential & Distance Relays - Analysis of Static Differential Relays - Static Relay schemes - Duo bias transformer differential protection –Harmonic restraint relay

Module II **23 Hours**

Static impedance-reactance - MHO and angle impedance relay -sampling comparator - realization of reactance and MHO relay using sampling comparator. Equipment Protection - Generators Percentage differential protection, Protection against stator internal faults, stator overheating protection; Rotor Protection – Field ground fault protection, loss of excitation protection; protection against motoring and protection against voltage regulator failure. Transformer: Percentage differential protection, protection against magnetizing inrush current, Buchholz relay, over fluxing protection. Microprocessor Based Protective Relays - (Block diagram and flowchart approach only): Over current relays–impedance relays-directional relay-reactance relay. Generalized mathematical expressions for distance relays-measurement of resistance and reactance – MHO and offset MHO relays-Realization of MHO characteristics - Realization of offset MHO characteristics -Basic principle of Digital computer relaying.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply the basic components of static relaying system and its design principles of phase and amplitude comparators and the application of static relays in over current protection scheme.	Apply
CO2: Implementation of static relay schemes for differential and distance relaying schemes.	Apply
CO3: Use advanced protective relay technologies to design equipment protection – Generators and Transformer schemes for power systems.	Apply
CO4: Develop the application of static relay schemes and model the operation and control of microprocessor based relays	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2	3								1	1			1	
CO3			3										1	
CO4	3					1			1	1			1	

High-3; Medium-2; Low-1

Textbooks:

T1. Badri Ram and D. N. Vishwakarma, “Power system protection and Switch gear”,2nd edition TMH publication New Delhi 2013.
T2. Vladimir Gurevich, “Digital Protective Relays, Problems and Solutions”, 2019, CRC Press, Delhi.

Reference Book(s):

R1. Y.G.Paithankar and S.R.Bhide, “Fundamentals of Power System Protection”, 2014, 2nd Edition, PHI Learning Private Limited, Delhi.
R2. C.L. Wadhwa, Electrical power systems, New age International (P) Limited,2017.

Web References:

1. https://nptel.microprocessor.ac.in/courses/108/101/108101039/
2. https://nptel.contoller.ac.in/courses/108/107/108107167/
3. https://nptel.microcontroller.ac.in/courses/108/107/108107113/

Course Code: 23EEE041		Course Title: HVDC Transmission	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The HVDC Transmission course aims to provide students with a understanding of the principles, design, operation, and control of high-voltage direct current (HVDC) transmission systems.

Module I **22 Hours**

Introduction - DC Power transmission technology -Comparison of AC and DC transmission HVDC: Description, DC links, Planning, Reliability, current trends, Advantages, Limitations & Applications — Global scenario. **HVDC System Control** - Principles of DC link control — converter control & bridge characteristics of 12 Pulse converters— system control: firing angle control, individual phase control and equidistant phase control — comparison — current and extinction angle control — starting and stopping of DC link — power control. **MTDC and Protection** - Multi terminal HVDC Systems: Introduction-Types of faults — commutation failure —arc through and misfire — Basics of protection — DC reactors

Module II **23 Hours**

voltage and current oscillations — circuit breakers — over voltage protection — switching surges — lightning surges — lightning arresters for DC systems. **Harmonics and Filters** - Sources of harmonics in HVDC systems —harmonic distortion factor — types and design of filter: AC & DC filter - Smoothing reactors -IEEE standard 1124-2003: DC Side Harmonic Performance of HVDC Transmission Systems. **High Voltage Testing of Electrical Power Apparatus** - Introduction of DC cables —DC insulation — Practical dielectrics — Dielectric stress consideration — Economics of DC cables compared with AC cables-applications

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Implement HVDC control strategies for voltage and power regulation.	Apply
CO2: Design the control methods and protection schemes for HVDC systems by identifying its fault	Apply
CO3: Design a suitable filter for harmonic elimination, types, application of cables in HVDC system	Apply
CO4: Apply knowledge to Test and validate HVDC system components.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3					1			1	1			1	
CO2			3						1	2			1	
CO3			3			1			1	3			1	
CO4	3												1	

High-3; Medium-2; Low-1

Textbooks:

T1. Padiyar, K. R., "HVDC power transmission system", Third edition, Wiley Eastern Limited, New Delhi 2014
T2. Dragan Jovcic, "High Voltage Direct Current Transmission: Converters, Systems and DC Grids", 2019, Wiley Publications
T3. S.Kamakshaiah,V.Kamaraju,"HVDC Transmission", Second Edition, McGraw Hill,2020

Reference Book(s):

R1. Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering",4th Edition New Age Interantional (P) Ltd., New Delhi 2011.
R2. Dragan Jovcic, Khaled Ahmed, "HVDC: High Voltage Direct Current Transmission line",1st Edition, Wiley 2015
R3. K.R.Padiyar,"HVDC Power Transmission Systems " New Academic Science , 2017

Web References:

1. https://nptel.harmonics.in/courses/108104048/
2. https://nptel.power apparatus.in/courses/108104013/
3. https://nptel.highvoltage.in/courses/108/106/108106160/

Course Code: 23EEE042		Course Title: Distributed Generation and Microgrid	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives: The course aims to provide an in-depth understanding of conventional and non-conventional energy sources, distributed generation, and microgrid technologies.

Module I **23 Hours**

Conventional power generation: advantages and disadvantages, Energy crises, Non - conventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources.
Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants

Requirements for grid interconnection, limits on operational parameters: voltage, frequency, THD, response to grid abnormal operating conditions. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

Module II **22 Hours**

Concept and definition of micro-grid, micro-grid drivers and benefits, review of sources of microgrids, typical structure and configuration of a micro-grid, AC and DC micro-grids, Power Electronics interfaces in DC and AC micro-grids.

Modes of operation and control of micro-grid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques, micro-grid communication infrastructure, Power quality issues in micro-grids, regulatory standards, Micro-grid economics, Introduction to smart microgrids.

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO 1: Assess and synthesize the integration of conventional and non-conventional energy sources (Solar PV, Wind, Biomass, Fuel Cells) into power systems for sustainable energy generation, considering technical, economic, and environmental factors.	Apply
CO2: Formulate and implement distributed generation (DG) systems, selecting appropriate energy sources, ensuring grid interconnection compliance (IEEE 1547), and addressing security and operational issues.	Apply

CO3: Optimize and apply energy storage technologies (e.g., batteries, ultra-capacitors, flywheels) to enhance energy management, stability, and performance in microgrids and distributed power systems.	Apply
CO4: Design and critically evaluate control and protection strategies for microgrids, focusing on active/reactive power management, anti-islanding techniques, and power quality optimization in compliance with regulatory standards.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2	3								1	1			1	
CO3	3								1	3			1	
CO4				3					1	3			1	

High-3; Medium-2; Low-1

Textbooks:

T1. Nadarajah Mithulananthan, Duong Quoc Hung, Kwang Y. Lee, “Intelligent Network Integration of Distributed Renewable Generation”, Springer International Publishing, Switzerland, 2017.
T2.S. Chowdhury, S.P. Chowdhury and P. Crossley, “Microgrids and Active Distribution Networks”, The Institution of Engineering and Technology, London, United Kingdom, 2009.
T3.Math H. Bollen , Fainan Hassan, “Integration of Distributed Generation in the Power

Reference Book(s):

R1.Magdi S. Mahmoud, Fouad M. AL-Sunni, “Control and Optimization of Distributed Generation Systems”, Springer International Publishing, Switzerland, 2015.
R2. Nick Jenkins, JanakaEkanayake , GoranStrbac , “Distributed Generation”, Institution of Engineering and Technology, London, UK,2010.
R3. Ali K., M.N. Marwali, Min Dai, “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley and sons, New Jersey, 2010.

Web References:

1. https://archive.nptel.ac.in/courses/108/108/108108034/
2. https://nptel.ac.in/courses/108107143
3. https://onlinecourses.nptel.ac.in/noc19_ee63/preview

Course Code: 23EEE043		Course Title: Power System Reliability	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives: This course covers probability theory and its applications in power systems, focusing on reliability analysis, load forecasting, and system planning.

Module I **22 Hours**

Probability - The binomial distribution - The Poisson distribution - The normal distribution – The general reliability function – The exponential distribution – Mean time to failure - Modeling of series and parallel systems – Markov processes – Continuous Markov Process – Application of Markov Process - Recursive techniques.

Classification and characteristics of Loads – Approaches to load forecasting – Forecasting methodology – Extrapolation – Correlation - Energy forecasting – Residential, Industrial and Commercial sales forecasts – Peak demand forecasting – Weather load model – Non-weather sensitive forecast – Weather sensitive forecast – Total forecast – Seasonal and annual forecasts – Annual and monthly peak demand forecasts - Use of AI in load forecasting.
Probabilistic generating unit models – Probabilistic load models – Reliability analysis for an isolated system.

Module II **23 Hours**

Interconnected systems – Load and Generator models – Interconnected effective load probability distribution – Reliability analysis of Interconnected areas - Determination of LOLP and expected value of demand not served – Determination of reliability of ISO and interconnected generation systems.

Deterministic contingency analysis – DC Power Flow and Z Matrix method for contingency analysis - Probabilistic transmission system reliability analysis - Determination of reliability indices like LOLP and expected value of demand not served.

Basic concepts on expansion planning-procedure followed for integrate transmission system planning, current practice in India-Capacitor placer problem in transmission system and radial distributions system.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Utilize probabilistic distributions (binomial, Poisson, normal, exponential) and reliability functions to evaluate and optimize the reliability of power systems, including series and parallel configurations.	Apply

CO2: Implement advanced load forecasting techniques (extrapolation, correlation, weather-sensitive and non-weather-sensitive models) to generate precise energy demand predictions and peak load forecasts across residential, industrial, and commercial sectors.	Apply
CO3: Model and assess the reliability of generating units and interconnected systems using probabilistic methods, calculating LOLP and expected demand not served for system optimization.	Apply
CO4: Conduct contingency analysis and reliability evaluation using methods like DC power flow, Z Matrix, and probabilistic transmission analysis, applying reliability indices for strategic system planning.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2	3												1	
CO3	3					1		1	1	1			1	
CO4	3					1		1	1	3			1	

High-3; Medium-2; Low-1

Textbooks:

T1. A. J. Wood and B. F. Wollenberg, "Power Generation Operation and Control", John Wiley and sons, New York, 2016.
T2. Billinton R. and Ronald N.A. "Reliability Evaluation of Engineering Systems Concepts and Techniques", Pitman Advanced Publishing Program, 2008.
T3. Prabha S. Kundur, Om P.Malik,"Power System Stability and Control", McGraw Hill, 2nd Edition 2022.

Reference Book(s):

R1.Marko Cepin, "Assessment of Power System Reliability", Springer Publications, 2011.
R2.Ali Chowdhury; Don Koval, 'Power Distribution System Reliability: Practical Methods and Applications", Wiley-IEEE Press,2009.
R3.Birolini, "Reliability Engineering: Theory and Practice by Alessandro",Springer Publications, 2004.

Web References:

1. https://www.udemy.com/course/power-system-reliability-concepts/
2. https://nptel.ac.in/courses/108/105/108105104/
3. https://pdhonline.com/courses/e485/e485_new.html

Course Code: 23EEE044		Course Title: Smart Grid	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course on Smart Grid aims to provide students with a comprehensive understanding of the technologies, systems, principles and concepts of various monitoring system, different smart meters and advanced metering infrastructure and various communication technologies, protocols, applications and energy storage devices used for smart-grid.

Module I **22 Hours**

Introduction to Smart Grid - Evolution of Electric Grid - Difference between conventional & Smart Grid - Need for Smart Grid - Smart grid drivers: functions, opportunities, challenges and benefits - Concept of Resilient &Self- Healing Grid - Present development & International policies in Smart Grid.

Wide Area Monitoring System - Fundamentals of synchro phasor technology - concept and benefits of wide area monitoring system - Structure and functions of Phasor Measuring Unit (PMU) and Phasor Data Concentrator (PDC) - Operational experience and Blackout analysis using PMU.

Smart Meters and Advanced Metering Infrastructure - Introduction to Smart Meters - Advanced Metering infrastructure (AMI) drivers and benefits-AMI protocols - Standards and initiatives

Module II **23 Hours**

AMI needs in the smart grid - Intelligent Electronic Devices (IED) for monitoring & protection.
Information and Communication Technology - Overview of smart grid communication system· - Radio communication - Mobile communication - Power line communication - Optical fiber communication - Communication protocol for smart grid.

Smart Grid Applications- Overview and concept of renewable integration - Micro grids - Typical structure and configuration of a micro grid, AC and DC micro grids - Advanced Energy Storage Technology: Flow battery, Fuel cell, SMES, Super capacitors - Plug- in Hybrid electric Vehicles

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Use basic concepts of the smart grid to solve practical problems or make simple predictions.	Apply

CO2: Use knowledge of WAMS to address practical problems or scenarios in power system operation.	Apply
CO3: Demonstrate how to read a smart meter's display and interpret the data it provides about energy usage.	Apply
CO4: Apply the various communication technologies for smart grid applications.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2	3								1	1			1	
CO3	3												1	
CO4	3								1	1			1	

High-3; Medium-2; Low-1

Textbooks:

T1. James Momoh, "Smart Grid: Fundamentals of design and analysis", John Wiley & sonsInc, IEEE press, 1st edition, 2012.

T2. Janaka Ekanayake, Nick Jenkins, Kithsiriliyanage, Jianzhong Wu, Akihiko Yokoyama,"Smart Grid: Technology and Applications", John Wiley & sons Inc, 1st edition, 2012.

T3. Stuart Borlase "Smart Grid: Infrastructure, Technology and Solutions", CRC Press, 1st edition, 2012.

Reference Book(s):

R1. Fereidoon Perry Sioshansi "Smart Grid: Integrating Renewable, Distributed & Efficient Energy" Elsevier·,1st edition, 2012.

R2. Pengwei Du, Ning Lu, "Energy storage for smart grids: planning and operation for renewable and variable energy resources" Elsevfer, 1st edition, 2015

R3. Quang-Dung Ho, YueGao, Gowdemy Rajalingham, Tho Le-Ngoc, "Wireless Communications Networks for the Smart Grid", Springer International – Publishing,1st edition, 2014.

Web References:

1. https://onlinecourses.nptel.ac.in/noc23_ee60/preview
2. https://archive.nptel.ac.in/courses/108/107/108107113/
3. https://onlinecourses.nptel.ac.in/noc21_ee68/preview

Course Code: 23EEE045		Course Title: Transients in Power System	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives: The course aims to provide an understanding of power system transients, including their causes, effects, and importance in system planning. It covers switching transients, lightning phenomena, and transient computations using traveling wave concepts, with emphasis on techniques like Bewley's lattice diagram, and methods for transient analysis in power systems and lightning protection.

Module I **22 Hours**

Review and importance of the study of transients - causes for transients. RL circuit transient with sine wave excitation - double frequency transients - basic transforms of the RLC circuit transients. Different types of power system transients - effect of transients on power systems – role of the study of transients in system planning.

Simple Switching Transients: Circuit closing and recovery transients, Arcing grounds, Damping, resistance switching and equivalent circuit for interrupting the resistor current.

Abnormal Switching Transients: Current chopping, Capacitance switching, Ferro-resonance, Transformer magnetizing inrush currents, Re-striking phenomenon and its effects on recovery voltage. Switching of three phase transformers, Effect of types of neutral connection, Three phase capacitance switching

Module II **23 Hours**

Symmetrical component method of analysis of three phase switching transients, Effect of open conductors.

Review of the theories in the formation of clouds and charge formation - rate of charging of thunder clouds – mechanism of lightning discharges and characteristics of lightning strokes – model for lightning stroke - factors contributing to good line design - protection using ground wires - tower footing resistance - Interaction between lightning and power system.

Computation of transients - transient response of systems with series and shunt lumped parameters and distributed lines. Traveling wave concept - step response - Bewely's lattice diagram - standing waves and natural frequencies - reflection and refraction of travelling waves.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: **Analyze and apply the principles of power system transients** caused by switching, lightning, and fault conditions, evaluating their effects on system performance and planning.	Analyze
CO2: **Design and simulate transient responses** in RL and RLC circuits under various excitations, using appropriate mathematical models and transformations.	Apply
CO3: **Evaluate and mitigate the impact of abnormal switching transients**, including current chopping, ferro-resonance, and transformer magnetizing inrush, on power system components.	Analyze
CO4: **Model and compute transient behavior** of power systems, utilizing concepts like traveling waves, reflection, and refraction to predict system response and improve protection strategies.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3											1	
CO2			3						1	1			1	
CO3				3		1		1	1	1			1	
CO4	3								1	1			1	

High-3; Medium-2; Low-1

Textbooks:

T1. Allan Greenwood, 'Electrical Transients in Power Systems', Wiley Inter Science, New York, 2nd Edition, 2010.

T2. Pritindra Chowdhari, "Electromagnetic transients in Power System", John Wiley and Sons Inc., 2nd Edition, 2009.

T3. C.S. Indulkar, D.P.Kothari, K. Ramalingam, 'Power System Transients – A statistical approach', PHI Learning Private Limited, 2nd Edition, 2010.

T4. Akihiro Ametani, Naoto Nagaoka, Yoshihiro Baba, Teruo Ohno, Koichi Yamabuki," Power System Transients", CRC Press,2nd Edition,2020

Reference Book(s):

R1. M.S.Naidu and V.Kamaraju, 'High Voltage Engineering', McGraw Hill, 5th Edition,2013.

R2. R.D. Begamudre, 'Extra High Voltage AC Transmission Engineering', Wiley Eastern Limited, 1986.

R3. Y.Hase, Handbook of Power System Engineering," Wiley India, 2012.

Web References:

1.https://nptel.transients.ac.in/courses/108/105/108105133/

2.https://nptel.lightning transients.ac.in/courses/108/105/108105104/

3.https://nptel.travelling concepts.ac.in/courses/108/104/108104051/

Course Code: 23EEE046		Course Title: Restructured Power System	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives: The course aims to provide a comprehensive understanding of power system restructuring and deregulation, covering market models, pricing mechanisms, congestion management, locational marginal pricing (LMP), ancillary services, and transmission pricing.

Module I **22 Hours**

Reasons for restructuring - Understanding the restructuring process - objectives of deregulation of various power systems across the world - Consumer behaviour - Supplier behaviour - Market equilibrium - Short-run and Long-run costs - Various costs of production.

The Philosophy of Market models: market models based on contractual arrangements - Market architecture-Importance of congestion management in deregulated environment - Classification of congestion management methods - Calculation of ATC - Non-market methods - Market based methods – Nodal pricing - Inter-zonal Intra-zonal congestion management - Price area congestion management - Capacity alleviation method.

Module II **23 Hours**

Fundamentals of locational marginal pricing - Lossless DCOPF model for LMP calculation – Loss compensated DCOPF model for LMP calculation - ACOPF model for LMP calculation - Risk Hedging Functionality Of financial Transmission Rights - FTR issuance process - Treatment of revenue shortfall - Secondary trading of FTRs - Flow Gate rights - FTR and market power.

Types of ancillary services -Load-generation balancing related services - Voltage control and reactive power support services - Black start capability service - Mandatory provision of ancillary services - Markets for ancillary services - Co-optimization of energy and reserve services – International comparison.

Pricing of transmission network: wheeling - principles of transmission pricing -transmission pricing methods - Marginal transmission pricing paradigm - Composite pricing paradigm loss allocation methods.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO 1: Apply the principles of power system restructuring and deregulation to evaluate the impact of market models and pricing structures on the efficiency and competitiveness of electricity markets	Apply
CO2: Apply congestion management techniques (e.g., market-based methods, nodal pricing) to resolve transmission constraints and ensure optimal dispatch in a deregulated power system.	Apply

CO3: Apply the concepts of locational marginal pricing (LMP) and ancillary services to manage power generation, grid stability, and transmission system operations effectively in a competitive electricity market.	Apply
CO4: Apply various transmission pricing and loss allocation methods to design optimal transmission pricing mechanisms and ensure efficient utilization of the transmission network.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2	3								1	3			1	
CO3	3												1	
CO4			3						1	3			1	

High-3; Medium-2; Low-1

Textbooks:

T1. Mohammad Shahidehpour, Muwaffaq Alomoush, “Restructured electrical power systems: operation, trading and volatility” Marcel Dekker Pub.,2001,e Book 31 January 2017.

T2. Kankar Bhattacharya, Math H.J.Boolen, and JaapE. Daadler, "Operation of restructured power systems”, Kluwer AcademicPub.,2012.

Reference Book(s):

R1. Paranjothi, S.R., “Modern Power Systems The Economics of Restructuring”, New Age International Publishers, First Edition: 2017.

R2. Steven Stoft," Power System Economics: Designing Markets for Electricity”,Wiley-IEEE Press, 2002.

Web References:

1. https://nptel.ac.in/courses/108101005/.

Course Code: 23EEE047		Course Title: Under Ground Cable Engineering	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives

This course provides an understanding of cable characteristics, insulation materials, and lighting schemes. It explores cable types in distribution and transmission systems, focusing on supply methods.

