Loyola-ICAM

College of Engineering and Technology (LICET)

(Autonomous)

Loyola Campus, Nungambakkam, Chennai – 600 034

Curriculum and Syllabi (R-2024)

(Revision No.: 04/ BoS Dt. 30.04.2026/ AC Dt. 23.05.2026)

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING



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CURRICULUM AND SYLLABI (R-2024)

CHOICE BASED CREDIT SYSTEM (CBCS)

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

Vision of the Institution:

- To form responsible engineers, who would engineer a just society.

Mission of the Institution:

- To provide technical education in a Christian atmosphere to deserving students who are economically poor and socially marginalized.
- To train young men and women of quality to be leaders in all walks of life and serve their fellow men with justice, truth and love.
- To implement teaching learning processes that ensure guidance and mentoring for students throughout their period of study.
- To provide higher education through academic collaboration and pursue research in international perspective of Engineering.

Vision of the Department:

- To transform the students into globally competent electrical engineers, researchers, and entrepreneurs, and thereby contributing value to the technological needs of the society.

Mission of the Department:

M1: To equip the students with advanced knowledge and technological skills to cater to the needs of industries.

M2: To enable students to create and develop innovative engineering applications for the benefit of Marginalized communities.

M3: To enable students to become responsible citizens with a willingness to make a Positive difference to society through their education.

Programme Educational Objectives:

PEO1: Graduates are prepared to have successful career in industry, research areas and motivation for higher education and to provide an opportunity to work in inter-disciplinary groups and to become future entrepreneurs.

PEO2: Graduates will possess necessary foundation on computational platforms and software applications in electrical engineering that will continue to develop their knowledge and skills throughout their career.
PEO3: Graduates will be inculcated professional ethics and instilled social responsibility to work in teams for the welfare of the society and fellow countrymen.
Programme Outcomes:

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5).

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6).

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9).

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8).

Programme Specific Outcomes:

PSO1: Use technical and logical skills to model, simulate and analyse the working principle, control, reliability of electric components, circuits, and systems that are forming part of power generation, transmission, and distribution.

PSO2: Ability to apply the fundamental engineering concepts to solve real-time problems using engineering software tools such as Electrical modelling software, Open-source alternatives, Virtual labs, RT Lab, and suitable algorithms.

PSO3: Adapt to emerging technologies like sustainable energy, electric mobility, and industrial automation to stay current with emerging trends in the industry.

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B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

SEMESTER – I

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
THEORY COURSES								
1	MA24101	Calculus for Engineers	BSC	3	1	0	4	4
2	BE24102	Basic Civil and Mechanical Engineering	ESC	3	0	0	3	3
3	HS24101	English for Professional Communication	HSMC	3	0	0	3	3
4	PH24101	Physics for Electrical Engineers	BSC	3	0	0	3	3
5	GE24101	Heritage of Tamils	HSMC	1	0	0	1	1
LABORATORY INTEGRATED THEORY COURSES								
6	GE24111	Engineering Graphics	ESC	2	0	4	6	4
LABORATORY COURSES								
7	GE24122	Engineering Practices Laboratory – Electrical and Electronics	ESC	0	0	2	2	1
8	PH24121	Physics Laboratory	BSC	0	0	2	2	1
FORMATION COURSES								
9	GE24123	Design Thinking[$]	HSMC	0	0	2	2	1
10	FC24102	Cultural Identities and Globalization	HSMC	2	0	0	2	0
			TOTAL	18	0	10	28	21

[$]Skill based courses

SEMESTER – II

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
THEORY COURSES								
1	EE24201	Circuit Theory	PCC	3	1	0	4	4
2	MA24202	Laplace Transforms and Complex Variables	BSC	3	1	0	4	4
3	CS24201	Programming in C	ESC	3	0	0	3	3
4	CY24201	Chemistry for Electronic Engineering	BSC	3	0	0	3	3
5	GE24201	Tamils and Technology	HSMC	1	0	0	1	1
LABORATORY COURSES								
6	CS24221	C Programming Laboratory	ESC	0	0	4	4	2
7	EE24221	Circuit Theory Laboratory	PCC	0	0	4	4	2
8	CY24121	Engineering Chemistry Laboratory	BSC	0	0	2	2	1
9	GE24121	Engineering Practices Laboratory – Civil and Mechanical	ESC	0	0	2	2	1
FORMATION COURSES								
9	FC24101	Life Skills[$]	HSMC	2	0	0	2	1
TOTAL				15	2	12	29	22