Module I **22 Hours**

Development of Underground Cables – Electric Lighting- Distribution of Energy for Lighting- – Paper Insulated Cables – Underground Residential Distribution Systems Underground Residential Distribution Systems- Medium Voltage Cable Development. Architecture of Underground Cabling System – Basic Dielectric Theory of Cable – Conductors -Armour and Protective Finishes – Cable Characteristics: Electrical Fundamentals of Electrical Insulation Materials – Electrical Properties of Cable Insulating Materials – Cable Standards and Quality Assurance – Cable design parameters- Current Carrying Capacity – Short-circuit Ratings. Supply Distribution Systems – Distribution Cable Types, Design and Applications – Paper Insulated Distribution Cables – PVC Insulated Cables.

Module II **23 Hours**

Polymeric Insulated Distribution Cables for 6-30 kV – Manufacture of Distribution Cables – Joints and Terminations for Distribution Cables – Testing of Distribution Cables. Basic Cable Types for A.C. Transmission – Self-contained Fluid-filled Cables – Gas Pressure Cables – High Pressure Fluid-filled Pipe Cables – Polymeric Insulated Cables for Transmission Voltages – Techniques for Increasing Current Carrying Capacity – Transmission Cable Accessories and Jointing for Pressure-assisted and Polymeric Cables. Installation of Transmission Cables - Splicing, Terminating, and Accessories – Sheath Bonding and Grounding-Testing of Transmission Cable Systems – Underground System Fault Locating – Field Assessment of Power Cable Systems- Condition monitoring tests – PD measurements.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Analyze and select appropriate cables and lighting schemes based on technical requirements, safety standards, and operational conditions.	Apply
CO2: Design and evaluate various cable characteristics and insulation materials, considering factors like voltage rating, thermal performance, and environmental conditions.	Analyze
CO3: Model and simulate different types of cable supply systems in distribution networks, ensuring optimal performance and reliability.	Apply
CO4: Implement and optimize different cable supply configurations in transmission systems, ensuring efficiency, safety, and compliance with industry standards.	Apply
CO5: Evaluate and manage the installation, testing, and maintenance processes of cables, ensuring system reliability and compliance with safety regulations.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2		3											1	
CO3	3												1	
CO4	3												1	
CO5				3		1	1						1	

High-3; Medium-2; Low-1

Textbooks:

T1.William Thue, Electrical Power Cable Engineering, CRC Press Taylor & Francis Group., 6000 Broken Sound Parkway NW, Suite 300Boca Raton, FL 33487-2742, 3rd Edition 2017.

T2.G. F. Moore, Electric Cables Handbook -Third edition, Blackwell Science Ltd, 9600 Garsington Road, Oxford OX4 2DQ, UK., January 2017.

T3.“Electric power Distribution system Engineering “– by Turan Gonen, Mc Graw-Hill book company,3rd Edition 2014.

Reference Book(s):

R1. V. Kamaraju, Electrical Power Distribution Systems, Tata Mc Graw Hill Publishing Company, 3rd edition, 2017.

R2. Electric Power Distribution – by Dale R. Patrick, Stephen W. Fardo, 2nd edition, 2009.

Web References:

1.https://www.shiksha.com/online-courses/underground-cable-engineer-certification-

2.https://dbatu.ac.in/wp-content/uploads/2020/07/ELECTRICAL-ENGINEERING-Course-Contents-NPTEL-minor.pdf

3.https://www.shiksha.com/online-courses/underground-cable-engineer-certification-126

Vertical 5: Communication and Signal Processing Electives

Course Code: 23EEE050		Course Title: Analog and Digital Communication	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours:**	**Max Marks:100**

Course Objective: The course is intended to analyze and compare different analog modulation techniques, pulse modulation techniques, baseband and pass band transmission systems and the behavior of digital communication system using spread spectrum modulation

Module I **22 Hours**

Analog Modulation Systems: Amplitude Modulation: AM power distribution - Generation of AM waves: DSBSC - SSB - VSB Detection of AM waves: Super heterodyne Receiver. Angle Modulation Systems: Narrow band and wideband FM - Generation of FM waves: Direct and Indirect methods - Detection of FM waves: Foster Seeley Discriminator - Principle of Phase Modulation systems - Noise in Analog Modulation systems.

Pulse Modulation Systems: Sampling Process - Quantization and its types - Analog Pulse Modulation systems: PAM - PWM - PPM -Digital pulse Modulation systems: Pulse Code Modulation - Concept of Linear Prediction filtering - DPCM - Delta Modulation - Adaptive Delta Modulation - Noise consideration in Pulse - Code Modulation and Delta Modulation systems.

Module II **23 Hours**

Baseband and Passband Systems: Baseband transmission: Line codes & its properties - ISI - Nyquist Criteria for distortion less transmission - Correlative coding - Eye Pattern - Principle of Equalization technique. Pass band transmission: Generation, Detection & BER of Coherent BFSK, BPSK, QAM - Principle of DPSK.

Error Control Coding: Channel coding theorem - Linear Block codes - Hamming codes - Convolutional codes - Viterbi decoding - Trellis coding.

Spread Spectrum Modulation: Pseudo noise sequences - properties of spread spectrum - Direct sequence spread spectrum - Direct sequence spread spectrum: Signal space dimensionality, Probability of error, processing gain - Frequency hopping spread spectrum, Overview of spread spectrum modulation in 4G & 5G Technologies.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Analyze the principles and techniques of analog modulation systems (AM, FM, PM), including their generation, power distribution, and detection methods, by simulating and interpreting their performance in real-time applications using MATLAB/Simulink.	Analyze

CO2: Analyze the functioning of pulse modulation systems (PAM, PWM, PCM, DPCM, DM) and their behavior in real-time conditions, considering the effects of noise and signal fidelity, through hands-on prototyping and testing.	Analyze
CO3: Apply baseband and passband transmission techniques to simulate communication systems, using line codes, Nyquist criteria, and equalization methods to achieve error-free transmission.	Apply
CO4: Apply error control coding techniques, including linear block codes, convolutional codes, and Viterbi decoding, to ensure reliable communication and data integrity in noisy environments.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3			1								1	
CO2	3	3			1								1	
CO3	3	3			1								1	
CO4	3	3				1							1	

High-3; Medium-2; Low-1

Textbooks:

T1. Sam Shanmugam, "Digital Communication Systems", Springer, 2nd Edition, 2018.

T2. Simon Haykin, "Communication Systems", John Wiley & Sons, 6th Edition, 2013.

Reference Book(s):

R1. George Kennedy and Bernard Davis, Electronic Communication Systems, Tata McGraw-Hill, 7th Edition, 2018.

R2. B.P. Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, Oxford University Press, 5th Edition, 2021.

R3. Bernard Sklar and Pabitra Kumar Ray, Digital Communications: Fundamentals and Applications, Pearson Education, 3rd Edition, 2020.

R4. John G. Proakis and Masoud Salehi, Digital Communications, McGraw-Hill Education, 5th Edition, 2022.

R5. M. Bala Krishna and Jaime Lloret Maur, Advances in Mobile Computing and Communications: Perspectives and Emerging Trends in 5G Networks, CRC Press, 2nd Edition, 2021.

Web References:

1.https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-451-introduction-to-communication-theory-spring-2009/

2. https://www.coursera.org/learn/digital-communication

3. https://ieeexplore.ieee.org/Xplore/home.jsp

Course Code: 23EEE051		Course Title: Computer Communication Networks	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours:**	**Max Marks:100**

Course Objective: The course is intended to compare the layers of OSI model with TCP/IP protocol suite, illustrate error control techniques in networks and analyze the network routing algorithms, congestion control algorithms in the communication networks.

Module I **22 Hours**

Physical Layer: Data Communications – Network Edge - Network Core – Performance metrics - Networks Coaxial Cable – Error detection: Parity Checks, Cyclic Redundancy Check (CRC)

Data Link Layer: Framing – Flow Control and Error control techniques: Stop and wait – Go back N ARQ – Selective repeat ARQ – sliding window techniques – Multiple Access Techniques: Random access protocol, Controlled access protocol – Ethernet: IEEE 802.3 – Wireless LANS:IEEE802.11.

Module II **23 Hours**

Network Layer: Internetworking devices: hub, repeater, bridge, switch, router, Gateway – Basic Internetworking (IP, ARP, DHCP, ICMP), IPV4, IPV6 – Routing: Link State Routing, Distance Vector Routing

Transport Layer: Process – to – Process delivery – User Datagram Protocol (UDP) – Transmission Control Protocol (TCP) – Congestion Control -Quality of services (QoS) – Techniques to improve QoS– Integrated Services – Differentiated Services

Application Layer: Traditional Applications: Domain Name System (DNS) – E-mail (MIME, SMTP, POP3, IMAP) – WWW – HTTP – SNMP – Telnet.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Apply error detection and correction techniques in data communication systems, including parity checks, cyclic redundancy checks (CRC), and flow control methods, through case study analysis and practical simulations.	Apply
CO2: Analyze the performance of data link layer protocols and multiple access techniques (ARQ, Ethernet, Wi-Fi) in communication systems, focusing on key metrics in both wired and wireless networks through simulations.	Analyze

CO3: Analyze the functionality of internetworking devices (hub, router, switch, and gateway) and network protocols (IP, ARP, DHCP, ICMP, IPv4, IPv6), focusing on their roles in data transmission and routing, through network configuration and using simulators like Cisco Packet Tracer or GNS3.	Analyze
CO4: Analyze transport layer protocols (UDP, TCP), congestion control methods, and quality of service (QoS) techniques, with a focus on improving network performance in various application scenarios, through case study analysis and simulations using tools like Wireshark or NS-3.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3			1				1				1	
CO2	3	3			1								1	
CO3	3	3			1								1	
CO4	3	3			1				1				1	

High-3; Medium-2; Low-1

Textbooks:

T1. Behrouz A. Forouzan, "Data Communication and Networking", 6th Edition, McGraw-Hill Education, 2017.
T2. James F. Kurose & Keith W. Ross, "Computer Networking: A Top-Down Approach Featuring the Internet", 7th Edition, Pearson Education, 2017.

Reference Book(s):

R1. Andrew S. Tanenbaum, "Computer Networks", Pearson Education, 5th Edition, 2011.
R2. Larry L. Peterson and Peter S. Davie, "Computer Networks", 5th Edition, Morgan Kaufmann, 2021.
R3. Wayne Tomasi, "Introduction to Data Communication and Networking", Pearson Education, 6th Edition, 2013.
R4. William Stallings, "Data and Computer Communications", 10th Edition, Pearson Education, 2013.

Web References:

1. https://nptel.ac.in/courses/106/105/106105166/
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-829-computer-networks-fall-2004/
3. https://nptel.ac.in/courses/106/105/106105151/

Course Code: 23EEE053		Course Title: Principles of Communication Systems	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours:**	**Max Marks:100**

Course Objective: The course is intended to distinguish analog and digital Modulation techniques used in various Communication systems

Module I **22 Hours**

Amplitude Modulation: Introduction to Modulation, Need for Modulation, Ordinary Amplitude Modulation – Modulation index, Side bands, AM Power, Double Side Band Suppressed Carrier Modulation, Single Side Band Modulation, Vestigial Side Band Modulation, AM demodulation, Applications of AM.

Angle Modulation: Angle Modulation fundamentals, Frequency Modulation – Modulation index and sidebands, Narrowband FM, Wideband FM, Principles of Phase Modulation, Frequency Modulation verses Amplitude Modulation, FM demodulation, Frequency Division Multiplexing, Applications of FM.

Module II **23 Hours**

Signal Sampling and Analog Pulse Communication: Ideal Sampling, Pulse Amplitude Modulation, Pulse Width Modulation, Pulse Position Modulation. Digital Communication Techniques: Quantization, Digital Transmission of Data, Parallel and Serial Transmission, Data Conversion, Time Division Multiplexing, Pulse Code Modulation, Delta Modulation.

Transmission of Binary Data in Communication Systems: Digital Codes, Principles of Digital Transmission, Transmission Efficiency, Modem Concepts and Methods – FSK, BPSK, Error Detection and Correction

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Analyze the principles of Amplitude Modulation (AM) and Frequency Modulation (FM), including their modulation indices, sidebands, and power distribution, by performing simulations.	Analyze
CO2: Analyze the differences between FM and AM in terms of modulation techniques, sidebands, and demodulation, through case studies and simulations of real-world communication systems.	Analyze
CO3: Analyze signal sampling and analog pulse communication techniques (PAM, PWM, PPM) through hands-on simulation exercises and group discussions to understand their impact on communication system performance.	Analyze

CO4: Analyze digital communication techniques like PCM**,** Delta Modulation**,** and TDM through real-world case studies and experiments to understand their role in binary data transmission and error handling.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3			1								1	
CO2	3	3			1								1	
CO3	3	3				1							1	
CO4	3	3				1							1	

High-3; Medium-2; Low-1

Textbooks:

T1. Simon Haykin & Moher, Communication Systems, 6th Edition, John Wiley & Sons, 2013, ISBN: 978-1-118-67038-2.
T2. H. Taub & D. L. Schilling, Principles of Communication Systems, 4th Edition, Tata McGraw-Hill, 2019, ISBN: 978-0-07-107649-9.

Reference Book(s):

R1.Harold P. E., Samy A. Mahmoud, and Lee Elliott Stern, Communication Systems, 4th Edition, Pearson Education, 2018, ISBN: 978-0-13-486786-5.

R2.Louis E. Frenzel, Principles of Electronic Communication Systems, 4th Edition, Tata McGraw-Hill, 2017, ISBN: 978-0-07-107051-9.

R3.Wayne Tomasi, Electronic Communications Systems, 6th Edition, Pearson Education, 2013, ISBN: 978-0-13-295937-6.

R4.John G. Proakis and Masoud Salehi, Communication Systems Engineering, 5th Edition, Pearson Education, 2014, ISBN: 978-0-13-291127-5.

Web References:

1. https://nptel.ac.in/courses/106/105/106105166/
2. https://www.coursera.org/learn/computer-communications-and-networks
3. https://www.edx.org/course/computer-networking-and-security

Course Code: 23EEE054		Course Title: Biomedical Signal Processing	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours:	Max Marks:100

Course Objective: The course is intended to explore the characteristics of common biomedical signals, design filters for noise and artifact removal, and apply engineering methods to analyse cardiac and neurological signals.

Module I **22 Hours**

Introduction to biosignals: Action Potential and Its Generation, Origin and Waveform Characteristics of Basic Biomedical Signals Like: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Phonocardiogram (PCG), Electroneurogram (ENG), Event-Related Potentials (ERPS), Electrogastrogram (EGG), Objectives of Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis, Computer-Aided Diagnosis.

Noise and artifacts removal from bio signals : Random and Structured Noise, Physiological Interference, Stationary and Nonstationary Processes, Noises and Artifacts Present in ECG, Time and Frequency Domain Filtering.

Cardio Signal Analysis: ECG Signal Processing, QRS detection, Adaptive noise canceling in ECG, Computation of diagnostic signal parameters of ECG like Heart rate and QRS detection using Multivariate analysis (PCA and ICA). Segmentation of PCG, intensity patterns, Spectral modeling and analysis of PCG signals.

Module II **23 Hours**

Neuro signal Analysis: EEG rhythms & waveforms, EEG applications- Epilepsy, sleep disorders, brain computer interface. Modeling EEG- linear, stochastic models - Nonlinear modeling of EEG - artifacts in EEG & their characteristics and processing – Nonparametric spectral analysis, Model based spectral analysis - EEG segmentation - Joint Time-Frequency analysis - correlation analysis of EEG channels - Evoked potentials- noise characteristics, Noise reduction by linear filtering.

Classification of bio signals through advanced techniques: Modeling intramuscular EMG-Intramuscular signal decomposition-Fractal analysis of EMG signals. Statistical analysis of VAG signals. Analysis on amplitude and latency of EMG signals. Analysis of ERP effect. Signal classification and recognition – Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification. Analysis of EEG using Empirical mode decomposition (EMD).

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Examine the underlying spectral components for various type of biomedical signals to identify patterns and signal interpretation	Analyze
CO2: Evalauate the choice of filters to remove noise and artifacts from biomedical signals.	Evaluate
CO3: Evaluate diagnostic signal parameters of ECG	Analyze
CO4: Derive power and correlation spectra of EEG signals.	Analyze
CO5: Analyze biomedical signals through advanced techniques	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3											1	
CO2				3									1	
CO3		3											1	
CO4		3											1	
CO5		3											1	

High-3; Medium-2; Low-1

Textbooks:

T1. Rangaraj M. Rangayyan, ‘Biomedical Signal Analysis-A case study approach’, Wiley- Inderscience/IEEE Press, 2009
T2. Willis J Tompkins, “Biomedical Digital Signal Processing”, Prentice Hall, 1998

Reference Book(s):

R1. D.C.Reddy,”Biomedical Signal Processing – Principles and Techniques”,TMH,New Delhi,2005
R2. Arnon Cohen, “Bio-Medical Signal Processing Vol I and Vol II”, CRC Press Inc., Boca Rato, Florida 2021
R3. Bruce, “Biomedical Signal Processing & Signal Modeling,” Wiley, 2007.
R4. Sörnmo, L. and Laguna, P., “Bioelectrical signal processing in cardiac and neurological applications (Vol. 8). Academic Press, 2005

Web References:

1. https://nptel.ac.in/courses/108105101
2. https://archive.nptel.ac.in/noc/courses/noc21/SEM1/noc21-ee17/

Course Code: 23EEE055		Course Title: Fiber Optic Communication	
Course Category: Elective		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours:	Max Marks:100

Course Objective: The course is intended to provide a comprehensive understanding of optical fiber technology and explore the construction of optical fibers, analyze their transmission characteristics, describe the various types and features of optical sources with introduction to fiber optic measurements

Module I **22 Hours**

Introduction to Optical Fibers: Evolution of fiber optic system- Element of an Optical Fiber Transmission link- Ray Optics Optical Fiber Modes and Configurations –Mode theory of Circular Wave guides- Overview of Modes-Key Modal concepts- Linearly Polarized Modes –Single Mode Fibers-Graded Index fiber structure. Fiber materials

Transmission Characteristic of Optical Fiber : Attenuation-absorption --scattering losses-bending losses-core and cladding losses-signal dispersion –inter symbol interference and bandwidth-intra model dispersion-material dispersion waveguide dispersion-polarization mode dispersion-intermodal dispersion-dispersion optimization of single mode fiber-characteristics of single mode fiber

Optical Sources: Intrinsic and extrinsic material-direct and indirect band gaps-LED-LED structures-surface emitting LED-Edge emitting LED-quantum efficiency and LED power-light source materials modulation of LED-LASER diodes-modes and threshold conditions-Rate equations-external quantum efficiency-resonant frequencies-structures and radiation patterns.

Module II **23 Hours**

Optical Detectors: PIN photo detector-Avalanche photo diodes-Photo detector noise-noise sources-SNR-detector response time-Avalanche multiplication noise-temperature effects-comparisons of photo detectors. Fiber diameter measurements- dispersion measurement-Numerical Aperture measurement - Source to Fiber Power Launching-Lensing Schemes for Coupling Management-Fiber to Fiber Joints-LED Coupling to Single Mode Fibers-Fiber Splicing-Optical Fiber connectors.

Optical Communication Systems and Networks: System design consideration Point – to –Point link design –Link power budget –rise time budget, WDM –Passive DWDM Components-Elements of optical networks-SONET/SDH-Optical Interfaces-SONET/SDH Rings and Networks- Optical ETHERNET-Soliton

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Realize basic elements in optical fibers, different modes and configurations.	Analyze
CO2: Analyze the transmission characteristics associated with dispersion and polarization techniques.	Analyze
CO3: Examine characteristics of optical sources with their use in optical communication system	Analyze
CO4: Formulate fiber optic measurements and coupling techniques.	Analyze
CO5: Design optical communication systems and its networks**.**	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3											1	
CO2		3											1	
CO3		3											1	
CO4		3											1	
CO5	3												1	

High-3; Medium-2; Low-1

Textbooks:

T1. GredKeiser,"Optical Fiber Communication‖, McGraw Hill Education (India) Private Limited. Fifth Edition, 2017

T2. John M.Senior, — “Optical Fiber Communications: Principles and Practice “ , Pearson Education, third edition.2014.

Reference Book(s):

R1. P.Chakrabarti, "Optical Fiber Communication, McGraw Hill Education (India) Private Limited, 2019

R2. Rajiv Ramaswami, —Optical Networks, A Practical Perspective, Morgan Kaufmann ,3rd Edition-2009

R3. J.Gower, —Optical Communication System, Prentice Hall of India, 2001.

R4.Govind P. Agrawal, —Fiber-optic communication systems, 5th edition, John Wiley & sons, 2021f

Web References:

1.https://nptel.ac.in/courses/117/107/117107094/

2. https://nptel.ac.in/courses/117/106/117106088/

<table>
<tr><td colspan="2">Course Code: 23EEE056</td><td colspan="3">Course Title: Digital Image Processing</td></tr>
<tr><td colspan="2">Course Category: Major</td><td colspan="3">Course Level: Higher/Advanced</td></tr>
<tr><td>L:T:P(Hours/Week) 3:0:0</td><td>Credits: 3</td><td>Total Contact Hours: 45</td><td colspan="2">Max Marks:100</td></tr>
<tr><td colspan="5">Course Objective: The course is intended to learn and understand the fundamentals of Digital Image Processing</td></tr>
<tr><td colspan="4">Module I</td><td>23 Hours</td></tr>
<tr><td colspan="5">Elements of digital image processing systems, Digital Camera, Elements of visual perception, brightness, contrast, hue, saturation, Mach band effect, Color image fundamentals-RGB,HSI models, Image sampling, Quantization, 2D transforms-DFT, DCT, KLT and SVD
Image Enhancement: -Spatial Domain techniques: Intensity transformations, contrast stretching, Histogram equalization and specification techniques, Smoothing filters, sharpening filters, gradient and laplacian. Frequency domain techniques: Smoothening filters, sharpening filters and Homomorphic filtering.
Model of Image restoration process- Noise models- Restoration in the presence of noise (both spatial and frequency domain) Linear Image restoration techniques: Inverse filtering- Wiener filtering.</td></tr>
<tr><td colspan="4">Module II</td><td>22 Hours</td></tr>
<tr><td colspan="5">Edge detection, Edge linking-Region based segmentation–Region growing –Region splitting and Merging. Clustering techniques: K-means clustering. Basic Morphological operations for Image Processing
Need for data compression- Classification of Image compression schemes- Run length coding Huffman coding - Arithmetic coding - LZW coding, Transform based compression – Image compression standards.</td></tr>
</table>

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply the various 2D Image transforms for processing images.	Apply
CO2: Model the various filtering techniques in spatial domain and frequency domain for Digital Images	Apply
CO3: Identify the different image segmentation techniques.	Apply
CO4:. Distinguish loss and lossless compression methods.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3											1	
CO2			3										1	
CO3			3										1	
CO4			3										1	

High-3; Medium-2; Low-1

Textbooks:

T1. Rafael C.Gonzalez and Richard E. Woods, ―Digital Image Processing‖, Pearson Education, 2nd Edition,2010.
T2.. Anil K. Jain, ―Fundamentals of Digital Image Processing‖, Prentice Hall of India, 2009.

Reference Book(s):

R1. Dr. Jayaraman, S., Essakirajan, S., and Veerakumar, T.,―Digital Image Processing‖, Tata McGraw Hill, New Delhi, 2012.
R2. William K-Pratt, ―Digital Image Processing‖, 4thEdition, John Wiley and Sons, 2007.

Web References:

1. https://archive.nptel.ac.in/courses/117/105/117105135/

Course Code: 23EEE056		Course Title: Wavelets and Its Applications	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objective: The course is intended to understand the concept of wavelet and its applications

Module I **23 Hours**

Vector Spaces – Properties– Dot Product – Basis – Dimension, Orthogonality and Orthonormality – Relationship Between Vectors and Signals – Signal Spaces – Concept of Convergence. Fourier basis & Fourier Transform – Need for Time-Frequency Analysis – Heisenberg‟s Uncertainty principle – Short time Fourier transform (STFT) – short comings of STFT– Need for Wavelets

Decimation and Interpolation in Time domain - Decimation and Interpolation in Frequency domain – Multi rate systems for a rational factor.

Wavelet basis – Continuous time Wavelet Transform (CWT) – need for scaling function

Module II **22 Hours**

Two channel filter bank – Perfect Reconstruction (PR) condition – relationship between filter banks and wavelet basis – DWT – Filter banks for Daubachies wavelet function

Wavelet denoising- Speckel removal-Edge detection and noise removal- Image fusion-object detection- discrete wavelet multitone modulation- Image compression

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Understand the need for wavelet transform through time–frequency analysis	Understand
CO2: Analyze the multirate system for rational factor.	Analyze
CO3: Analyze the relationship between the filter bank and wavelet from perfect reconstruction condition	Analyze
CO4: Apply of wavelets for various applications.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3											1	
CO2			3										1	
CO3			3										1	
CO4			3										1	

High-3; Medium-2; Low-1

Textbooks:

T1. K.P.Soman , K.I. Ramachandran, N.G. Rasmi,"Insight Into Wavelets: From Theory to Practice" PHI Learning Private Limited, 3rd Edition, 2010
T2. Rao R M and A S Bopardikar, Wavelet Transforms -Introduction to theory and Applications, Pearson Education, Asia, 2000

Reference Book(s):

R1. Stephane G Mallat, A Wavelet Tour of Signal Processing:The sponse way" Academic Press, Third edition, 2008
R2. Y.T. Chan, Wavelet Basics, Kluwer Publishers, Boston, 1993.

Web References:

1. https://onlinecourses.nptel.ac.in/noc23_ee32

Course Code: 23EEE057		Course Title: Speech and Audio Processing	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objective: The course is intended to discuss the mechanism of speech production, time domain speech signal with various speech coding techniques and concepts of perceptual audio coding.

Module I **22 Hours**

Mechanism of speech production – Categorization of speech sounds – Discrete time modeling of speech production: Vocal tract, Radiation, Excitation, The complete model – Human Auditory System.

Time domain parameters of speech: Short-time Energy and Average Magnitude, Short-time Average Zero-Crossing Rate – Speech vs. Silence discrimination using Energy and Zero-Crossings – Short-time Autocorrelation function – Pitch period estimation using the autocorrelation function.

Short-Time Fourier Transform – Analysis and Synthesis – Homomorphic Filtering – Cepstrum of voiced and unvoiced – Pitch Detection – Formant Estimation.

Module II **23 Hours**

Scalar Quantization – Vector Quantization – Subband Coding – Sinusoidal Coding – Linear Predictive Coding (LPC) – Mixed Excitation LPC (MELP) – Code-Excited Linear Prediction (CELP) – Acoustics: Echo, Reverberation – Echo Cancellation.

Transparent Audio Coding – Perceptual Masking – Noise Shaping: subband analysis, temporal noise shaping – Example coding schemes: MPEG-1 Audio layers I and II, MPEG-1 Audio Layer III (mp3), MPEG-2 AAC.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Compare the mechanism of speech production and auditory perception.	Apply
CO2: Analyze speech signals using time domain parameters for voiced and unvoiced signal classification.	Analyze
CO3: Illustrate the various frequency domain techniques used for processing and extracting information from speech signals.	Apply

CO4: Explain the different coding techniques used for speech signals with concepts of perceptual audio coding for lossy compression of audio signals with Case study to societal issue as individual.	Evaluate

ourse Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	1	-
CO2	-	2	-	-	-	-	-	-	-	-	-	-	1	-
CO3	2	-	-	-	-	-	-	-	-	-	-	-	1	-
CO4	-	-	-	2	-	-	1	-	-	-	-	1	1	-

High-3; Medium-2; Low-1

Textbooks:

T1. Daniel Jurafsky and James H. Martin, “Speech and Language Processing”, Pearson Third Edition, 2024.
T2. Anupam Biswas, Emile Wennekes, Alicja Wieczorkowska, Rabul Hussain Laskar, “Advances in Speech and Music Technology: Computational Aspects and Applications”, Springer, 2023.
T3. Ben Gold, Nelson Morgan and Dan Ellis, “AI for Computational Audition: Sound and Music Processing”, SpringerOpen, 2023.

Reference Book(s):

R1. Ian Vince McLoughlin, “Speech and Audio Processing: A MATLAB®-Based Approach”, Cambridge University Press, 2023.
R2. Yu Zhang and James Glass, “Deep Learning Techniques for Speech Processing”, Springer, 2023.

Web References:

1. https://nptel.ac.in/courses/117/105/117105081/
2. https://web.ece.ucsb.edu/Faculty/Rabiner/ece259/speech%20course.html

Course Code: 23EEE058		**Course Title: Wireless Communication**	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objective: The course is intended to acquire the skills to analyze, and compare diversity techniques in wireless communication, with different MIMO techniques.

Module I **22 Hours**

Introduction to wireless communication systems- Evolution of mobile communication system- 2G, 3G,4G, UMTS, LTE, WLL, WLAN, WPAN, Bluetooth, Ultra wide band.

Large scale path loss – Path loss models: Free Space and Two-Ray models -Link Budget design – Small scale fading- Parameters of mobile multipath channels – Time dispersion parameters - Coherence bandwidth – Doppler spread & Coherence time, fading due to Multipath time delay spread – flat fading – frequency selective fading – Fading due to Doppler spread – fast fading – slow fading.

Introduction, Frequency reuse, Cell Assignment techniques, Hand off Strategies, Interference and System Capacity, Trunking and Grade of Service, Improving Coverage and capacity in cellular systems.

Multiple Access techniques: FDMA, TDMA, CDMA, SDMA.

Module II **23 Hours**

Modulation techniques: M-QAM, M-PSK, GMSK - Spread Spectrum Systems: PN sequence- m-sequence- Direct Sequence Spread Spectrum-Frequency Hopping Spread Spectrum, Synchronization techniques for Spread Spectrum signals

Diversity and Combining Techniques: Time Diversity, Frequency diversity, Space Diversity- combining techniques-Selection combining, Equal gain combining, Maximum ratio Combining - RAKE receiver- Multi carrier system-OFDM.

MIMO systems – spatial multiplexing -System model -Pre-coding - Beam forming – Space Time Coding, Alamouti scheme - Channel State Information-capacity in fading and non-fading channels.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Compare various wireless communication standards and analyze different propagation models.	Apply
CO2: Illustrate cellular communication technique and analyze modulation schemes used in wireless methods.	Apply
CO3: Compare the wireless techniques in wireless communication.	Apply
CO4: Distinguish different MIMO techniques with latest techniques as practices using MATLAB communication toolbox report as individual.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	1	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	1	-
CO3	2	-	-	-	-	-	-	-	-	-	-	-	1	-
CO4	-	-	-	2	1	-	-	-	-	-	-	1	1	-

High-3; Medium-2; Low-1

Textbooks:

T1. T.S. Rappaport, "Wireless Communications: Principles and Practices", Second Edition, Prentice Hall of India, 2024

T2. Oscar Bejarano, "Wireless: A Total Beginner's Guide to Modern Wireless Communication Technologies", Bitflip Media, 2023.

T3. Dr. Krzysztof Wesolowski, "Introduction to Wireless Communications and Networks" Springer, 2022.

Reference Book(s):

R1. Andreas F. Molisch," Wireless Communications: From Fundamentals to Beyond 5G" Third Edition, Wiley-IEEE Press, 2022.

R2. Theodore S. Rappaport, Robert W. Heath Jr., Robert C. Daniels, James N. Murdock," Millimeter Wave Wireless Communications", Second edition, Prentice Hall, 2015.

Web References:

1. https://archive.nptel.ac.in/courses/117/102/117102062/
2. https://onlinecourses.nptel.ac.in/noc21_ee66/preview

Course Code: 23EEE059		Course Title: Information Theory and Coding	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objective: The course is intended to understand the basics of Information Theory, Principle of Information Coding and Concepts of linear block codes and convolution codes.

Module I **22 Hours**

Introduction to Information theory – Self Information – Entropy – Conditional Entropy – Characteristics of Entropy function – Mutual Information –Information rate – Channel capacity – Redundancy and Efficiency of channels – Binary symmetric channel – Binary asymmetric channel.

Encoding techniques – Purpose of encoding – Instantaneous codes – Kraft's Inequality – Coding efficiency and redundancy – Source coding theorem.

Statistical Methods – Shannon-Fano Algorithm, Run-length coding, Huffman algorithm, Arithmetic coding; Dictionary Methods – Static and Adaptive Dictionary – LZ77, LZ78, LZW algorithms.

Module II **23 Hours**

Parity check coding – Linear block codes –Error detecting and correcting capabilities – Generator and Parity check matrices – Hamming codes – Encoding and Decoding of cyclic codes.

Introduction to convolutional codes – Encoding – State, Tree and Trellis diagrams, Maximum likelihood decoding of convolutional codes – Viterbi algorithm.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Compare the basic concepts of information theory related to data.	Apply
CO2: Illustrate the principles of source coding techniques for message signals.	Apply
CO3: Apply statistical and dictionary based coding to compress text data.	Apply

CO4: Apply Linear block codes for error detection and correction & Convolution Codes for coding and decoding of message signals with basic MATLAB codes with report as individual.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO4	3	-	-	-	1	-	-	-	-	-	-	1	1	-

High-3; Medium-2; Low-1

Textbooks:

T1. Yury Polyanskiy and Yihong Wu, “Information Theory: From Coding to Learning” Cambridge University Press, 2024.

T2. William E. Ryan, Shu Lin, and Stephen G. Wilson, “Channel Codes: Classical and Modern”, Cambridge University Press, 2024.

T3. Xiaohui Liang and Qingqing Ding. A. Thomas, “Deep Learning for Information and Communication Technology”, Springer, 2023.

Reference Book(s):

R1. S. M. Bhandari and A. Srivastava, “Next-Generation Wireless Technologies”, Wiley, 3rd Edition, 2023.

R2. Mark Kelbert, “Information Theory and Coding by Example”, Cambridge University Press, 2023.

Web References:

1. https://nptel.ac.in/courses/108/102/108102117/
2. https://nptel.ac.in/courses/117/101/117101053/

Vertical 6: VLSI Domain Electives

Course Code: 23EEE060		Course Title: VLSI Design	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course aims to provide students with a strong foundation in the VLSI design process, transistor-level digital circuit implementation, VHDL programming, and circuit testing.

Module I **22 Hours**

VLSI Design process: Design specification- design entry – functional simulation – planning, placement and routing – timing simulation, fabricating into chip- CMOS processing technologies –nWell - pWell - Twin tub - Silicon on insulator.

MOS Transistors and Inverters Basic MOS Transistors -Threshold Voltage-Derivation of drain current- Channel length modulation- Body Effect –Trans conductance – MOSFETs as Switches - CMOS Inverter – Latch-up in CMOS Circuit - Power dissipation in CMOS Circuits - Scaling of MOSFETs and its effects.

Logic gates in static CMOS– Ratioed circuits: Pseudo NMOS – cascade voltage switch logic - Dynamic CMOS logic: domino logic, dual rail domino logic –Transmission gate - pass-transistor circuits

Module II **23 Hours**

Transistor sizing – Stick diagram, Layout diagrams and design rules

VHDL Programming for subsystem design Introduction to VHDL: Entities, architectures, signals, variables and constants – inertial and transport delay - arrays–operators - functions – procedures – packages and libraries - Types of modeling: Structural, dataflow and behavioral modeling –VHDL programs for simple adders and multipliers –Test Bench - FPGA: Architecture and programming technologies.

Testing of digital circuits- Need for testing – Failures and Faults – Modeling of faults : Stuck at faults – Bridging faults – Break and transistor stuck on / open faults– Delay faults –Temporary faults – Design for testability : Ad-hoc testing, Scan design, BIST, IDDQ testing, Boundary scan.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1:Apply the VLSI design flow and CMOS design processes to develop basic integrated circuit modules using suitable fabrication technologies.	Apply

CO2:Analyze the operation and characteristics of MOS transistors and CMOS inverters to evaluate their performance in digital circuit design.	Analyze
CO3: Design various digital circuits using appropriate CMOS logic styles.	Apply
CO4: Develop VHDL Programs for various digital logic circuits using data path	Apply
CO5:Categorize the faults in VLSI circuits using suitable testing methods and report the inference as a case study.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	1	-
CO3	-	-	3	-	-	-	-	-	-	1	-		1	-
CO4	-	-	3	-	1	-	-	-	-	-	-		1	-
CO5	-	-		3	-	-	-	-	-	1	-	1	1	-

High-3; Medium-2; Low-1

Text Book(s)

T1. Weste and Harris, “CMOS VLSI Design” Pearson Education, Third Edition, 2005.

T2. Charles H.Roth, “Digital System design using VHDL”, Thomson business information India Pvt Ltd, 2006.

T3. Neil H.E. Weste and Kamran Eshraghian, “Principles of CMOS VLSI Design”, Pearson Education ASIA, Second Edition, 2000.

Reference Book(s)

R1. John P.Uyemura “Introduction to VLSI Circuits and Systems”, John Wiley and Sons, Inc., 2002.

R2. Eugene D.Fabricius, “Introduction to VLSI Design”, McGraw Hill International Edition, 1990.

R3. Pucknell, “Basic VLSI Design”, Prentice Hall of India Publication, 1995.

R4. Wayne Wolf, “Modern VLSI Design System on chip”, Pearson Education, 2002.

R5. P.K. Lala, “Digital Circuit Testing and Testability”, Academic Press, 2002.

Web References

1. http://nptel.ac.in/courses/117106093/1
2. http://nptel.ac.in/courses/106103116/41
3. https://www.youtube.com/watch?v=VUSTLyPtPgk

Course Code: 23EEE061		Course Title: CMOS Analog IC Design	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course aims to explore the fundamentals of CMOS technology and analog MOSFET models, analyze and design basic analog MOS circuits, and construct amplifiers and switching circuits using CMOS technology. Students will also design operational amplifiers and nonlinear circuits, and compare the performance of various data conversion techniques.

Module I **22 Hours**

Introduction to CMOS Technologies and Analog MOSFET Model: MOSFET- Structure, MOSFET Capacitances, Threshold Voltage, IV Characteristics, SPICE modeling, DC equations, Short Channel MOSFET. MOS Passive Elements – Capacitors and Resistors, Temperature and Voltage dependence of Capacitors and Resistors. Analog MOSFET models - Low frequency model, High frequency model, Temperature effects, Noise in MOSFET

Analog MOS Modeling: Current Mirror, Current sources, Self-biasing techniques, Band gap voltage references, Beta Multiplier based references. Common Drain and Common Gate amplifiers, Voltage dividers

Differential Amplifiers: Differential Amplifier – Source coupled pair, Source cross coupled pair, Cascade load, Wideswing differential amplifiers.

Module II **23 Hours**

Dynamic Analog Circuits: Dynamic Analog Circuits -MOSFET switch, Switched capacitor circuit.

Operational Amplifiers: Operational Amplifiers – Basic CMOS Op-amp, Operational Trans conductance amplifier,Differential output Op-amp. Design of CMOS op-amps, Compensation of opamps, Design of Two stage op-amps, Cascode op-amps. Non Linear Analog Circuits - CMOS comparator, Analog multiplier, Level shifting circuit, Multiplier using squaring circuit

Mixed Signal Circuits: Data Conversion Fundamentals - Analog Vs. Discrete time signal, Converting analog to digital signal - Sample and hold circuit, mixed signal layout issues. Data Conversion Architecture –DAC, ADC.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Design and implement basic analog MOS circuits, such as current mirrors, self-biasing techniques, and band-gap voltage references.	Apply
CO 2: Analyze and model MOSFETs, including low and high-frequency models, and understand their behavior in various temperature and noise conditions.	Analyze
CO3: Design CMOS-based operational amplifiers, including differential, cascode, and two-stage op-amps and report the presentation on implementation in EDA software.	Apply
CO4: Design and implement dynamic analog circuits, such as switched capacitor circuits and MOSFET switches.	Apply
CO5: Analyze mixed-signal circuits, including data conversion techniques and differential amplifiers and report the inference in semiconductor industry as seminar presentation.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2		3											1	
CO3			3			1				1			1	
CO4			3										1	
CO5				3						1			1	

High-3; Medium-2; Low-1

Text Book(s):

1. P. Allen and D. Holberg, “CMOS Analog Circuit Design”, Oxford University Press, Second Edition, 2012.
2. Mohammed Ismail and Terri Faiz, Analog VLSI Signal and Information Process, McGraw-Hill Book company, 2014.

Reference Book(s):

1. Paul R. Gray and Meyer.R.G., Analysis and design of Analog Integrated circuits, John Wiley and Sons inc., USA, third Edition, 1993.Reprint, 2012.
2. CMOS Analog Circuit Design” by Phillip Allen and Douglas R. Holberg, OUP USA; Third Edition September 2011.
3. Malcom.R.Haskard, LanC.May, Analog VLSI Design - NMOS and CMOS ",Prentice Hall, 2018.
4. B. Razavi, “Design of Analog CMOS Integrated Circuits”, McGraw Hill, 2013.

5. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, “Analysis and Design of Analog Integrated Circuits”, Wiley Publishers, Fifth Edition, 2009.

Web Reference(s):

1. http://nptel.ac.in/courses/117101105/
2. http://www.nptel.ac.in/syllabus/117101006/
3. http://www.people.rit.edu /iffeee/basic-analog-circuits.pdf

Course Code: 23EEE062		Course Title: ASIC Design	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course aims to provide an understanding of various types of ASICs and logic cells used in ASIC design, exploring the architecture of programmable logic cells and their interconnects. It also covers the design software utilized for programmable logic cells.

Module I **22 Hours**

Introduction to ASIC: Types of ASICs - Design flow – CMOS transistors- CMOS Design rules -Combinational logicCell - Sequential logic cell - Transistor as Resistor - Transistor parasitic capacitance – Librarycell design.

Programmable ASICS, Logic Cells and I/O Cells: Anti-fuse - Static RAM - EPROM and EEPROM technology - Actel ACT - Xilinx LCA, Xilinx I/O blocks –- Altera MAX 5000 - Altera FLEX

ASIC Interconnect: Actel ACT -Xilinx LCA - Xilinx EPLD - Altera MAX 5000 - Altera FLEX - Latest Version - FPGAs and CPLDs and Soft-core processors

Module II **23 Hours**

Design Software: Design systems – Logic Synthesis - Half gate ASIC -Low level design language - PLA tools

Logic Synthesis: A logic synthesis example: - Adder and MUX units, FSM synthesis in VHDL, Memory synthesis in VHDL

Floor Planning, Placement and Routing: Floor planning, Placement, Routing- Global routing, detailed routing, special routing, Parasitic extraction, LVS and DRC.