[$]Skill based courses

SEMESTER – III

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
THEORY COURSES								
1	MA24302	Statistics And Numerical Methods	BSC	3	1	0	4	4
2	EE24301	Analog Electronics	PCC	3	0	0	3	3
3	EE24302	DC Machines and Transformers	PCC	3	0	0	3	3
4	EE24303	Electromagnetic Theory	PCC	3	0	0	3	3
LABORATORY INTEGRATED THEORY COURSES								
5	EE24311	Digital Logic Circuits	PCC	3	0	2	5	4
6	EE24312	OOP using C++	PCC	2	0	2	4	3
LABORATORY COURSES								
7	EE24321	Analog Electronics Laboratory	PCC	0	0	3	3	1.5
8	EE24322	DC Machines and Transformers Laboratory	PCC	0	0	3	3	1.5
FORMATION COURSES								
9	HS24321	Communication Skills Building Laboratory[$]	HSMC	0	0	2	2	1
10	FC24301	Soft Skills[$]	HSMC	2	0	0	2	1
TOTAL				19	1	12	32	25

[$]Skill based courses

SEMESTER – IV

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
THEORY COURSES								
1	BS24301	Environmental Science and Sustainability	BSC	3	0	0	3	3
2	EE24401	Measurements and Instrumentation	PCC	3	0	0	3	3
3	EE24402	Synchronous and Induction Machines	PCC	3	0	0	3	3
LABORATORY INTEGRATED THEORY COURSES								
4	EE24411	Control Systems Design	PCC	3	0	2	5	4
5	EE24412	Transmission and Distribution	PCC	3	0	2	5	4
6	EE24413	Python Programming and Data Structures	PCC	2	0	2	4	3
LABORATORY COURSES								
7	EE24421	Synchronous and Induction Machines Laboratory	PCC	0	0	3	3	1.5
8	EE24422	Measurement and Instrumentation Laboratory	PCC	0	0	3	3	1.5
FORMATION COURSES								
9	EE24423	Project Driven Learning[$]	EEC	0	0	2	2	1
10	BS24321	System Discovery and Analysis	BSC	0	0	2	2	0
TOTAL				17	0	16	33	24

[$]Skill based courses

Foreign Language should be completed by the end of IV semester.

SEMESTER – V

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
THEORY COURSES								
1	EE24501	Power Electronics	PCC	3	0	0	3	3
2	EE24502	Microprocessor and Microcontroller	PCC	3	0	0	3	3
3	GE24502	Entrepreneurship and International Business Market	HSMC	2	0	0	2	2
LABORATORY INTEGRATED THEORY COURSES								
4	EE24511	Power System Analysis	PCC	3	0	2	5	4
5		Professional Elective – 1	PEC				4	3
6		Professional Elective – 2	PEC				4	3
LABORATORY COURSES								
7	EE24521	Microprocessor and Microcontroller Laboratory	PCC	0	0	3	3	1.5
8	EE24522	Power Electronics Laboratory	PCC	0	0	3	3	1.5
FORMATION COURSES								
9	FC24501	Universal Human Values and Service Learning[$]	HSMC	1	0	1[*]	1	1
10	BS24502	Logical Reasoning and Aptitude Training	BSC	2	0	0	2	1[#]
TOTAL							30	22

[$]Skill based courses

*Activities on non-working days/ hours

[#] Not included for GPA calculation

SEMESTER – VI

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
THEORY COURSES								
1	GE24501	Project Management and Operation Management	HSMC	2	0	0	2	2
2		Open elective – I	OEC	3	0	0	3	3
3		Professional Elective – 3	PEC				3	3
4		Professional Elective – 4	PEC				3	3
LABORATORY INTEGRATED THEORY COURSES								
5	EE24612	Power System Operation and Control	PCC	3	0	2	5	4
6	EE24613	Protection and Switchgear	PCC	3	0	2	5	4
7	EE24614	Energy Systems	PCC	2	0	2	4	3
FORMATION COURSES								
8	GE24503	Financial Literacy	HSMC	2	0	0	2	0
9	GE24621	Interdisciplinary Project[$]	EEC	0	0	2	2	1
10	GE24622	Problem Solving Techniques	EEC	0	0	2	2	1[#]
TOTAL							31	23

[$]Skill based courses

[#] Not included for GPA Calculation

SEMESTER – VII

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
THEORY COURSES								
1		Open Elective – II	OEC	3	0	0	3	3
2		Open Elective – III	OEC	3	0	0	3	3
3	GE24701	Working to Engineer a Better World	ESC	2	0	0	2	2
4		Audit Course	HSMC	2	0	0	2	0
LABORATORY INTEGRATED THEORY COURSES								
5		Professional Elective – 5	PEC				4	3
6		Professional Elective – 6	PEC				4	3
7		Professional Elective – 7	PEC				4	3
LABORATORY COURSES								
8	EE24722	Professional Project – I	EEC	1	0	2	3	2
FORMATION COURSES								
9	EE24723	Internship[$]	EEC				-	2
TOTAL							25	21