System-On-Chip Design - SoC Design Flow, Platform-based and IP based SoC Designs, Basic Concepts of Bus-Based Communication Architectures, On-Chip Communication Architecture Standards, Low-Power SoC Design

High performance algorithms for ASICS/ SoCs as case studies – Canonic Signed Digit Arithmetic, KCM, Distributed Arithmetic, High performance digital filters for sigma-delta ADC, USB controllers, OMAP.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Differentiate between different types of ASICs, understand CMOS design rules, and design combinational and sequential logic cells for ASIC implementation.	Analyze
CO2: Select programmable logic devices such as FPGAs, CPLDs, and I/O blocks in programmable ASICs, including popular technologies like Xilinx and Altera for a societal application and report the case study	Apply
CO3: Implement digital circuits in EDA software and report the inference on digital design flow	Apply
CO4: Analyse System-on-Chip (SoC) architectures, focusing on platform-based and IP-based designs, along with low-power and high-performance algorithms for SoCs.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3												
CO2	3													
CO3			3		1							1	1	
CO4		3												

High-3; Medium-2; Low-1

Text Book(s):

1. Michel John Sebastian Smith, Application Specific Integrated Circuits, Addison Wesley Professional, 2018.
2. Norman G. Einspruch, "Application Specific Integrated Circuit (ASIC) Technology", Academic Press, 2012.

Reference Book(s):

1. Morris Mano.M, Digital Design, Pearson Education Pvt.Ltd, third Edition, 2013.
2. DouglasL. Perry,VHDL: Programming by Example‖, McGraw-Hill, fourth Edition,2002

Web Reference(s):

1. www.vlsi.wpi.edu/cds/explanations/lvs.html
2. http://www.eng.auburn.edu/
3. http://www.geoffknagge.com/fyp/index.shtml

Course Code: 23EEE063		Course Title: VLSI Design Flow RTL to GDS	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

This course covers the RTL to GDS VLSI design flow, through various stages of logic synthesis, verification, physical design, and testing.

Module I **22 Hours**

Overview of VLSI Design Flow: Design Flows and Abstraction; Pre-RTL Methodologies: Hardware-software Partitioning, SoC Design, Intellectual Property (IP) Assembly, Behavioral Synthesis

Overview of VLSI Design Flow: RTL to GDS Implementation: Logic Synthesis, Physical Design; Verification and Testing; Post-GDS Processes

Hardware Modeling: Introduction to Verilog Functional verification using simulation: testbench, coverage, mechanism of simulation in Verilog

RTL Synthesis: Verilog Constructs to Hardware Logic Optimization: Definitions, Two-level logic optimization

Logic Optimization: Multi-level logic optimization

Formal Verification: Model Checking, Combinational Equivalence Checking Technology Library: Delay models of Combinational and Sequential Cells

Module II **23 Hours**

Static Timing Analysis: Synchronous Behavior, Timing Requirements, Timing Graph, Mechanism, Delay Calculation, Graph-based Analysis, Path-based Analysis, Accounting for Variations

Constraints: Clock, I/O, Timing Exceptions Technology Mapping Timing-driven Optimizations

Power Analysis, Power-driven Optimizations Design for Test: Basics and Fault Models, Scan Design Methodology

Basic Concepts for Physical Design: Interconnects and Parasitics, Signal Integrity, Antenna Effect, LEF files

Chip Planning: Partitioning, Floorplanning, Power Planning Placement: Global Placement, Wirelength Estimates, Legalization, Detailed Placement, Timing-driven Placement, Scan Cell Reordering.

Clock Tree Synthesis: Terminologies, Clock Distribution Networks, Clock Network Architectures, Useful Skews Routing: Global and Detailed, Optimizations Physical Verification: Extraction, LVS, ERC, DRC, ECO and Sign-off.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply the entire VLSI design flow, including pre-RTL methodologies, RTL to GDS implementation, and post-GDS processes, using EDA Software.	Apply
CO2: Analyze hardware modeling using Verilog and perform functional verification through simulation, including test-bench creation and coverage analysis.	Analyze
CO3: Apply logic optimization techniques, static timing analysis, and timing-driven optimization for efficient circuit design.	Apply
CO4: Evaluate power analysis and design for testability, including fault models and scan design methodology using EDA Software.	Evaluate
CO5: Apply the physical design aspects, including chip planning, placement, routing, clock tree synthesis, and physical verification for optimized VLSI designs.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2		3											1	
CO3	3												1	
CO4				3	1								1	
CO5			3										1	

High-3; Medium-2; Low-1

Textbooks:

1.Sneh Saurabh, “Introduction to VLSI Design Flow”, Cambridge University Press, 2023.

2.M.J.S. Smith, “Application-specific integrated circuits”, Addison-Wesley, 2008.

Reference Book(s)

R1.L. Lavagno, I. L. Markov, G. Martin, and L. K. Scheffer (Editors), “Electronic Design Automation for IC Implementation, Circuit Design, and Process Technology”, CRC Press, 2016.

R2.S. Palnitkar, “Verilog HDL: a guide to digital design and synthesis”, Pearson Education India, 2003.

R3.J. Bhasker and R. Chadha, “Static timing analysis for nanometer designs: A practical approach”, Springer Science Business Media, 2009.

R4.G. D. Micheli, “Synthesis and optimization of digital circuits”, McGraw-Hill Higher Education, 2004.
R.5.M. Bushnell and V. Agrawal, “Essentials of electronic testing for digital, memory and mixed-signal VLSI circuits”, Springer Science & Business Media, 2004.

Web References:

1. https://onlinecourses.nptel.ac.in/noc23_ee137/preview
2. https://ocw.mit.edu/courses/6-884-complex-digital-systems-spring-2005/

Course Code: 23EEE064		Course Title: Microelectronics: Devices to Circuits	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours:	Max Marks:100

Course Objectives:

The objective of this course is to develop the ability to analyse and design electronic circuits both analog and digital, discrete and integrated. The course starts with the basics of the device most seldom encountered in mixed designs and then go on to do circuit analysis in the later parts.

Module I **22 Hours**

MOS Amplifier and its behavior as an analog switch, CMOS CS/CG/SF Amplifier Configuration, Internal cap models and high frequency modelling, JFET, structure and operation.

Multistage and Differential Amplifier, Small Signal Operation and Differential Amplifier,

MOS Differential Amplifier, Bi-CMOS Amplifier with Active Load, Multistage Amplifier with SPICE Simulation ,s-domain analysis, transfer function, poles and zeros, High Frequency Response of CS and CE Amplifier, Frequency Response of CC and SF Configuration, Frequency Response of the Differential Amplifier, Cascode Connection and its Operation

General Feedback structure and properties of negative feedback, Basic Feedback Topologies, Design of Feedback Amplifier for all configuration, Stability and Amplifier poles, Bode Plots and Frequency Compensation

Module II **23 Hours**

Ideal Operational Amplifier and its terminals, Inverting and Non- Inverting Configuration, As an integrator and Differentiator, Introduction to Analog Computer,

Large Signal Operation of Op-Amp and Second order offsets.

Butterworth and Chebyshev Filters, First and Second Order Filter Functions,

Switched Capacitor based filters, Single-Amplifier Biquadratic Filters, Second Order LCR Resonator. Combinational Logic Design, Sequential Logic Design, Clock Strategies for Sequential Design, Concept of Memory

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply the behavior of MOS amplifiers as analog switches and understand various amplifier configurations, including CMOS CS/CG/SF and differential amplifiers.	Apply
CO2: Examine high-frequency modeling of amplifiers, including JFET structures, s-domain analysis, and frequency response analysis for different amplifier configurations.	Analyze
CO3: Apply the principles of feedback in amplifiers, including feedback topologies, amplifier stability, and frequency compensation techniques.	Apply
CO4: Apply operational amplifier configurations, in inverting, non-inverting, integrator, and differentiator functions.	Analyze
CO5: Design and analyze filters, including Butterworth, Chebyshev, switched capacitor, and biquadratic filters, and apply them in combinational and sequential logic designs and report the inference as an individual.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	3												1	
CO2		3											1	
CO3	3												1	
CO4				3									1	
CO5			3							1		1	1	

High-3; Medium-2; Low-1

Text Book(s):

T1. Sedra and Smith, Microlectronics Circuits, Oxford University Press, 2008.

T2. Rabaey, Chandrakasan and Nikolic,Digital Integrated Circuit A Design Perspective, PHI Latest Edition,2009

Reference Book(s):

R1. Weste and Eshraghian, Principles of CMOS VLSI Design Addison Wesley, Latest Edition

R2. B.G.Streetman and S. Banerjee, Solid State Electronic Devices, Prentice Hall.

Web References:

1. https://onlinecourses.nptel.ac.in/noc21_ee86/preview
2. https://ocw.mit.edu/courses/6-012-microelectronic-devices-and-circuits-fall-2009/

Course Code: 23EEE065		Course Title: Semiconductor device modeling	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 45	Total Contact Hours:	Max Marks:100

The course aims to develop a sound physical and intuitive understanding of semiconductor devices and achieve ability to make some key decisions while designing applications specific semiconductor devices.

Module I **22 Hours**

Introduction -Si-Based Nano-electronics and Device Scaling, Nano scale and Hetero structure Devices, Crystal structure-Unit cell and Miller Indices

Reciprocal Space, Doping, Band Structure, Effective Mass

Density of states, Electron Mobility, Semiconductor Statistics- Fermi-Dirac function and carrier concentration calculation

P-N junction under equilibrium, derivation of I-V relation, Minority carrier diffusion equation, Non-idealities in the p-n junction diode (Breakdown and Generation-Recombination currents), Transistor configurations

BJT- I-V relation and gain, Ebers-Moll model, Non-idealities in BJT.

BJT Transient and small signal behavior, Metal-Semiconductor contact (Schottky Barrier/Diode, Ohmic Contacts) and capacitance characteristics, Thermionic emission current flow and fermi-level pinning

Module II **23 Hours**

Field Effect Transistors (JFET, MESFET), MOS Band diagram and C-V characteristics, Threshold voltage and Interface charges, MOSFET I-V, gradual channel approximation and frequency response, non-idealities and CMOS

Semi classical Transport Theory -: Distribution Function, Boltzmann Transport Equation (BTE), Relaxation-Time Approximation (RTA), Scattering and Mobility-Monte Carlo simulations.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Analyze the carrier concentration, density of states, and electron mobility in semiconductor materials.	Analyze
CO2: Derive and apply the I-V relationship of P-N junctions in equilibrium, analyze minority carrier diffusion equations, and address non-idealities like breakdown and generation-recombination currents.	Apply

CO3: Compute MOSFET I-V relations, understand the gradual channel approximation, and analyze the frequency response, along with non-idealities in CMOS devices.	Apply
CO4: Apply the fundamentals of semiconductor statistics	Apply
CO5: Model carrier transport in semiconductor devices using Monte Carlo simulations and understand how these models apply to the analysis of device performance.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1		3											1	
CO2	3												1	
CO3	3												1	
CO4	3												1	
CO5			3		1									

High-3; Medium-2; Low-1

Textbooks:

T1. G. Streetman, and S. K. Banerjee, “Solid State Electronic Devices,” Seventh Edition, Pearson,2014.

T2. S. M. Sze and K. N. Kwok, “Physics of Semiconductor Devices,” third edition, John Wiley&Sons, 2006.

Reference Book(s):

R1.D Vasileska, SM. Goodnick, G Klimeck, "Computational Electronics: Semiclassical and Quantum Device Modeling and Simulation," CRC Press 2010.

R2. Selberherr Siegfried, “Analysis and Simulation of Semiconductor Devices”, 1984

Course Code: 23EEE066		Course Title: Introduction to Time Varying Electrical Networks	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

This course covers MNA, Tellegen's theorem, and reciprocity for analyzing electrical networks, noise analysis, and modeling LPTV systems. It includes impedance, admittance, N-path principles, signal-flow graphs, chopped amplifiers, sampled systems, and equivalent LTI filters for practical applications.

Module I **22 Hours**

Introduction - Review of linearity and time-variance - Review of electrical network basics, incidence matrix, Tellegen's theorem and its use to prove reciprocity in bilateral networks-Reciprocity in networks with controlled sources- inter-reciprocal networks- Modified Nodal Analysis (MNA) formulation to write network equations - MNA stamps of circuit elements, Reciprocity and inter-reciprocity.

Introduction to noise in electronic circuits-Noise in RLC circuits, Nyquist's theorem, Bode's Noise Theorem- input referred noise sources in networks - equivalent noise voltage and current sources- Equivalent noise sources, noise factor.

Time-varying circuits and systems- Linear time-varying (LTV) system basics- Linear Periodically Time-Varying (LPTV) systems- Harmonic transfer functions - Zadeh expansion-MNA equations in LPTV networks with Harmonic transfer matrices-LPTV circuit example : the sampling mixer.

Module II **23 Hours**

Impedance and admittance in LPTV networks- Norton and Thevenin equivalents-The N-path principle - the time-interleaved ADC-the multiphase dc-dc converter- introduction to the N-path filter - input impedance and gain-Reciprocity and inter-reciprocity in LPTV networks - time-reversal to generate the adjoint- transfer function theorem- the frequency-reversal theorem.

Inter-reciprocal signal-flow graphs - chopped amplifiers-Chopped-amplifiers with sinusoidal and square-wave modulation - Adjoint networks - the switched-RC kernel example; time-domain implications of adjoint networks-Time-domain implications of the adjoint - example of a switched - RC network. Sampled LPTV networks-Equivalent LTI filter of a sampled LPTV system; derivation of the equivalent impulse response, switched-RC network - time delta-sigma as a sampled LPTV system.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Apply Modified Nodal Analysis, Tellegen's theorem, and reciprocity principles to solve time-invariant and time-varying network equations,	Apply
CO2: Analyze noise in electronic circuits, model input-referred noise sources, and understand time-varying systems using harmonic transfer functions, LPTV analysis, and practical applications like sampling mixers.	Analyze
CO3: Model inter-reciprocal signal-flow graphs, chopped amplifiers, and sampled LPTV networks, including time-domain implications and equivalent LTI filters for systems like switched-RC and delta-sigma circuits.	Analyze
CO4: Analyze impedance, admittance, and equivalence in LPTV networks, apply N-path principles, and study time-reversal, transfer function, and frequency-reversal theorems for advanced circuit design and analysis.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2		3											1	
CO3		3											1	
CO4				3									1	

High-3; Medium-2; Low-1

Textbooks:

T1. M.E. Van Valkenburg, Network Analysis, Prentice Hall, 2006.

Reference Book(s):

R1. William H. Hayt and Jack E. Kemmerly, Engineering Circuit Analysis, McGraw-Hill Education, 2012.
R2. S. M. Sze, Introduction to Noise in Electronic Circuits, Wiley-Interscience, 2002.
R3. Richard L. Freeman, Microwave Filters for RF/Microwave Applications, Wiley-Interscience, 2002.

Web References:

1. https://archive.nptel.ac.in/courses/108/106/108106174/
2. https://www.ee.iitm.ac.in/vinita/pdf/ee2015/Lecture_22_Scribe.pdf

Course Code: 23EEE067		**Course Title: Circuit Analysis for Analog Designers**	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

This course covers MNA, Tellegen's theorem, reciprocity, and analog filter design using Butterworth approximation and biquad cascades. It includes noise analysis, scattering parameters, Smith chart, and nonlinear effects like harmonic distortion and gain compression.

Module I **22 Hours**

Introduction- Kirchoff's Current and Voltage Laws, and the Incidence Matrix- Power Conservation -Tellegen's Theorem- Reciprocity in linear resistive networks, linear time-invariant networks- Inter-reciprocity in networks with ideal operational amplifiers-Review of Modified Nodal Analysis (MNA) of linear networks -MNA stamps of controlled sources – VCCS, VCVS, CCCS & CCVS.- Inter-reciprocity in linear networks - using the MNA stamp approach.

The Adjoint Network-MNA stamp of an ideal opamp -Properties of circuits with multiple ideal opamps- Introduction to Analog Active Filters - Magnitude approximation principles-The maximally flat (Butterworth) approximation- Connection between magnitude response and pole locations in an all-pole filter-Cascade-of-biquads, realization of stray-insensitive first-order section.

Opamp-RC biquadratic sections and Impedance scaling- High-order filters using cascade of biquads, Dynamic range scaling in opamp-RC filters-The finite gain-bandwidth model of nonideal opamps-Effect of finite opamp bandwidth on an active-RC integrator and RC biquad.

Module II **23 Hours**

Transconductance-Capacitance integrators - Introduction to noise in electrical networks- Noise processed by a linear time-invariant system- kT/C noise in a sample-and-hold circuit- Noise in RLC networks- Bode's Noise Theorem - Frequency domain- Input referred noise in electrical network-Noise Factor Examples.The Smith chart- Scattering parameters: Introduction-Scattering matrices properties-The one-port vector network analyzer-The two-port vector network analyzer-Weak nonlinearity in electronic circuits, second-order harmonic distortion, HD2 and IM2-Gain compression and third-order harmonic distortion.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply MNA, Tellegen's theorem, and reciprocity to analyze linear resistive and time-invariant networks with controlled sources and opamps.	Apply
CO2: Design analog active filters using magnitude approximation principles, Butterworth approximation, and biquad cascades for filter realization.	Apply
CO3: Analyze noise in electrical networks, including kT/C noise, Bode's Noise Theorem, and noise factor in linear systems.	Analyze
CO4: Apply Smith chart and scattering parameters to analyze network behavior and study nonlinearity, harmonic distortion, and gain compression.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2	3												1	
CO3		3											1	
CO4				3									1	

High-3; Medium-2; Low-1

Textbooks:

T1. William H. Hayt, Jack E. Kemmerly, and Steven M. Durbin, Engineering Circuit Analysis, Eighth Edition, McGraw-Hill Education, 2012.

Reference Book(s):

R1. M.E. Van Valkenburg, *Network Analysis*, Third Edition, Prentice Hall, 2006.

R2. David A. Johns and Ken Martin, *Analog Integrated Circuit Design*, Wiley, 2007.

R3**.** Behzad Razavi, *Design of Analog CMOS Integrated Circuits*, McGraw-Hill, 2001.

R4. Thomas L. Floyd, *Electronic Devices*, nineth Edition, Pearson, 2012.

Web References:

1. https://cds.cern.ch/record/1417989/files/p95.pdf
2. https://www.analog.com/media/en/training-seminars/design-handbooks/Amplifier-Applicatons-Guide/Section6.pdf

Course Code: 23EEE068		Course Title: Testing of VLSI Circuits	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course aims to provide students with the knowledge and skills required to identify and diagnose faults in digital circuits effectively. It focuses on enabling the creation of optimized test patterns for both combinational and sequential logic circuits. Additionally, the course explores various testability techniques.

Module I **22 Hours**

Testing and Logic Simulation: Introduction to testing – Faults in Digital Circuits – Modeling of faults – Logical Fault Models -Fault detection and redundancy – Fault equivalence and fault Location – Fault dominance – Logic simulation – Types of simulation – Delay models – Gate Level Event – driven simulation. Fault simulation applications, General fault simulation algorithms- Serial, and parallel, Deductive fault simulation algorithms.

Test Generation for Combinational Circuits: Test generation for combinational logic circuits – Testable combinational logic circuit design.

Test Generation for Sequential Circuits: Test generation for sequential circuits

Module II **23 Hours**

Design for Sequential Circuits: Design of testable sequential Logic circuits.

Design for Testability: Design for Testability – Ad-hoc design – generic scan based design – classical scan based design – system level DFT approaches.

Self-Test and Test Algorithms: Built-In-Self-Test – test pattern generation for BIST – Circular BIST – BIST Architectures – Testable Memory Design – Test Algorithms – Test generation for Embedded RAMs.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply fault modeling techniques, including logical fault models, for detecting and localizing faults in digital circuits using various fault simulation algorithms.	Apply
CO2: Generate effective test patterns for both combinational and sequential circuits, ensuring the design of testable and reliable digital systems and report the cost incurred for testing as case study.	Apply

CO3: Design testable sequential circuits and implement design-for-testability (DFT) techniques, including ad-hoc and scan-based approaches, to enhance circuit testability.	Apply
CO4: Analyze Built-In Self-Test (BIST) architectures, generate test patterns for BIST, and apply test algorithms for embedded memories, including RAMs and report the presentation as an individual.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2	3										1		1	
CO3			3										1	
CO4		3										1	1	

High-3; Medium-2; Low-1

Text Book(s):

1. M.Abramovici, M.A.Breuer and A.D. Friedman, Digital systems and Testable Design, Jaico Publishing House, 2016.
2. P.K. Lala, Digital Circuit Testing and Testability, Academic Press, Academic Press, 2012.

Reference Book(s):

1. M.L.Bushnell and V.D.Agrawal, Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits, Kluwer Academic Publishers, 2015.
2. A.L.Crouch, Design Test for Digital IC's and Embedded Core Systems, Prentice Hall. International, 2015.
3. Robert J., Jr. Feugate, stevan M. McIntyre, Introduction to VLSI Testing, Prentice Hall International, 2018.
4. Angela Krstic and Kwang-Ting Cheng Delay fault testing for VLSI Circuits, Kluwer Academic Publishers,2018 .
5. W. W. Wen, “VLSI Test Principles and Architectures Design for Testability”, Morgan Kaufmann Publishers. 2016

Web Reference(s):

1. http://onlinelibrary.wiley.com/doi/10.1002/0471457787.fmatter/pdf
2. http://nptel.ac.in/courses/106103016/30
3. www.cs.colostate.edu/~malaiya/530/08/resources.html

Vertical 7: Embedded Systems Electives

Course Code: 23EEE070		**Course Title: Embedded Systems Design**	
Course Category: Major		**Course Level: Advanced/Higher**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objective(s):

The course offers an in-depth knowledge of embedded system design principles, covering the fundamentals of embedded systems and peripheral design. It also examines principles of real-time operating systems, communication techniques, and approaches for system design.

Module I **22 Hours**

Fundamentals of Embedded Systems : Basic Terminologies – Characteristics of Embedded Computing Applications– Embedded Software Development Process – Challenges in Embedded System Design – Embedded System Architecture– Memory Devices and their Characteristics – UML Diagrams - Examples

Real Time Operating Systems

Concept of OS-based Software Development – Real-Time Operating Systems: Definition, Characteristics and Structure – Task Management: Classification, Structure, States, and Scheduling – Concept of Pseudo Multitasking and True Multitasking – Task Synchronization – Inter-task Communication – Features of Free RTOS

Module II **23 Hours**

Communication Devices and Bus Standards

I/O Devices: Types and Examples of I/O devices, Synchronous, Iso-synchronous and Asynchronous Communications from Serial Devices, Internal Serial-Communication Devices: SPI, UART - Timer and Counting Devices – Serial Communication using: 'I2C'- 'CAN'- Advanced I/O Serial high speed buses

System Design Techniques

Design Methodologies, Requirement Analysis, Specification, System Analysis and Architecture Design. Design Examples: Telephone PBX- System Architecture - Ink jet printer - Hardware Design and Software Design- Personal Digital Assistants- Set-top Boxes.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply fundamental concepts of embedded systems to analyze and address practical scenarios.	Apply
CO2: Examine the significance of operating systems in embedded system design	Apply
CO3: Analyze suitable communication techniques for effective peripheral Interfacing.	Analyze
CO4: Apply system architecture principles to design and develop solutions based on existing product designs.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	1
CO2	3				2								1	1
CO3		3			2								1	1
CO4			3										1	1

High-3; Medium-2; Low-1

Textbooks:

T1. Raj Kamal, "Embedded Systems: Architecture, Programming and Design," Fourth Edition, McGraw Hill, 2020.

T2. Marilyn Wolf, "Computers as Components: Principles of Embedded Computing System Design," Fifthth Edition, Morgan Kaufmann, 2022.

Reference Book(s):

R1. Hermann Kopetz and Wilfried Steiner, "Real-Time Systems: Design Principles for Distributed Embedded Applications," third Edition, Springer, 2022.

R2. K.C. Wang, "Embedded and Real-Time Operating Systems," second Edition, Springer, 2023.

R3. Andrew N. Sloss, Dominic Symes, and Chris Wright, "ARM System Developer’s Guide: Designing and Optimizing System Software," Morgan Kaufmann, Elsevier, 2004.

R4. Marilyn Wolf, "Computers as Components: Principles of Embedded Computing System Design," Fifth Edition, Morgan Kaufmann, 2022.

R5. Shibu K.V., "Introduction to Embedded Systems," Second Edition, McGraw Hill Education, 2017.

Web References:

1. http://www.nxp.com/documents/user_manual/UM10139.pdf.
2. Embedded Systems: https://archive.nptel.ac.in/courses/106/105/106105193/
3. Real-Time Operating Systems: https://archive.nptel.ac.in/courses/106/105/106105172/
4. Embedded System Design with ARM: https://archive.nptel.ac.in/courses/106/105/106105159/

Course Code: 23EEE071		Course Title: Advanced Microprocessors	
Course Category: Major		Course Level: Advanced/Higher	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

This course explore advanced microprocessors, covering Pentium and RISC architectures, superscalar processors, and PC hardware programming and interfacing for system design.

Module I **22 Hours**

Microprocessor Architecture: Instruction Set – data formats -addressing modes-memory hierarchy-register file-cache—virtual memory and paging-segmentation- pipelining- instruction pipeline— pipeline hazard-instruction level parallelism-reduced instruction set- RISC VS CISC

Pentium Microprocessors: Introduction to Pentium Microprocessor- real and production mode operation- software model of Pentium – function description –registers-data organization-summary of the 80286,80386, and 80486- CPU architecture –bus operation-pipelining-branch

Module II **23 Hours**

RISC Processors: PowerPC620 – Instruction fetching – Branch Prediction – Fetching – Speculation, Instruction Dispatching –dispatch stalls – Instruction Execution – Issue stalls-Execution Parallelism– Instruction completion – Basics of P6 micro architecture – Pipelining – Memory subsystem. Intel i960 – Intel IA32- MIPS R8000 – MIPS R10000 – Motorola 88110 – Ultra SPARC Processor- SPARC version 8 – SPARC version 9.

PC Hardware Overview: Functional Units & Interconnection, New Generation Mother Boards 286 to Pentium 4 Bus Interface- ISA- EISA- VESA- PCI- PCIX. Peripheral Interfaces and Controller, Memory and I/O Port Addresses

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Apply advanced microprocessor concepts to develop solutions for computational tasks in embedded systems.	Apply
CO2: Examine the architecture of Pentium processors to identify design constraints and opportunities for optimization.	Analyze
CO3: Assess the effectiveness of RISC processor architectures in enhancing system performance and reliability.	Analyze
CO4: Evaluate PC hardware interfacing techniques to recommend optimal solutions for system integration challenges.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	1
CO2		3											1	1
CO3				3									1	1
CO4				3									1	1

High-3; Medium-2; Low-1

Textbooks:

T1. Barry B. Brey, "The Intel Microprocessors: 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro Processor, Pentium II, Pentium III, Pentium 4, and Core2 with 64-Bit Extensions: Architecture, Programming, and Interfacing," 8th Edition, Pearson, 2008.

T2.John Paul Shen and Mikko H. Lipasti, "Modern Processor Design: Fundamentals of Superscalar Processors," Reprint Edition, Waveland Press, 2013.

Reference Book(s):

R1. Daniel Tabak,"Advanced Microprocessors", McGrawHill.Inc., 2ndEdition 2012.

R2. David A. Patterson and John L. Hennessy, "Computer Organization and Design RISC-V Edition: The Hardware Software Interface," 2nd Edition, Morgan Kaufmann, 2020.

R3. Jean-Loup Baer, "Microprocessor Architecture: From Simple Pipelines to Chip Multiprocessors," 1st Edition, Cambridge University Press, 2010.

R4. Douglas V.Hall, —Microprocessors and Interfacing‖, Tata McGraw Hill, 2nd Edition 2006

Web References:

1. Microprocessors and Microcontrollers:
https://archive.nptel.ac.in/courses/106/108/106108100/
2. Advanced Computer Architecture: https://archive.nptel.ac.in/courses/106/103/106103206/
3. Computer Architecture and Organization:
https://onlinecourses.nptel.ac.in/noc20_cs64/preview

Course Code: 23EEE072		Course Title: STM32 Microcontroller and Its Interfacing	
Course Category: Major		**Course Level: Advanced/Higher**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

This course empowers students with skills in Embedded C programming tailored for STM32F407VGT6, facilitating adept program development for on-chip peripherals. Through in-depth exploration, students will gain proficiency in crafting systems that utilize communication protocols with microcontrollers. Additionally, they will acquire the ability to critically assess interfacing modules, ensuring their effective integration into a variety of electronic applications.

Module I **22 Hours**

Introduction

Introduction to Microcontroller - Von Neumann and Harvard architecture - RISC vs CSIC- **STM32F407VGT6**: Architecture - Memory organization - Memory Map - Boot configuration - Embedded Flash memory interface - STM Debugger

On chip peripheral interfacing

General purpose I/Os - Analog to Digital Converter - Digital to Analog converter - Timers: Basic Timer/Counter, PWM, Interrupt - External Interrupt – USART - RTC

Module II **23 Hours**

Communication Protocol

Serial Peripheral Interface - Inter-Integrated Circuit Interface - Controller Area Network interface – Wi-Fi – Bluetooth interface

APPLICATION

LED and Switch interfacing-LCD Interfacing – Keyboard Interfacing- Relay interfacing – Sensor Interfacing - Stepper Motor Interfacing - DC Motor Interfacing

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply Embedded C for writing STM32F407VGT6 microcontroller	Apply
CO2: Develop programs for on-chip peripherals	Apply
CO3: Design a system using communication protocol with microcontroller	Apply
CO4: Analyze the interfacing modules of microcontrollers using an IDE	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	1
CO2	3				1								1	1
CO3			3		1								1	1
CO4		3			1								1	1

High-3; Medium-2; Low-1

Textbooks:

T1.Geoffrey Brown,” Discovering the STM32 Microcontroller”, Indiana University, 2016.

T2.Muhammad Ali Mazidi ,“STM32 Arm Programming for Embedded Systems”, Micro Digital Edition,2018.

T3.Reference manual STM32F405/415, STM32F407/417, STM32F427/437 and STM32F429/439 advanced Arm-based 32-bit MCUs

Reference Book(s):

R1.Yifeng Zhu, “Embedded Systems with Arm Cortex-M Microcontrollers in Assembly Language and C”, Second edition, E-Man Press LLC, 2016.

R2.Carmine Noviello," Mastering the STM32 Microcontroller ", Leanpub, 2022.

R3.Norris, Donald, “Programming with STM32: Getting Started with the Nucleo Board and C/C++”, McGraw Hill Professional, 2018.

R4.Shibu K V, ”Introduction to Embedded Systems”, Tata McGraw Hill Education Private Limited, Second Edition, 2017.

Web References:

1. https://www.st.com/en/embedded-software/stm32-standard-peripheral-libraries.html
2. https://www.keil.com/dd/docs/datashts/st/stm32f30x/dm00043574.pdf
3. Embedded System Design with ARM: https://onlinecourses.nptel.ac.in/noc20_cs15/preview

Course Code: 23EEE073		Course Title: Embedded Linux	
Course Category: Major		**Course Level: Advanced/Higher**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

To provide a thorough understanding of Linux operating system architecture, file systems, and device drivers, along with practical skills in Linux system programming and device driver development.

Module I **22 Hours**

Basic Architecture: Evolution of Linux OS – Main characteristics of Linux – Typical Linux distributions – Linux directory structure – User and super/root users – access rights – Home directory – Vi editior - Commands – Overview of shell and GUI.

Linux Kernal Architecture: Layer diagram of OS - Hardware Abstraction Layer (HAL) – Memory manager – scheduler – file system – I/O subsystem – Networking subsystem – IPC – user space.

Module II **23 Hours**

Linux File System: Layers of Linux file system – structure of inode – process file system – The Ext2 File system –System programming concepts – API & ABIs – C library and compiler.

Device Driver: System start up (Booting) Methods - PC I/O architecture – classification of Linux devices: character and block devices – port I/O – PCI and ISA bus – polling, interrupt, and waiting queue – Device Files - Device driver Registration – Device driver initialization – I/O operation - typical Linux driver – dynamic and static drivers - kernel modules – Linking and unlinking of modules – On Demand modules linking.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the characteristics and architecture of the Linux operating system to meet practical system requirements effectively.	Apply
CO2: Examine the Linux directory structure, user permissions, and commands to identify and resolve system-level challenges.	Analyze

CO3: Assess the layers and structure of the Linux file system to optimize performance and effectively integrate system programming technique	Analyze
CO4: Evaluate and manage Linux device drivers, focusing on registration, initialization, and I/O operations for enhanced system functionality	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	1
CO2		3											1	1
CO3				3									1	1
CO4				3									1	1

High-3; Medium-2; Low-1

Text Book(s):

T1. Professional Linux Kernel Architecture" by Wolfgang Mauerer, First Edition, Wrox, 2008.

T2. Linux Device Drivers Development" by John Madieu, First Edition, Packt Publishing, 2017.

Reference Book(s):

R1.Michael beck, Harald bohme, Mirko dziadzka, Ulrich Kunitz & quot;Linux Kernel Programming & quot, Pearson Education, Reprint 2009.

R2.Raghavan P., Amol Lad, Sriram Neelakandan “Embedded Linux System Design and Development”, Tailor & Francis Group, reprint 2019

R3.Daniel P.Bovet, Marco Cesati “Understanding the Linux kernel”, Shroff publishers & distributors Pvt Ltd, 2019,

R4. Robert Love “LINUX System Programming” Shroff publishers & distributors Pvt Ltd, 2013.

R5.Tim jones M. “GNU/Linux Application Programming”, Wiley Dreamtech India Pvt. Ltd, New Delhi, 2008.

Web References:

1. Operating Systems: https://archive.nptel.ac.in/courses/106/108/106108101/
2. Operating Systems: https://archive.nptel.ac.in/courses/106/102/106102132/

Course Code: 23EEE074		**Course Title: IoT for Smart Systems**	
Course Category: Major		**Course Level: Advanced/Higher**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course introduces IoT technologies, infrastructure, processors for IoT, sensors and communication techniques, and various IoT platforms, offering comprehensive insights into IoT for smart systems and real-time applications.

Module I **22 Hours**

Introduction to Internet of Things:

Overview, Hardware and software requirements for IoT, Sensor and actuators ,Technology drivers , Business drivers, Typical IoT applications , Trends and implications.

IoT Architecture:

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture , IoT standards, Cloud computing for IoT

IoT Protocols:

MQTT, CoAP, Bluetooth and BLE, LoRA and LORAWAN, Zig bee, WiFi -Recent trends.

Module II **23 Hours**

Embedded processors for IoT

Introduction to Python programming - Building IoT with Rasperry pi / Arduino - Implementation of IoT- Collect data from the edge devices to gateway using local network, Send the data to a server, Control the device from a server – Security.

Case Studies -Industrial IoT - Home Automation - Smart cities - Smart Grid - Connected vehicles - Patient Monitoring in Health Care – Agriculture - Productivity Applications - IoT Defense.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply the concepts of IoT and its recent developments to address real-world challenges in system design.	Apply
CO2: Analyze various IoT platforms and infrastructures to determine their suitability for specific applications.	Analyze
CO3: Design and implement embedded processor-based IoT solutions tailored for real-world scenarios.	Apply
CO4: Evaluate IoT solutions for smart applications by assessing their performance, scalability, and impact on efficiency.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	1
CO2		3											1	1
CO3			3										1	1
CO4				3									1	1

High-3; Medium-2; Low-1

Textbooks:

T1.Arshdeep Bahga and Vijai Madisetti:A Hands-on Approach “Internet of Things”, Universities Press 2015.

T2.Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.

T3.Adrian McEwen and Hakim Cassimally “Designing the Internet of Things “Wiley, 2014.

Reference Book(s):

R1.Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.

R2.Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2014.

R3.Lingyang Song/Dusit Niyato/ Zhu Han/ Ekram Hossain,” Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.

R4.OvidiuVermesan and Peter Friess (Editors), “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers Series in Communication, 2013.

Web References:

1.Introduction to Internet of Things: https://onlinecourses.nptel.ac.in/noc21_cs17/preview

2.Design for Internet of Things: https://archive.nptel.ac.in/courses/108/108/108108179/

3.Embedded Systems: https://archive.nptel.ac.in/courses/106/105/106105166/

Course Code: 23EEE075		Course Title: Embedded Control of Electric Drives	
Course Category: Major		Course Level: Advanced/Higher	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course covers functions and torque characteristics of drives, rectifier and chopper-fed DC motor drives, induction motor speed control, synchronous and BLDC motor drives, and electric drive applications, interprets the embedded control of electrical drives and explores control strategies.

Module I **22 Hours**

Electrical Drives - Driving forces and evolving technologies - Advantages and Application of electric drives - Elements of drive system - Drive characteristics - Load dynamics and steady state stability –Multi quadrant operation - Electric motors for drives - Power electronic converters for drives - Modern trends in industrial drives and control - Evaluation of microcontrollers for motor control

Dc Motor Drives: Introduction to DC - motor drives - Speed control of DC motor drive with controlled rectifiers and choppers of DC drives - Embedded controller based implementation of DC drives - Converter structure - Modes of operation - Control algorithm

Induction Motor Drives: Induction Motor Drives: PWM inverter fed induction motor drives - Vector control - Open loop and Closed loop PWM control - Sensor less IM drives: a study - Embedded controller based speed control implementation for IM drive - Control algorithm of speed measurement during high speed/low speed regions – Development of closed loop control block

Module II **23 Hours**

Synchronous Motor Drive: Open loop VSI fed drive and its characteristics - Self-control - Torque control - Torque angle control - Maximum Torque per Ampere control - Power factor control - Field oriented control - Design of closed loop operation of Synchronous motor drive systems. PM Synchronous Motor Drives: Types and Torque developed in PMSM - Stationary and rotor reference frame modeling of PMSM - PMSM control system - Development of speed control algorithm for Synchronous motor drive using Embedded controllers.

Special Machines Drives

Switched Reluctance Motor drive: Fundamentals and control of SRM drives - Open loop and Closed loop torque and speed control. Brushless DC Motor Drives: Principals of operation - Torque generation - Open loop and Closed control of BLDC drive.Stepper Motor Drives: Types and basic operation - Development of speed control algorithm for Special Electrical Machines drive using Embedded controllers.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Apply the principles of electric drives and load dynamics to design suitable drive systems for various industrial applications.	Apply
CO2: Analyze the performance and control strategies of DC and induction motor drives to optimize speed and torque control in different operating modes.	Analyze
CO3: Design advanced embedded controller-based control systems for synchronous and special machine drives, ensuring effective torque and speed control under various conditions.	Apply
CO4: Evaluate the efficiency and performance of modern drive systems, including special electrical machines, using embedded controllers for optimized speed and torque regulation.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	1
CO2		3											1	1
CO3			3										1	1
CO4				3									1	1

High-3; Medium-2; Low-1

Textbooks:

T1. Bose B K, "Modern Power Electronics and AC Drives", Pearson Education Pvt. Ltd, New Delhi, 2014.

T2. Vedam Subramaniam, "Electrical Drives and Applications", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2010.

T3. G.K.Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2nd Edition, 2002.

Reference Book(s):

R1. Ion Boldea and Nasar S A, "Electric Drives", CRC Press LLC, New York, 2008.

R2. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC Motor Drives", CRC Press, Taylor & Francis Group, 2010.

Web References:

1. https://archive.nptel.ac.in/courses/108/104/108104140/
2. https://www.embedded.com/mcus-or-dsps-which-is-in-motor-control/

Course Code: 23EEE076		Course Title: FPGA based System Design	
Course Category: Major		**Course Level: Advanced/Higher**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives: The course explores the advanced design and analysis of digital circuits with HDL. The course enables students to apply their knowledge for the design of advanced digital hardware systems with help of FPGA tools.

Module I **22 Hours**

Verilog HDL Coding Style: Lexical Conventions - Ports and Modules – Operators - Gate Level Modeling - System Tasks &Compiler Directives - Test Bench - Data Flow Modeling - Behavioral level Modeling -Tasks & Functions.

Overview of FPGA Architectures and Technologies: FPGA Architectural options, coarse vs fine grained, vendor specific issues (emphasis on Xilinx FPGA), Antifuse, SRAM and EPROM based FPGAs, FPGA logic cells, interconnection network and I/O Pad.

Module II **23 Hours**

Verilog Modelling of Combinational and Sequential Circuits: Behavioral, Data Flow and Structural Realization – Adders – Multipliers- Comparators - Flip Flops - Realization of Shift Register - Realization of a Counter- Synchronous and Asynchronous FIFO –Single port and Dual port RAM – Pseudo Random LFSR – Cyclic Redundancy Check.

Synchronous Sequential Circuit: State diagram-state table –state assignment-choice of flip-flops – Timing diagram –One hot encoding Mealy and Moore state machines – Design of serial adder using Mealy and Moore state machines - State minimization – Sequence detection-Design examples: Sequence detector, Serial adder, Vending machine using One Hot Controller.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Design and model digital circuits with Verilog HDL at behavioral, structural, and RTL Levels.	Apply
CO2: Model Combinational and sequential digital circuits by Verilog HDL and analyse the FPGA architecture needs for the application.	Analyze
CO3: Design and optimize complex combinational and sequential digital circuits.	Analyze
CO4: Implementation of the combinational and sequential digital circuits in FPGA.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	1
CO2		3											1	1
CO3		3											1	1
CO4	3				1								1	1

High-3; Medium-2; Low-1

Textbooks:

T1. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis" Prentice Hall, Second Edition, 2003
T2. W. Wolf, "FPGA based system design", Pearson, 2004.

Reference Book(s):

R1. Stephen Brown & Zvonko Vranesic, "Digital Logic Design with Verilog HDL" TATA McGraw Hill Ltd. 2nd Edition 2007.
R2. Peter Ashenden, "Digital Design using Verilog", Elsevier, 2007.

Web References:

1. https://onlinecourses.nptel.ac.in/noc23_ee29/preview
2. https://archive.nptel.ac.in/courses/117/108/117108040/
3. https://www.udemy.com/course/digital-system-design-with-vhdl-and-verilog/
4. https://www.coursera.org/learn/intro-fpga-design-embedded-systems
5. https://www.coursera.org/learn/fpga-hardware-description-languages

Course Code: 23EEE077		Course Title: Embedded Sensing, Actuation and Interfacing Systems	
Course Category: Major		Course Level: Advanced/Higher	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives: The course explores the technical skills to integrate various sensing, actuation units and other required accessories with embedded controller and build a complete modern embedded control system for intended applications.

Module I **23 Hours**

Embedded Sensors and Actuators: Overview of embedded system; Importance of sensors, actuators and interfacing circuits in Embedded Sensors and Actuators - Various types of important sensors, actuators and their working principles: e.g., thermal, mechanical, electrical, magnetic, optical, smart material and meta material based.

Interfacing Aspects and Communication Protocols: Signal conditioning circuits; Op-Amp based interfacing circuit implementation; Various Serial Communication protocols for interfacing. Resistive sensor examples; non-idealities in basic interfacing circuits; Linearization techniques; Error reduction schemes due to environmental effects and remote communication.

Module II **22 Hours**

Advanced passive sensors interfacing: Embedded controller based excitation system; Direct interfacing schemes of various resistive sensors topologies to microcontrollers; Interfacing scheme for sensor array. Capacitive sensor examples; Interfacing scheme for different capacitive sensor configurations; Direct interfacing schemes. Lossy Capacitive sensor characteristics; Various advanced interfacing schemes for lossy capacitive sensor

Miniaturized Smart Sensors and Actuators: Miniaturized device fabrication technology; Various types of important MEMS sensors and actuators, their design and operation; Integration techniques; System-On-Chip integration for various MEMS sensors and actuators; Applications in Renewable Energy Harvesters.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply the principles of embedded systems to implement and interface sensors, actuators, and signal conditioning circuits for various applications.	Apply
CO2: Analyze communication protocols and interfacing techniques for resistive and capacitive sensors to address non-idealities and environmental effects.	Analyze
CO3: Design embedded controller-based systems for advanced sensor configurations, including lossy capacitive sensors and sensor arrays, to optimize performance.	Apply
CO4: Evaluate the integration of MEMS-based miniaturized smart sensors and actuators in System-On-Chip designs for innovative applications such as renewable energy harvesters.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	1
CO2		3											1	1
CO3			3										1	1
CO4				3									1	1

High-3; Medium-2; Low-1

Textbooks:

T1. Nathan Ida, 'Sensors, Actuators, and their Interfaces', First Edition, SciTech Publishing, 2014.

T2. Marc Madou, 'Fundamentals of Micro fabrication and Nanotechnology', CRC press, Third Edition, 2018.

Reference Book(s):

R1. Stuart R. Ball, 'Analog Interfacing to Embedded Microprocessor Systems', Elsevier, 2004.

R2. B. George, J. Roy, V. Jagadeesh Kumar, S. C. Mukhopadhyay, 'Advanced Interfacing Techniques for Sensors', First Edition, Springer, 2017.

Web References:

1. https://onlinecourses.nptel.ac.in/noc24_ee68/
2. https://www.udemy.com/course/mastering-microcontroller-with-peripheral-driver-development/
3. https://www.smeclabs.com/embedded-system-online-training-courses-vlsi-online-training-courses/
4. https://lp.emertxe.com/lp/online-embedded-courses/

Diversified Electives

Course Code: 23EEE080		**Course Title: Renewable Energy Systems**	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

To give exposure to the students about the concepts of the solar energy conversion system, wind energy conversion system, the energy conversion process of biomass and biogas, ocean thermal, geo thermal, hydel energy and new energy sources like hydrogen and fuel cell.

Module I **22 Hours**

Solar Energy: Solar radiation - its measurements - solar thermal flat plate collectors, concentrating collectors – Applications: hydrogen production, cooking. Principle of photovoltaic conversion of solar energy- conversion efficiency and power output- solar cell module - Applications: battery charger, domestic lighting, street lighting. Design of Solar thermal and Solar PV.

Wind Energy: Principles of wind power -Wind Energy Conversion Systems – Wind data and energy estimation- site selection characteristics - Wind Energy generators and its performance - horizontal and vertical axis types - Wind Energy Storage – Applications – Hybrid systems-safety and environmental aspects.

Module II **23 Hours**

Bio-Energy: Principles of Bio-Energy – biomass conversion: Wet and dry process – Photosynthesis – Biogas Generation- factors affecting gas generation – Classification of biogas plants – Biogas from plant wastes- Urban waste to energy conversion – thermal gasification – Pyrolysis.

Ocean Thermal Energy Conversion, Tidal, Geothermal and Hydel Energy: Ocean energy resources - principles of ocean thermal energy conversion systems - ocean thermal power plants –Tidal power: Principals and components –Geothermal energy: Introduction, sources and environmental issues - Small hydroelectric: Development, Classification, limitations and advantages - Turbines and generators for hydroelectric power generation.

New Energy Sources: Hydrogen: Production, storage, transport and utilization–Safety and management- Applications - Fuel cell: Classification, fuels for fuel cells, efficiency, V-I characteristics, Fuel cell power plant, Environmental effects- Design of Co-Gen, Design of Tri-Gen-Introduction to Microgrid.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Apply the principles of solar and wind energy systems to select appropriate renewable energy solutions for power generation applications.	Apply
CO 2: Apply the principles of bio-energy and biomass conversion processes to design and maintain biogas systems for energy generation from organic and urban waste.	Apply
CO 3: Select the renewable sources like ocean thermal, geo thermal, hydel energy, hydrogen and fuel cell by applying their principles.	Apply
CO 4: Analyze real-world case studies to compare and determine the most suitable renewable energy solutions for specific application scenarios.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3													
CO3	3													
CO4			3			1	1					1	1	1

High-3; Medium-2; Low-1

Textbooks:

T1. G.D Rai, "Non-conventional Energy Sources", Khanna Publications, New Delhi, 5th Edition, 2016.

T2. B.H.Khan, “Nonconventional Energy Resources”, Tata McGraw Hill, 1st Edition, 2006.

Reference Book(s):

R1. Kreith, F and Kreider, J. F.,” Principles of Solar Engineering”, McGraw-Hill, 2nd Edition 2000.

R2. Godfrey Boyle, “Renewable Energy: Power for a Sustainable Future”, Oxford University Press, 3rd Edition, 2012.

R3. Sukhatme, S.P., “Solar Energy”, Tata McGraw Hill, 3rd Edition, 2009

R4. Hart, A.B., and Womack, G. J., “Fuel Cells: Theory & Applications”, Prentice Hall,1997

Web References:

1. http://www.pveducation.org/
2. https://www.britannica.com/technology/solar-cell
3. https://www.renewableenergyhub.co.uk/main/wind-turbines/

Course Code: 23EEE081		**Course Title: Electrical Energy Utilization and Conservation**	
Course Category: Major		**Course Level: Advanced/Higher**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course aims to provide a comprehensive understanding of the need for traction system and energy saving concept by different ways of illumination. It additional applications methods of electric heating and electric welding. Moreover, the course introduce knowledge on power factor improvement, tariff and concepts of energy audit.

Module I **22 Hours**

Electric Traction: Requirements of traction system - Systems of traction - Systems of track electrification - Speed-Time curves - Tractive effort - Power of traction motor - Specific energy consumption Block Diagram of Modern Locomotive Main and Auxiliary Power supply circuits Current Collection Systems -Motors for traction - Starting and speed control - Electric braking.

Electric heating: Merits, types: Resistance, Induction, Dielectric- Temperature control – induction furnace - Choice of voltage and frequencies for Dielectric heating. Welding: types Resistance, Arc, Laser, Ultrasonic.

Illumination: Nature of light - Luminous intensity - Illumination - Brightness - Lamp efficiency – Luminous efficiency - Laws of illumination. BEE standards

Module II **23 Hours**

Economic Aspects of Utilization: Time-of-use - Demand Side Management Peak clipping Peak shifting valley filling - Use of off-peak energy.

Energy Management & Audit: Definition, Energy audit- need, Types of energy audit, - Energy management (audit) approach standards - understanding energy costs, Bench marking, Energy performance, matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments. Overview of energy conservation practices-Star Rating.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Analyze various electric traction systems, their components, and operational characteristics for effective transportation and power utilization.	Analyze
CO2: Demonstrate knowledge of electric heating, welding, and illumination technologies with emphasis on efficiency, application, and safety standards.	Apply
CO3: Analyze the characteristics and applications of various electrical light sources and design indoor and outdoor lighting systems.	Analyze
CO4: Evaluate energy utilization patterns and apply principles of energy management and auditing for effective energy conservation and cost reduction.	Analyze
CO5: Undertake a case study-based mini project to analyze, design, and propose improvements for an electrical system related to traction, heating, lighting, or energy management, demonstrating the integration of theoretical knowledge with real-world energy efficiency practices and BEE	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3												
CO2	3							1						
CO3		3												
CO4		3												
CO5				3		1	1		1	1			1	

High-3; Medium-2; Low-1

Textbooks:

T1. Uppal S.L, Rao.S" Electrical Power System", Khanna Publishers, New Delhi,15thEdition, 2009.

T2. F.Kerith,D.YGoswami, “Energy Management and Conservation Handbook”, CRC Press, 2008.

Reference Book(s):

R1. Taylor E.O. and VVL Rao, “Utilization of Electric Energy”, Orient Longman, New Delhi,3rd Edition,2007.

R2. Suryanarayanan, N.V., Utilization of Electric Power Including Electric Drives and Electric Traction New Age International Publishers, New Delhi,2nd Edition 2014.

R3. Abbi Y P, Shashank Jain, “Handbook on Energy Audit and Environment Management”, Teri Press, New Delhi, 2006.

R4. Wadhwa C L, “Generation, Distribution and Utilization of Electrical Energy” ,New Age International Publishers, New Delhi, 4th Edition, 2012.

Web References:

1. https://nptel.ac.in/courses/108/104/108104140/
2. http://cleenet.org/index.php/en/online-courses/modul-2/126-energy-auditing-and-energyefficiency-measures
3. https://beeindia.gov.in/

Course Code: 23EEE083		Course Title: Digital Control on Switched Mode Power Supplies	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 2:0:2	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course is intended to equip students with the fundamental knowledge and practical skills required to design and implement digital control systems for switched mode power converters (SMPCs).

Module I **15 Hours**

Introduction and Control Techniques: Introduction to digital control in SMPCs and its advantages - Overview of digital control implementation platforms (microcontrollers, FPGAs) - Feedback and Feedforward control methods in SMPCs - Fixed vs. Variable Frequency Modulation Techniques - Levels of Digitization in Single-loop and Multi-loop Feedback Control - Introduction to Digital Pulse Width Modulation (DPWM) - Voltage and Current Mode principles

Modeling and Design Foundations: Continuous-Time vs. Discrete-Time Modeling Concepts - Deriving Simplified Discrete-Time Models - Importance of Model Validation using Simulation Tools - Frequency Domain Analysis for Control Design.

Module II **15 Hours**

Design Considerations and Implementation Techniques: Selection of Sampling Frequency and its Impact on System Performance - Stability Analysis Techniques for Digital Control Systems - Introduction to Loop Shaping Techniques for Digital Control Design - Introduction to Hardware Description Languages for Digital Control - Fixed-point Arithmetic for Embedded Control Systems.

Case Studies and Advancements: Introduction to Digital Current Mode Control Design Techniques - Introduction to Multi-Mode Digital Control Techniques for Efficiency Optimization - Industry Perspective on Digital Control Implementation in Power Converters.

List of Experiments **15 Hours**

1. Development of MATLAB model for digital Controller using difference equations
2. Generation of different PWM signals using Code generation tools
3. Generation of Constant ON/OFF time control using FPGA/DSP Controllers
4. Simulation of Digital Voltage Mode Controller for Buck Converter using MATLAB/SIMULINK
5. Development of MATLAB model for Constant ON/OFF time control for DC-DC converters
6. Development of MATLAB model for Digital Current Hysteresis Control

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply knowledge of voltage and current mode control, and levels of digitization to design single-loop and multi-loop controllers for SMPC systems.	Apply
CO2: Apply the concepts of continuous and discrete modeling to construct simplified discrete-time models and analyze them in the frequency domain for control applications.	Apply
CO3: Analyze stability, and loop shaping techniques to develop and implement digital controllers using hardware description languages and fixed-point arithmetic for embedded applications.	Analyze
CO5: Design and develop digital controllers for DC-DC converters by applying difference equations, generating PWM signals, and using simulation and embedded tools for voltage and current mode control.	Apply

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2				3										1
CO3		3											1	
CO4				3								1		1

Text Book(s):

T1. Ned Mohan Tore M. Undel and, Power Electronics: Converters, Applications, and Design,3rd Edition, John Wiley & Sons, 2007.

T2. Abraham I. Pressman, Switching Power Supply Design, McGraw Hill International, 3 rd Edition, 2009.

T3. Philip T Krein, Elements of Power Electronicsǁ, 2 nd Edition, Oxford Press, 2014.

Reference Book(s):

R1. S. Kapat and P. T. Krein, ""A Tutorial and Review Discussion of Modulation, Control and Tuning of High- Performance DC-DC Converters based on Small-Signal and Large-Signal Approaches"" IEEE Open Journal of Power Electronics , vol. 1, pp. 339 - 371, Aug. 2020.

R2. R. W. Erickson and D. Maksimovic, Fundamentals of Power Electronics, 3rd Ed., Springer, 2020.

Web References:

1. https://archive.nptel.ac.in/courses/108/105/108105186/

Course Code: 23EEE083		Course Title: Protection and Switchgear	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives: The course aims to explain protection schemes, relay types and settings, and various protection methods for alternators, transformers, motors, and lines, along with different types of circuit breakers.

Module I **23 Hours**

Principles and need for protective schemes - Nature and cause of faults - Types of fault - Power system earthing - Zones of protection and essential qualities of protection - Current limiting reactors - CTs and PTs and their applications in protection schemes. Surge: Switching surges - Lightning phenomenon - Protections against lightning - Lightning arresters – Types: Rod arrester, Horn gap arrester, Multi gap arrester, Expulsion type lightning arrester, valve type lightning arrester - Surge absorbers.

Definition - Requirement of relays - Relay torque equation - Non directional and directional over current relays - Earth fault relays - Distance relays: Impedance, Mho and Reactance relays - Differential relays - Negative sequence relays - Under frequency relays - Introduction to static relays - Microprocessor and computer based protective relaying.

Alternator: modified scheme of differentia relay, circulating current protection scheme, balanced earth fault protection.

Module II **22 Hours**

Transformer: differential protection, balanced earth fault protection, buchholz’s relay.

Bus bar: frame leakage protection, circulating current protection Motor protection: short circuit protection, stalling protection- Feeder Protection: Pilot (Translay) relay, Power line carrier communication, Carrier and Microwave pilot relays.

Circuit Breakers and Arc Interruption: Functions of switchgear - Elementary principles of arc extinction - Arc control devices - Recovery voltage and restriking voltage - Current chopping and capacitance current breaking - Air blast, and Sulphur hexafluoride(SF6) and Vacuum circuit breakers - HVDC breakers – Rating - Testing of circuit breakers.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO 1: Apply the principles and need for protective schemes, nature and types of faults, power system earthing, and the role of CTs, PTs, and reactors in protection.	Apply
CO2: Apply suitable lightning arresters and surge absorbers to protect power systems from switching and lightning surges.	Apply
CO3: Analyze and Identify appropriate protection methods for transmission lines, transformers, bus bars, motors, and feeders using relevant relays and communication- based protection systems.	Analyze
CO4: Apply the principles of arc extinction and select suitable switchgear and circuit breakers, including HVDC breakers, for various power system applications.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3													
CO3		3												
CO4				2		1	1		1	1			1	

High-3; Medium-2; Low-1

Textbooks:

T1. Soni M L, Gupta P V, Bhatnagar U S and Chakrabarti A, "A Text Book on Power Systems Engineering", DhanpatRai& Co Ltd., Delhi, 2013.

T2. K.Mehta, Rohit Mehta," Principles of Power System", Fourth Edition, S Chand & Co Ltd, 2011.

Reference Book(s):

R1. Badri Ram, Vishwakarma D N, "Power System Protection and Switch Gear", Tata McGraw Hill Education Private Limited, New Delhi, 2011.

R2. Wadhwa, C.L., "Electrical Power Systems‟, Sixth Edition, New age International, 2014.

R3. Ravindranath B and Chander M, "Power System Protection and Switchgear", New Age International Ltd., New Delhi, 2011.

Web References:

1. http://www.accessengineeringlibrary.com/
2. http://www.nptel.ac.in/downloads/108101039/
3. http://nptel.ac.in/courses/Webcourse-contents/IIT%20Bombay
4. https://onlinecourses.nptel.ac.in/noc20_ee80

Course Code: 23EEE084	Course Title: Hardware Description Language		
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week): 3: 0: 0	Credits: 3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course equip learners with a comprehensive understanding of computer-aided digital design using Hardware Description Languages (HDLs), focusing on design methodologies, simulation components, and Verilog-based modelling techniques.

Module I **23 Hours**

Evolution of Computer-Aided Digital Design- Emergence of HDLs- Typical Design low-Importance of HDLs-Popularity of HDL- Trends in HDLs. Top-down and bottom-up design methodology -Modules –Instances- Components of a simulation- Design block, Stimulus block

Basic Concepts: Lexical conventions-data types- system tasks- compiler directives. Modules and Ports Module: Definition- port declaration- connecting ports-hierarchical name referencing.

Gate-Level modelling: Modelling using basic Verilog gate primitive- description of and/or and buf/not type gates- rise, fall and turn-off delays- min, max, and typical delays.

Module 2 **22 Hours**

Dataflow modelling: Continuous assignments-delay specification-expressions- operators-operands-operator types.

Structured procedures-initial and always- blocking and non-blocking statements - delay control- generate statement - event control - conditional statements - Multiway branching – loops - sequential and parallel blocks

Differences between tasks and functions, declaration, invocation, automatic tasks and

Functions, Procedural continuous assignments, overriding parameters, conditional compilation and Execution, useful system tasks.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Implement the Basic concepts of digital circuits using Verilog programming	Apply
CO2: Examine Gate Level, Data flow modelling and structural modelling for different types of digital circuits	Analyze
CO3: Apply structured procedural constructs in Verilog, including tasks, functions, control statements, and system tasks, to develop efficient and scalable digital designs.	Apply
CO4: Analyze suitable modelling techniques based on the real time application by doing a mini project using a suitable software and hardware tool.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2		3												
CO3	3													
CO4				3	1								1	

High-3; Medium-2;Low-1

Text Book(s):

T1. Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis”, Pearson Education, 2nd Edition 2003

T2. Kevin Skahill, “VHDL for Programmable Logic”, PHI/Pearson education, 2006.

Reference Book(s):

R1. Donald E. Thomas, Philip R. Moorby, “The Verilog Hardware Description Language”, Springer Science,Business Media, LLC,1996

R2. Michael D. Ciletti, “Advanced Digital Design with the Verilog HDL” Pearson (Prentice Hall), 2nd Edition.2011

R3. Padmanabhan, Tripura Sundari, “Design through Verilog HDL”, Wiley, 2016

Web References:

1. https://nptel.ac.in/courses/106/105/106105165/
2. https://onlinecourses.nptel.ac.in/noc20_cs63
3. https://archive.nptel.ac.in/noc/courses/noc21/SEM2/noc21-cs60

Course Code: 23EEE085		Course Title: Automotive Electronics	
Course Category: Major		**Course Level: Higher/Advanced**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives: The learners will be able to develop foundational knowledge of mechanical and electronic systems in modern automobiles. Additionally, the course focus on the role and implementation of embedded systems and X-by-wire technologies in automotive applications.

Module I **22 Hours**

Automotive Mechanical Systems: Overview of vehicle systems including the powertrain (air, fuel, ignition, exhaust and cooling, transmission types, braking systems, and steering mechanisms.

Electronics in Automotive Systems: Role of electronics in enhancing performance, control and compliance with legislation. Introduction to chassis subsystems (ABS, TCS, ESP), and comfort/safety features (airbags, seatbelt tensioners, cruise control).

Module II **23 Hours**

Drive-By-Wire Technologies: X-by-wire technologies: Steer-by-wire, brake-by-wire, shift-by-wire, and future trends.

Embedded Systems and EV Introduction: Sensor and actuator systems in gasoline/diesel engines (NOx, knock, MAP, oxygen, throttle position), thermal actuators, and body electronics (central locking, climate control). Introduction to electric vehicle classifications.

Vehicle Communication Protocols: Overview of SPI, I2C and automotive-specific protocols including CAN, LIN and MOST. Introduction to AUTOSAR framework for standardization and Ethernet.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Identify the key components and functions of automotive mechanical systems such as powertrain, transmission, braking, and steering, safety,	Apply
CO2: Apply the role of electronic systems in enhancing vehicle performance, safety features, and regulatory compliance.	Apply
CO3: Examine the working principles of X-by-wire technologies and apply knowledge of sensors and actuators in automotive embedded system design.	Apply
CO4: Apply standard in-vehicle communication protocols to develop basic automotive communication systems and demonstrate the use of AUTOSAR for system integration.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2	3												1	
CO3	3												1	
CO4	3								1	1			1	

High-3; Medium-2; Low-1

Textbooks:

T1. Robert Bosch GmbH, "Bosch Automotive Handbook", 10th Edition, Wiley Publishers, 2019.

T2. William B. Ribbens, “Understanding Automotive Electronics”, 7th Edition, SAMS/Elsevier Publishing, 2012

Reference Book(s):

R1. Robert Bosch Gmbh, Automotive Electrics and Automotive Electronics, Systems and Components, Networking and Hybrid drive, 5th edition, Springer Vieweg, Wiesbaden 2014

R2. Knowles.D, Automotive Electronic and Computer Controlled Ignition Systems, Reston Pub Co,1990 R3. Denton.T , Automobile Electrical and Electronic Systems: Automotive Technology: Vehicle Maintenance and Repair, 2012

R4. Joerg Schaeuffele, Thomas Zurawka – Automotive Software Engineering – Principles, Processes, Methods and Tools, SAE, 2016

Web References:

1. www.austincc.edu/autotech
2. https://acconline.austincc.edu/webapps/portal/frameset.jsp

Course Code:23EEE086		Course Title: Machine Learning Techniques	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The objective of this course is to provide a comprehensive understanding of various machine learning algorithms, with a focus on both supervised and unsupervised learning techniques.

Module I **23 Hours**

Introduction: Introduction to Data Science, AI, ML and Deep Learning concepts-Paradigms of Machine Learning-Examples-Types of Learning-Types of Supervised Learning-Conditional Probability-Bayes Theorem-Continuous Probability.

Regression: Introduction- Linear Regression-iterative Solution-Gradient Descent-Taylor Series

Classification: Binary Classification-Multiclass Classification-Confusion Matrix-K-Nearest Neighbour Classification-Distance Metric and Cross Validation-Computation Efficiency of KNN-Logistic Regression

Module 2 **22 Hours**

Decision Trees: Introduction-Level Splitting- Measure of Impurity-Entropy and Information gain-Simple problems.

Artificial Neural Networks: Introduction-Activation Functions-Linearly separable - Perceptron Learning Rule - Multilayer neural networks.

Support Vector Machines: Introduction-Optimizing weights-Handling outliers-Kernel formation.

Ensemble Learning: Introduction-Bagging-Boosting-Ada algorithm

Unsupervised Learning: K means Clustering- Dimensionality Reduction- Principal Components Analysis- Linear Discriminant Analysis

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Apply regression algorithms to model the relationships between variables.	Apply
CO2: Evaluate the classification performance of K-Nearest Neighbours and logistic regression models using appropriate metrics and validation methods.	Analyze
CO3: Apply decision tree algorithms , perceptron and multilayer neural networks for solving classification tasks	Apply
CO4: Evaluate support vector machines in terms of margin maximization and kernel optimization for classification tasks.	Analyze
CO5: Apply clustering and dimensionality reduction techniques like K-means and PCA for unsupervised data analysis.	Apply
CO6: Demonstrate an ability to engage in independent learning of advanced machine learning techniques beyond the syllabus.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2		3												
CO3	3													
CO4		3												
CO5	3													
CO6	3											1	1	1

Text Book(s)

T1. Stephen Marsland, "Machine Learning – An Algorithmic Perspective" 2nd Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.

T2. Tom M Mitchell, "Machine Learning",1st Edition, McGraw Hill Education,2017

Reference Book(s)

R1. Anuradha Srinivasaraghavan, Vincy Joseph,"Machine Learning", 1st Edition, Wiley,2019.

R2. Peter Flach,"Machine Learning: The Art and Science of Algorithms that Make Sense of Data ", 1st Edition, Cambridge University Press, 2012.

Web References:

1. https://onlinecourses.nptel.ac.in/noc22_cs58/preview
2. https://onlinecourses.nptel.ac.in/noc23_cs18/preview

Course Code: 23EEE087		Course Title: Steering and Control System For Electrical Engineers	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

To impart knowledge on steering systems, sensors, actuators, motor control, embedded hardware, communication protocols, and project management for designing automotive steering control systems.

Module I **22 Hours**

Materials and Manufacturing

Introduction to Steering Systems: Types of steering systems - Mechanical and power assisted steering systems - Materials for steering system - Material Properties- rubber, plastics and polymer.

Manufacturing method for PCB, PCB routing - PCB gerber file generation - PCB single layer design - basic power supply design, Surface Mount Technology (SMT).

Sensors and actuators

Sensors used for steering system- Steering Angle Sensor (SAS)-Torque and Effort Sensors-Yaw Rate and Lateral Acceleration Sensors- Vehicle and Wheel Speed Sensors-Position Sensors (Optical, Magnetic, and Contactless) - LIDAR, RADAR, Camera. -actuators for automotive steering system.

Module II **23 Hours**

Motor

Working and characteristics- Brushed DC machine, Brushless DC machine, PMSM machine -, Feed control of motors, Speed control and testing of DC Machines- Motor Placement in Steering Systems- buck, boost, buck-boost converters, MOSFET, IGBT for switching application

Networks and Converter

Analog to Digital Converter (ADC) - Digital to Analog converter (DAC)- Interfacing Introduction to communication, Networks and Topology, Protocols and Standards- CAN, Network models-Layered tasks.

Microcontroller

Architecture of Microcontroller, Automotive microcontrollers - Renasas, Infenion, Hella, Bosch, Microcontroller datasheet, Electronic control unit for steering system – open source ECU. Project Management – Overview, PERT and CPM chart. (Delivery through Guest

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO 1: Apply knowledge of steering system types and materials to design suitable mechanical or power-assisted steering components.	Apply
CO2: Develop and simulate PCB layouts and basic power supply circuits using appropriate manufacturing methods and surface-mount	Apply
CO3: Analyze the characteristics and control methods of DC and PMSM motors for effective integration in automotive steering systems.	Analyze
CO4: Examine the role of sensors, actuators, microcontrollers, and communication networks in electronic steering systems to evaluate system performance and reliability.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2	3				2								1	
CO3		3											1	
CO4		3			2								1	

High-3; Medium-2; Low-1

Textbooks:

T1. William Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Pearson Education, 7th Edition, 2021.
T2. Robert Bosch GmbH, Automotive Handbook, Bentley Publishers, 10th Edition, 2018.

Reference Book(s):

R1. Marilyn Wolf, Computers as Components: Principles of Embedded Computer Systems Design, Morgan Kaufman Publishers, 2019.
R2. Behrouz A. Forouzan, Data Communications and Networking, McGraw Hill Education, 5th Edition, 2017.
R3. Muhammad Ali Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson Education, 2nd Edition, 2007
R4. William Ribbens, Understanding Automotive Electronics, Butterworth-Heinemann, 7th Edition, 2012.

Web References:

1. https://onlinecourses.nptel.ac.in/noc20_ee42
2. https://onlinecourses.nptel.ac.in/noc21_ee32

Course Code: 23EEE088		Course Title: Special Electrical Machines	
Course Category: Major		Course Level: Higher/Advanced	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives: The course is intended to impart knowledge on the stepper motor, switched reluctance motor, servo motor, permanent magnet motors, and commutator motors on their constructional details, characteristics, and control mechanism to utilize the machine for the suitable application.

Module I **22 Hours**

Stepper Motors: Constructional features –Principle of operation –Types – Torque predictions – Linear and Non-linear analysis – Characteristics – Drive circuits – Closed loop control – Applications.

Switched Reluctance Motors: Construction – Principle of working – Torque Equation – Power controllers: Two switching devices per phase, C-Dump and Split link – Microprocessor based control –- Sensor less operation of SRM – Current sensing-rotor position measurement and estimation methods.

Servo motors: Construction, Operation, Classifications, Characteristics, Control and applications.

Module II **23 Hours**

Permanent Magnet Brushless DC Motor: Permanent Magnet materials – Magnetic Characteristics - Principle of operation – Types– Torque equations – Power controllers – Motor characteristics - DSP based control - Applications.

Permanent Magnet Synchronous Motors: Principle of operation – EMF and torque equations –Phasor diagram – Converter Volt-ampere requirements – Torque speed characteristics –control methods - Applications.

Commutator motors: Construction, Principle of operation, Characteristics, Applications of Universal, repulsion motor.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Apply the principles of stepper motor operation by interfacing it with appropriate driver circuits for position and speed control applications.	Apply
CO2: Implement switched reluctance motor (SRM) systems with suitable controllers, analyzing their performance for industrial and automation applications.	Apply
CO3: Analyze the construction, operation and characteristics of permanent magnet brushless DC motors and controls of permanent magnet synchronous motors..	Analyze
CO5: Make use of the operation, performance, control of servo and commutator motors and report the case study selecting a suitable real world application.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												1	
CO2	3												1	
CO3		3											1	
CO4	3						1	1	1	1			1	

High-3; Medium-2; Low-1

Textbooks:

T1. E. G. Janardanan, Special Electrical Machines‘ PHI Learning Pvt. Ltd, 2014.

T2. Bilgin, Berker Emadi, Ali Jiang, James Weisheng - Switched reluctance motor drives: fundamentals to applications-CRC 2019.

T3. K. Venkataratnam, Special Electrical Machines ‘, Universities Press (India) Private Limited, 2008.

Reference Book(s):

R1. T. Kenjo, Stepping Motors and Their Microprocessor Controls ‘, Clarendon Press London,1995.

R2. Sen. P. C Principles of Electrical Machines and Power Electronics ‘, John Willey& Sons,2008

R3. T. J. E. Miller, Brushless Permanent Magnet and Reluctance Motor Drives‘, Clarendon Press, 1989.

Web References:

1. https://nptel.ac.in/courses/108102156
2. https://archive.nptel.ac.in/courses/108/105/108105155/
3. https://archive.nptel.ac.in/courses/108/105/108105131/

Course Code: 23ECE037		Course Title: Java Programming (Common to EA,EC,EE)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week):3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on the principles of Object Oriented Programming using Java. The course intends to provide in-depth knowledge on various concepts of Java programming to develop stand-alone applications.

Module I **23 Hours**

Principles of Object Oriented Programming and Java – Data types – Operators – Control flow.

Classes and Objects – Constructors – Access Specifiers – Static members – Inheritance and types – Method overloading and overriding – Nested and Inner class – Abstract classes and Abstract Methods – Final keyword.

Packages – Interfaces – Exception fundamentals and types – User defined Exceptions – Thread – Creating threads – Synchronization – Inter-thread communication.

Module II **22 Hours**

String Handling – String and String Buffer class and functions – String Tokenizer – Math and Clone functions.

Collections – Collection Interfaces: Set, Queue and List – Collection classes: LinkedList, ArrayList, HashSet and TreeSet – Java I/O classes and interfaces – Streams: DataInput/ OutputStream and Reader/ Writer – File concepts – Reading and Writing Files.

Java Swing – Layout Managers – Event Handling – Swing Components: JLabel, JButton, JTextField, JRadioButton and JTextArea.

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1:	Apply object oriented principles in programming to solve real world problems.	Apply
CO2:	Develop lifelong learning ability to provide software solutions for societal issues.	Apply
CO3:	Analyze the performance of Java programs and provide optimized sustainable solutions using advanced concepts.	Analyze
CO4:	Apply appropriate user interface components for an application.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2	-	2	-	-	-	1	-	-	-	-	-	2	-	-
CO3	-	3	-	-	-	-	1	-	-	-	-	-	-	-
CO4	-	-	2	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Herbert Schildt, "Java the Complete Reference", 12th Edition, McGraw-Hill Education, December 2022.

Reference Book(s):

R1. Cay. S. Horstmann, "Core Java – Volume 1: Fundamentals", 12th Edition, Oracle, 2021.

R2. Ken Arnold, James Gosling, David Holmes, Prakash Goteti, "The Java Programming Language", 3rd Edition, Pearson Education, 2000.

Web References:

1. Oracle, Java tutorials, URL: https://www.oracle.com/java/technologies/
2. NPTEL, Course on Programming in Java,
   URL: https://archive.nptel.ac.in/courses/106/105/106105191/
3. Core Java Tutorial, URL: https://javabeginnerstutorial.com/core-java-tutorial/

Course Code: 23ECE038		Course Title: Big Data Analytics and Cloud computing (Common to EA,EC,EE)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week):3 0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on big data and analytics and cloud computing concepts.

Module I **22 Hours**

Fundamentals of Big Data: Database Evolution – Evolution of Big data – Best Practices for Big data Analytics – Big data characteristics – Big data use cases

Understanding Big Data Storage: High Performance Architecture — HDFS —Map reduce and YARN — Map reduce Programming Model.

NoSQL Data Management for Big Data: NoSQL Databases: Schema less Models – Increasing Flexibility for Data Manipulation– Key Value Stores — Document Stores — Tabular Stores — Object Data Stores — Graph Databases– Hive — Sharding — Hbase.

Classification and Clustering: Decision Trees- Bayes Naïve Classifier- Clustering- K-means- Recommendation System

Module II **23 Hours**

Cloud Computing and Models: Cloud Computing: Cloud Types – Characteristics – Measuring Cloud Value and cloud computing cost- Cloud Architecture: Cloud Computing Stack – Cloud Services: IaaS – PaaS – SaaS – IDaaS –CaaS.

Virtualization and Architecture: Characteristics of Virtualized Environments - Taxonomy of Virtualization Techniques - Virtualization and Cloud Computing - Pros and Cons of Virtualization–Types of Virtualization: Full Virtualization and Para Virtualization - Types of Clouds.

Cloud Platforms Architecture: Data Center Design and Interconnection of networks - Architectural Design of Compute and Storage Clouds.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply Map reduce programming model to run big data applications	Apply
CO 2: Choose appropriate NoSQL databases for processing large scale data	Apply
CO 3 : Identify the architecture, infrastructure and delivery models of cloud computing	Analyze
CO 4: Apply concepts of cloud virtualization techniques to computing resources for solving real time problems	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	2	-

High-3; Medium-2;Low-1

Text Book(s):

T1. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", 2013.
T2. Barrie Sosinsky “Cloud Computing Bible”, Wiley Publishing, 2011

Reference Book(s):

R1. Tom White, “Hadoop: The Definitive Guide”, O‟Reilly Publication and Yahoo! Press, 4th Edition, 2015.

R2.Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, “Mastering Cloud Computing”, Tata McGraw-Hill,2013.

R3. Thomas Erl, Zaigham Mahood, Ricardo Puttini, “Cloud Computing, Concept, Technology & Architecture”, Prentice Hall, 2013.

Web References:

1. Hadoop complete reference URL: https://hadoop.apache.org
2. Cloud Computing,https://nptel.ac.in/courses/106105167
3. NPTEL Course content URL: https://onlinecourses.nptel.ac.in/noc20_cs92/

Course Code:23MEE008		**Course Title: PLM for Engineers (Common to all B.E/B.Tech Programmes)**	
Course Category: Minor		**Course Level: Higher**	
L:T:P (Hours/Week): 2: 0: 2	**Credits: 3**	**Total Contact Hours: 60**	**Max Marks:100**

Course Objectives:

The course is intended to apply Product Lifecycle Management (PLM) fundamentals and principles to develop strategies, manage product lifecycles, optimize engineering processes, configure Bills of Materials, and leverage digital manufacturing environments for practical applications and customer-centric use cases.

Module I **22 Hours**

Business Strategy in the PLM

Definition, PLM Lifecycle Model, Threads of PLM, Need for PLM, Opportunities and Benefits of PLM, Components and Phases of PLM, PLM feasibility Study, PLM Visioning, Strategy, Impact of strategy, Implementing a PLM strategy, PLM Initiatives to Support Corporate Objectives, Infrastructure Assessment.

Business Processes in the PLM and Product Development Concepts

Characteristics of PLM, Environment Driving PLM, PLM Elements, Drivers of PLM, Conceptualization, Design, Development, Validation, Production, Support of PLM. Engineering Vaulting, Product Reuse, Smart Parts, Engineering Change Management, Workflow Management.

Bill of Materials (E-BOM, M-BOM, S-BOM) and Process Consistency, Product Structure, Configuring BOM

Module II **23 Hours**

Digital Mock Up and Validation

Simulation Process Management, Variant Management, Digital Mock-Up and Prototype Development, Design for Environment, Virtual Testing and Validation, Marketing Collateral

Digital Manufacturing in the PLM

Digital Manufacturing, Benefits of Digital Manufacturing, Manufacturing the First-One, Ramp Up, Virtual Learning Curve, Manufacturing the Rest, Production Planning.

Customer Use Cases of the PLM

Impact and Challenges faced while implementing a successful PLM strategy -Rolls Royce, Nissan Motor, Sunseeker International , Xtrac ,kesslers international and monier and weatherford international.

List of Exercises: **15 Hours**

1. Demonstrate the 2-Tier & 4-Tier Architectures and Basic Team center applications like Organization, Project, and Schedule Manager.
2. Create CAD and Non-CAD datasets (MS Office, Notepad, etc.) by using explicit and implicit Check-In and Check-Out to create multiple iterations
3. Create the access control (Read, Write, and Delete) for the given dataset and block the access rights to other group members belongs to the same department. Also Perform the Impact Analysis (Where Used and Where Referenced) of a given dataset which is used in multiple assemblies.
4. Create the Product Structure in Structure Manager with 5 components assembled in first level and 3 components Assembled in second, third and fourth level with the sub-assemblies and export the assembly in local drive. Also, demonstrate the Variant Management.
5. Export the CAD dataset as a JT file and perform the various visualization tasks like Measurements, Sectioning, PMI, and Mark-up using JT2GO application

Course Outcomes At the end of the course students will able to	**Cognitive Level**
CO1: Apply the fundamentals of PLM principles to develop a PLM strategy for a system.	Apply
CO2: Apply PLM principles to manage product lifecycles, optimize engineering processes, and configure Bill of Materials with consistent workflows	Apply
CO3: Apply the Digital Manufacturing environment using PLM for use cases.	Apply
CO4: Develop and present a report individually by applying various modules of PLM software for an engineering project.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	1	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO4	-	-	3	-	-	-	-	-	1	1	-	-	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1. John Stark, “Product Lifecycle Management: Volume 1: 21st Century Paradigm for Product Realisation”, Springer International Publishing Switzerland, 4th Edition, 2020.

T2. Grieves Michael, “Product Lifecycle Management- Driving the Next Generation of Lean Thinking”, McGraw-Hill, 2010.

T3. Wang, Lihui; Nee, Andrew Y.C. (Eds.) Collaborative Design and Planning for Digital Manufacturing, Springer, 2009.

. **Reference(s):**

R1. Elangovan, U., “Product Lifecycle Management (PLM)”. Boca Raton, CRC Press, 2020.

R2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006.

R3. Antti Saaksvuori, “ Product Life Cycle Management” - Anselmi Immonen, Springer, 3rd Edition, 2008.

Course Code:23MEE030		Course Title: Principles of Management (Common to EA,EC,EE,EV,ME)	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3:0 :0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

This course is intended to study the role of managers, the significance of planning, decision-making, and strategies in international business, the importance of organizing tasks, various motivational theories, and control techniques.

Module I **22 Hours**

OVERVIEW OF MANAGEMENT :

Organization – Management – Role of managers – Evolution of Management thought – Organization and the environmental factors – Managing globally – Strategies for International Business

PLANNING:

Nature and Purpose planning – Planning process – Types of Plans – Objectives – Managing by Objective (MBO) Strategies – Types of strategies – Policies – Decision Making – Types of decision – Decision Making Process – Rational Decision Making Process – Decision Making under different Conditions.

ORGANISING:

Nature and purpose of organizing – Organization structure – Formal and informal groups organization – Line and Staff authority – Departmentation – Span of Control – Centralization and Decentralization – Delegation of authority – Staffing – Selection and Recuritment – Orientation Career Development – Career stages – Training – Performance appraisal.

Module II **23 Hours**

DIRECTING :

Creativity and Innovation – Motivation and Satisfaction – Motivation Theories Leadership – Leadership theories – Communication – Hurdles to effective communication – organization culture – elements and types of culture – managing cultural diversity.

CONTROLLING:

Process of controlling – types of control – budgetary and non – budgetary control techniques – managing productivity – cost control – purchase control – maintenance control – quality control – planning operations.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Apply management principles to understand the roles and functions of managers in various organizational and business contexts.	Apply
CO 2: Develop and implement effective planning, decision-making, and strategic management practices to achieve organizational objectives in both domestic and international settings.	Apply
CO 3 : Prepare and present a seminar individually on organizational, motivational and control techniques including task allocation, employee engagement strategies, budgeting, and quality management to enhance productivity and efficiency.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	-	-	-	-	-	-	-	-	2	2	-	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. hen P. Robbins, Rolf Bergman and Mary Coulter, "Management", Prentice Hall of India, 8th edition, 2017.

T2. Charles W.L Hill, Steven L McShane, "Principles of Management", Mcgraw Hill Education, 2008

Reference Book(s):

R1. Hellriegel, Slocum & Jackson, “Management – A Competency Based Approach”, Thomson South Western, 10th edition, 2007.

R2. Harold Koontz, Heinz Weihrich and mark V Cannice, “Management – A global & Entrepreneurial Perspective”, Tata McGraw Hill, 12th edition, 2007.

R3. Andrew J. Dubrin, “Essentials of Management”, Thomson Southwestern, 7th edition, 2007

Course Code: 23AUE050		**Course Title: Entrepreneurship Development (Common to all B.E/B.Tech Programmes)**	
Course Category: Minor		**Course Level: Higher**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course is intended to develop entrepreneurial mindset and skills by identifying and validating problems through human-centered design, analyzing markets and customers to create value propositions and MVPs, exploring business models with financial and feasibility analysis, and preparing investible pitch decks to attract stakeholders.

Module I **22 Hours**

Entrepreneurial Mindset

Introduction to Entrepreneurship: Definition – Types of Entrepreneurs – Emerging Economics – Developing and Understanding an Entrepreneurial Mindset – Importance of Technology Entrepreneurship – Benefits to the Society.

Opportunities

Problems and Opportunities – Ideas and Opportunities – Identifying problems in society – Creation of opportunities – Exploring Market Types – Estimating the Market Size, - Knowing the Customer and Consumer - Customer Segmentation - Identifying niche markets – Customer discovery and validation; Market research techniques, tools for validation of ideas and opportunities

Activity Session: Identify emerging sectors / potential opportunities in existing markets - Customer Interviews: Conduct preliminary interviews with potential customers for Opportunity Validation - Analyse feedback to refine the opportunity.

Prototyping & Iteration

Prototyping – Importance in entrepreneurial process – Types of Prototypes - Different methods – Tools & Techniques. Hands-on sessions on prototyping tools (3D printing, electronics, software), Develop a prototype based on identified opportunities; Receive feedback and iterate on the prototypes.

Module II **23 Hours**

Business models & pitching

Business Model and Types - Lean Approach - 9 block Lean Canvas Model - Riskiest assumptions to Business Models – Using Business Model Canvas as a Tool – Pitching Techniques: Importance of pitching - Types of pitches - crafting a compelling pitch – pitch presentation skills - using storytelling to gain investor/customer attention.

Activity Session: Develop a business model canvas for the prototype; present and receive feedback from peers and mentors - Prepare and practice pitching the business ideas- Participate in a Pitching Competition and present to a panel of judges - receive & reflect feedback

Entrepreneurial Ecosystem

Understanding the Entrepreneurial Ecosystem – Components: Angels, Venture Capitalists, Maker Spaces, Incubators, Accelerators, Investors. Financing models – equity, debt, crowdfunding, etc, Support from the government and corporates. Navigating Ecosystem Support: Searching & Identifying the Right Ecosystem Partner – Leveraging the Ecosystem - Building the right stakeholder network

Activity Session: Arrangement of Guest Speaker Sessions by successful entrepreneurs and entrepreneurial ecosystem leaders (incubation managers; angels; etc), Visit one or two entrepreneurial ecosystem players (Travel and visit a research park or incubator or makerspace or interact with startup founders).

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Apply entrepreneurial mindset principles to identify societal problems and transform them into viable business opportunities.	Apply
CO2: Develop prototypes using suitable tools and techniques for the validated opportunities through iterative processes.	Apply
CO3: Demonstrate a Business Model Canvas using the Lean approach and pitch the startup idea effectively using storytelling and presentation skills.	Apply
CO4: Analyze customer segments, market size, and niche markets to validate entrepreneurial opportunities through market research and customer interviews.	Analyze
CO5: Evaluate the role and components of the entrepreneurial ecosystem to identify and engage the right ecosystem partners and funding models for startup success.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	1	-	-	-	-	-	-	2	-
CO2	-	-	3	-	1	-	-	-	-	-	-	-	-	-
CO3	-	-	3	-	-	-	-	-	1	1	-	-	2	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	2	-	-	-	-	-	-	1	1	-	-

High-3; Medium-2; Low-1

Reference Book(s):

1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha Entrepreneurship, McGrawHill, 11th Edition,2020.
2. Ries, E. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business,2011.
3. Blank, S. G., & Dorf, B. The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch.2012.
4. Roy, R. Indian Entrepreneurship: Theory and Practice. New Delhi: Oxford University Press,2017.
5. Osterwalder, A., & Pigneur, Y. Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons,2010.

<table>
<tr><td colspan="2">Course Code: 23AUE051</td><td colspan="3">Course Title: Design Thinking and Innovation
(Common to all B.E/B.Tech Praogrammes)</td></tr>
<tr><td colspan="3">Course Category: Major</td><td colspan="2">Course Level: Higher</td></tr>
<tr><td colspan="2">L:T:P: 3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
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Course Objective:

The course is intended to equip learners with practical skills in design thinking, empathy, prototyping, testing, and implementation for user-centered innovation and effective product development.

Module I **(17+ 6 hrs)**

Introduction- Importance of Design Thinking, Human Centered Design, Six-Step Design Thinking Process-Framework for Innovation-DT-a nonlinear process.

Empathy-importance of empathy in design thinking- empathy vs sympathy- steps of empathize-understanding customer needs-empathy methods and tools-empathy map-5W 1H framework-empathize in UX/UI Design-users Interview

Module II **(18+4 hrs)**

Prototype: Introduction to Proof of concept-MVP-Prototype and its types-prototype methodology- innovation and its types-Tools for prototyping: concept sketching/CAD/3D Printing.

Testing: Importance of testing in product development-design validation-market analysis: TAM-SAM-SOM-EVG.

Implementation - redesign of solution and iterative process.

List of activities

Core Stream

Empathy

1. What challenges does the user face daily commuting to work place?

2. What are the user’s biggest frustrations when interacting with vehicle maintenance engineer?

3. Understand the user for building old age home.

Define

1. A construction site supervisor needs better real-time communication tools because delayed updates cause safety risks. (Provide the empathy data)

2. “Drivers get confused by inconsistent road signs,” create: “How might we improve road sign clarity to reduce driver confusion?”

3. A daily commuter needs a safer way to cross busy intersections because current pedestrian signals are confusing and slow. (Provide the empathy data)

Ideate

1. Develop a creativity safer vehicle dashboard design

2. Develop an improved road drainage system

3. Design an innovative solution to reduce urban flooding caused by heavy rains.

4. Design a Hybrid engine designs incorporating solar panels on the car roof.

Prototype

1. Prototype development (both low fidelity and high fidelity) on any real world problem

IT and Circuit Stream:

Activity 1:

Students role-play as designers and users- create an empathy map with 4 quadrants: *Says, Thinks, Does, Feels*

Circuit Stream- Empathy Interview and Persona Creation

Define- development of problem Statement-Elements of a Good Problem Statement-Tools: Point-of-View (POV) Statements-How Might We (HMW) Questions-User Personas.

Ideation in Design Thinking-Importance of Ideation-Metrics of ideation -tools: Brainstorming-Mind Mapping-SWOT.

Activity 2:

IT Stream- SWOT analysis on software project idea.

Circuit Stream -Idea Pitch Canvas using Brainstorming + Mind Mapping

Convert ideas into quick prototypes and validate through early testing.

Activity 3:

IT Stream -Build a simple algorithm to test feasibility- TAM-SAM-SOM market analysis chart

Circuit Stream -MVP Canvas and Concept Sketching

Circuit Stream -Iterative Redesign and Peer Testing Sprint

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Apply design thinking tools like empathy mapping, problem definition, and ideation to create user-centered innovative solutions.	Apply
CO2: Apply prototyping, innovation, testing, and iterative redesign techniques in product development and market analysis..	Apply
CO3: Apply design thinking to develop, prototype, and validate innovative engineering solutions in capstone projects for real-world applications.	Apply

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	2	-	-	-	2			2	2	2	2	-	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Sabell Osann, Lena Mayer , Inga Wiele ,The Design Thinking Quick Start Guide: A 6-Step Process

for Generating and Implementing Creative Solutions, Wiley, 2020.

T2. Christian Müller-Roterberg, Handbook of Design Thinking, Kindle Direct Publishing,2018.

Reference Book(s):

R1. Teun den Dekker, Design Thinking, Taylor & Francis, International edition, 2020.

R2. Kaushik Kumar, Divya Zindani, J.Paulo Davim, Design Thinking to Digital Thinking, Springer, 2019.

R3.S. Balaram, Thinking Design, SAGE Publications, 2011.

Passed in 20th Board of Studies Meeting held on 26.04.2025

Approved in 20th Academic Council Meeting held on 04.07.2025 BOS Chairman

Course Code: 23SCE050		**Course Title: Cyber security (Common to AD,AM,AU,CE,EA,EC,EE,EV,ME)**	
Course Category: Minor		**Course Level: Higher**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Course Objectives: To provide foundational knowledge of cyberspace, cyber laws, and digital security practices to identify, prevent, and respond to cyber threats.

Module I: 22 Hours

Introduction to Cyber Security: Defining Cyberspace - Overview of Computer and Web-technology - Architecture of cyberspace, Internet, World wide web, Advent of internet, Internet infrastructure for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security.

Cyber-crime and Cyber law: Classification of cyber-crimes - cyber-crime targeting computers and mobiles, cyber-crime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero day and zero click attacks, Cybercriminals modus-operandi , Reporting of cyber-crimes, Remedial and mitigation measures, Legal perspective of cyber-crime, IT Act 2000 and its amendments, Cyber-crime and offences, Organizations dealing with Cyber-crime and Cyber security in India, Case studies

Module II: 23 Hours

Social media and Security: Introduction to Social networks, Social media – Types, platforms, monitoring, Hashtag, Viral content, marketing, Challenges, opportunities and pitfalls in online social network, Security issues related to social media, Flagging and reporting of inappropriate content, Laws regarding posting of inappropriate content, Best practices for the use of Social media, Case studies.

E-Commerce and Digital Payments: E- Commerce - Definition, Components, Security, Threats, Best practices - Digital payments – Components, stake holders, Modes of digital payments - Banking Cards, Unified Payment Interface (UPI), e-Wallets, Unstructured Supplementary Service Data (USSD), Aadhar enabled payments, Digital payments related common frauds and preventive measures. RBI guidelines on digital payments and customer protection in unauthorised banking transactions. Relevant provisions of Payment Settlement Act,2007.

Digital Devices Security, Tools and Technologies for Cyber Security: End Point device and Mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third party software, Device security policy, Cyber Security best practices, Significance of host firewall and Ant-virus, Management of host firewall and Anti-virus, Wi-Fi security, Configuration of basic security policy and permissions

Case studies and Assignments:

1. Prepare checklist for following scenarios :
   a) Reporting cybercrime at Cybercrime Police Station.
   b) Reporting cybercrime online.
   c) Using popular social media platforms.
   d) Secure net banking.
2. Demonstrate the following:
   a) Reporting phishing emails, email phishing attack and preventive measures.
   b) Reporting and redressal mechanism for violations and misuse of Social mediaplatforms.
3. Manage the following activities:
   a) Privacy and security settings for popular Social media platforms, Mobile Walletsand UPIs.
   b) Application permissions in mobile phone.
4. Perform the following activities:
   a) Setting, configuring and managing three password policy in the computer(BIOS, Administrator and Standard User).
   b) Setting and configuring two factor authentication in the Mobile phone.
5. Demonstrate the following:
   a) Security patch management and updates in computer and mobiles.
   b) Wi-Fi security management in computer and mobile.
6. Install and configure computer Anti-virus & Computer Host Firewall.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Design appropriate checklists and procedures for secure cyber practices and effective response to cybercrime incidents across various platforms.	Apply
CO2: Illustrate the functioning of cyberspace infrastructure and demonstrate how regulatory frameworks address cyber threats.	Apply
CO3: Analyze privacy and security configurations in social media platforms and digital applications to identify potential risks and propose suitable mitigation strategies.	Analyze
CO4: Apply evolving cybersecurity tools and device protection practices through continuous learning to address emerging digital security challenges.	Apply

Course Articulation Matrix:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	3	-	-	2	-	-	2	2	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	2	-	-	2	-	-	1	2	2	-	-	-	-
CO4	3	-	-	-	2	-	-	-	-	-	-	2	2	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Cyber Crime Impact in the New Millennium, R. C Mishra. Auther Press. 2010.

T2. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, 1^{st} Edition, Wiley India Pvt. Ltd, 2011.

T3. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform, Pearson Education, 2001.

Reference Book(s):

R1. Network Security Bible, Eric Cole, Ronald Krutz, James W. Conley, 2^{nd} Edition,Wiley India Pvt. Ltd, 2001

R2. Security Fundamentals of Network by E. Maiwald, McGraw Hill ,2014

R3. Cyber Laws: Intellectual Property & E-Commerce Security by Kumar K,Dominant Publishers, 2011.

Web Reference(s):

1. https://unacademy.com/content/upsc/study-material/science-and-technology/initiatives-taken-by-indian-government-for-cyber-security/
2. https://cybercrime.gov.in/
3. https://www.meity.gov.in/cyber-security-division
4. https://intellipaat.com/blog/what-is-cyber-security/

Course Code: 23ITE047		Course Title: Intellectual Property Rights (Common to all B.E/B.Tech Programmes)	
Course Category: Minor		Course Level: Higher	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives

The course is intended to learn the fundamental concepts of Intellectual Property Law, including patent classifications, trademark strategies, and copyright protections.

Module I **22 Hours**

Intellectual Property: An Introduction: Intellectual Property Law: Patent Law-Copyright Law-Trademark Law- Trade secret Law-Right of Publicity-Paralegal tasks in Intellectual Property Law-Ethical obligations of the paralegal in Intellectual Property Law-Trade secrets: Protectible as a trade secret-Maintaining trade secrets-Protecting an Idea.

Patents: Rights and Limitations: Sources of patent law-Subject matter of Patents: Utility Patents-Plant Patents-Design Patents-Design Patents and copyright-Design Patents and trademarks-Computer Software, Business methods and Patent Protection-Rights under Patent Law-Patent Requirements-Limitations on Patent Rights-Patent Ownership.

Module II **23 Hours**

Patents: Research, Applications, Disputes, and International Considerations: Patent Search Process-Patent Application Process-Patent Infringement-Patent Litigation, International Patent laws.

Principles of Trademark: Trademarks and Unfair Competition-Acquiring Trademark Rights-Types of Marks, Strong Marks Versus Weak Marks-Selecting and Evaluating a Trademark-International Trademark Laws.

Principles of Copyrights: Sources of Copyright Law- The Eight Categories of Works of Authorship-Derivative Works and Compilations- Rights and Limitations: Grant of Exclusive Rights–Copyrights Ownership- International Copyright Laws.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the fundamental concepts of Intellectual Property Law to real-world scenarios.	Apply
CO2: Demonstrate an understanding of the Rights and Limitations of various patents through practical examples.	Apply
CO3: Analyze the process of patent searching and application filing to assess its effectiveness in protecting intellectual property.	Analyze
CO4: Examine the principles of trademark and copyright to differentiate their roles and implications in intellectual property law.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2	-	-	-	2	-	-	-	-	-	-	-	-	-	2
CO3	-	3	-	-	2	-	-	-	-	2	-	-	-	-
CO4	-	2	-	-	3	-	-	3	2	-	-	-	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Richard Stim, “Intellectual Property: Copyrights, Trademark and Patents”, Cengage learning, 2nd edition 2012.

Reference Book(s):

R1. Deborah E. Bouchoux, “Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets”, Cengage Learning, 3rd Edition, 2013.

R2. Prabuddha Ganguli,”Intellectual Property Rights: Unleashing the Knowledge Economy”, McGraw Hill Education, 2017.

R3. David Llewelyn, Tanya Frances Aplin, “Intellectual Property Patents, Copyrights, Trademarks & Allied Rights”, Sweet & Maxwell, 2023.

R4. William F. Patry ,"Principles of Intellectual Property: Patents, Trademarks, and Copyrights", Wolters Kluwer, 2023.

Web References:

1. https://ipindia.gov.in/writereaddata/Portal/ev/sectionsindex.html

Open Electives

Course Code: 23EEO001		Course Title: Electric and Hybrid Vehicles	
Course Category: Minor		Course Level: Intermediate/Higher	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives: The course is intended to impart the knowledge of basic concepts and fundamentals involved in Electric and Hybrid Vehicles. Also the course details the requirements of various types of electric motors & energy storage systems in Electric and Hybrid Vehicles.

Module I:Electric & Hybrid Vehicles Fundamentals 22 Hours

Social and environmental importance of hybrid and electric vehicles, Layout of an electric vehicle-performance of electric vehicles – Traction motor characteristics, Tractive effort, Transmission requirements, Vehicle performance, Energy consumption, Impact of modern drivetrains on energy supplies, Advantage and limitations, Specifications, System components, Electronic control system. Introduction to various hybrid drive-train topologies, Concepts of hybrid electric drive train, Architecture of series and parallel hybrid electric drive train, Merits and demerits, Series and parallel hybrid electric drive train design.

Module II: Electric Propulsion & Energy Storage Systems in Electric and Hybrid Vehicles 23 Hours

DC motors, AC motors, Permanent magnet motors, Brushless DC and Reluctance motors, Characteristics, Regenerative braking, Control system principles, Speed and torque control – DC motors and AC Motors. Electromechanical batteries – Types of batteries – Lead acid batteries, Nickel based batteries, Lithium based batteries, Electrochemical reactions, Thermodynamic voltage, Specific Energy, Specific Power, Energy efficiency, Ultra capacitors, Fuel cell- Construction, Types and its Working with Equations.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Categorize the need, performances and control systems of Electric vehicles.	Analyze
CO2: Classify the various architectures of electric hybrid vehicles with its merits and demerits.	Analyze
CO3: Illustrate the electric propulsion system and motor controlling Techniques in Electric & Hybrid Vehicles	Apply
CO4: Describe the energy storage system technologies in Electric & Hybrid Vehicles and report the seminar presentation	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3										
CO2		3										
CO3	3											
CO4	3								1	1		

High-3; Medium-2; Low-1

Textbooks:

T1. Mehrdad Ehsani, Yimin Gao, Sebatien Gay and Ali Emadi, "Modern Electric, Hybrid, Electric and Fuel cell vehicles: Fundamentals, Theory and Design", CRC press, 2004

T2. James Larminie and John Loury, "Electric Vehicle Technology – Explained", John Wiley & Sons. McGraw-Hill Book company,1994.

Reference Book(s):

R1.Tom Denton and Hayley Pells, "Electric and Hybrid Vehicles",Routledge,2024.

R2.James D. Halderman, Curt Ward," Electric and Hybrid Electric Vehicles", Pearson , 2023.

R3. Shyam M. Ramnani, Kaustubh R. Kapadani," Electric and Hybrid Electric Vehicles", TechKnowledge Publications,2023.

Web References:

1. https://archive.nptel.ac.in/courses/108/103/108103009/
2. https://nptel.ac.in/courses/108106170
3. https://onlinecourses.nptel.ac.in/noc22_ee53/preview
4. https://archive.nptel.ac.in/courses/108/106/108106182/

Course Code: 23EEO002		**Course Title: Solar Energy System**	
Course Category: Minor		**Course Level: Intermediate/Higher**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

To give exposure to the students about the concepts of the solar energy conversion system with design of stand-alone and grid connected Solar PV systems

Module I **23 Hours**

Solar Radiation and Measurements: World solar energy - Indian solar energy scenario-The sun and the earth-Sun earth movement - Angle of sunrays on solar collector-Sun tracking-Estimation of solar radiation empirically- Measurement of solar radiation.

Solar Thermal Technologies: Solar thermal energy systems-Absorption and radiation-Solar cooking systems-Principle –Types of solar cooker-Solar distillation system-Operation and design-Solar heating systems.

Solar Photovoltaic Technologies: Solar photovoltaic(PV) energy conversion - Principles - Physics and operation of solar cells- Solar cell types and technologies-Factors affecting electricity generated by solar cell-Solar PV modules-Ratings of PV module-Standard PV module parameters- Factors affecting electricity generated by PV module-Measuring module parameters-Solar arrays-Connection of modules in series, parallel and Series-parallel.

Module II **22 Hours**

Balance of Systems: Batteries-Types-Parameters-Comparison of various rechargeable Batteries-Selection of Batteries-Batteries for PV Systems-Estimation of number of batteries required in series, parallel and series parallel for an application-Power converters-Types-Charge Controllers-Function- Working-types-features-Typical Specifications-Maximum power point tracking.

Solar PV System Design and Integration : Types of Solar PV systems-Design methodology for standalone Solar PV system-Configuration of grid connected solar PV system-Components of grid connected solar PV system-Design of grid connected solar PV systems.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply solar radiation data and measurement techniques to analyze the performance potential of solar energy systems in different geographical locations.	Apply
CO2: Evaluate and compare the efficiency and applications of solar cooking, distillation, and heating systems for domestic and industrial needs.	Analyze
CO3: Analyze the working principles of solar photovoltaic (PV) cells and assess the impact of environmental and operational factors on electricity generation.	Analyze
CO4: Examine and integrate the balance of system components in PV power plants for optimal performance and reliability.	Analyze
CO5:Design and simulate both standalone and grid-connected solar PV systems based on energy requirements, site conditions, and load profiles and submit a seminar presentation.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2		3										
CO3		3										
CO4		3										
CO5	3					1	1		1	1	1	

High-3; Medium-2; Low-1

Textbooks:

T1. Solar Photovoltaic Technology and Systems A manual for Technicians, Trainers, and Engineers **-**Chetan Singh Solanki-PHI Learning Private Limited-2013

T2. Solar Energy Utilisation, G.D.Rai, Khanna Publishers, 1993.

Reference Book(s):

R1. Solar Photovoltaics: Fundamentals, Technologies And Applications By Chetan Singh Solanki- PHI Learning Private Limited-2015

R2. Solar Energy by S P Sukhatme, J K Nayak, Tata McGraw Hill Publishing, 2008

R3. Renewable Energy Technologies: A Practical Guide for Beginners By Chetan Singh Solanki- PHI Learning Private Limited-2009

Web References:

1. http://www.pveducation.org/
2. http://www.ese.iitb.ac.in/~chetan/PVmaterial.html
3. https://www.britannica.com/technology/solar-cell
4. https://mnre.gov.in/file-anager/UserFiles/support_hrd_coursematerial_iti.html