[$]Skill based courses

SEMESTER – VIII

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
LABORATORY COURSES								
1	EE24722	Professional Project – II	EEC	0	0	20	20	10
TOTAL							20	10

CREDITS BREAK-UP

S. No.	Category	Credits per Semester								Total Credits
		I	II	III	IV	V	VI	VII	VIII	
1	**HSMC**	5	2	2	0	3	2			14
2	**BSC**	8	8	4	3					23
3	**ESC**	8	6					2		16
4	**PCC**		6	19	21	13	8	2		69
5	**PEC**					6	6	9		21
6	**OEC**						3	6		9
7	**EEC**				1		1	4	10	16
	NonCredit	-			-		-	-		
		21	**22**	**25**	**25**	**22**	**20**	**23**	**10**	**168**

PROFESSIONAL ELECTIVE COURSES: VERTICALS

POWER ENGINEERING	ELECTRIC VEHICLE TECHNOLOGY	ELECTRICAL DRIVES & CONTROL	SMART CONNECTIVITY SYSTEMS	DIVERSIFIED COURSES
High Voltage Engineering	Electric Vehicle Architecture and Dynamics	Power Electronics for Renewable Energy Systems	Embedded System Design	Drone Technologies
Smart Grid	Electric and Hybrid Vehicles	Multilevel Power Converters	Embedded C-programming using ARM Cortex-M	Biomedical Instrumentation & Wearables
Electrical Energy Generation, Utilisation and Conservation	Design of Motor and Power Converters for EVs	Power Electronic Drives	Embedded Processors	Robotics & Autonomous Systems
Power Quality	Battery Management System and Charging Technologies	Switched Mode Power Conversion	Smart System Automation	AI/ML & Cybersecurity in Electrical Systems
HVDC and FACTS	Design of Electric Vehicle Charging System	Control of Power Electronic Circuits	Basics of VLSI Design	Electrical machines for special applications
Grid Integration Techniques and Challenges	Grid Integration of Electric Vehicles	Embedded Control for Electric Drives	Digital Signal Processing Techniques	Energy Management and Auditing
Sustainable HV Insulation System	Intelligent Control of Electric Vehicles	Advanced Control Theory	Embedded System for Automotive Applications	Electrical Engineering Materials
Sustainable electrification of remote communities	Testing and Thermal Management of Electric Vehicles			

VERTICAL I: POWER ENGINEERING

S. No.	Course Code	Course Name	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	PEE2401	High Voltage Engineering	PEC	3	0	0	3	3
2	PEE2402	Smart Grid	PEC	3	0	0	3	3
3	PEE2403	Electrical Energy Generation, Utilisation and Conservation	PEC	3	0	0	3	3
4	PEE2404	Power Quality	PEC	3	0	0	3	3
5	PEE2405	HVDC and FACTS	PEC	3	0	0	3	3
6	PEE2406	Grid Integration Techniques and Challenges	PEC	3	0	0	3	3
7	PEE2407	Sustainable HV Insulation System	PEC	3	0	0	3	3
8	PEE2408	Sustainable electrification of remote communities	PEC	3	0	0	3	3

VERTICAL II: ELECTRIC VEHICLE TECHNOLOGY

S. No.	Course Code	Course Name	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	PEE2411	Electric Vehicle Architecture and Dynamics	PEC	3	0	0	3	3
2	PEE2412	Electric and Hybrid Vehicles	PEC	3	0	0	3	3
3	PEE2413	Design of Motor and Power Converters for EVs	PEC	3	0	0	3	3
4	PEE2414	Battery Management System and Charging Technologies	PEC	3	0	0	3	3
5	PEE2415	Design of Electric Vehicle Charging System	PEC	3	0	0	3	3
6	PEE2416	Grid Integration of Electric Vehicles	PEC	3	0	0	3	3
7	PEE2417	Intelligent Control of Electric Vehicles	PEC	3	0	0	3	3
8	PEE2418	Testing and Thermal Management of Electric Vehicles	PEC	3	0	0	3	3

VERTICAL - III: ELECTRICAL DRIVES & CONTROL

S. No.	Course Code	Course Name	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	PEE2421	Power Electronics for Renewable Energy Systems	PEC	2	0	2	4	3
2	PEE2422	Multilevel Power Converters	PEC	3	0	0	3	3
3	PEE2423	Power Electronic Drives	PEC	2	0	2	4	3
4	PEE2424	Switched Mode Power Conversion	PEC	3	0	0	3	3
5	PEE2425	Control of Power Electronic Circuits	PEC	2	0	2	4	3
6	PEE2426	Embedded Control for Electric Drives	PEC	3	0	0	3	3
7	PEE2427	Advanced Control Theory	PEC	2	0	2	4	3

VERTICAL - IV: SMART CONNECTIVITY SYSTEMS

S. No.	Course Code	Course Name	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	PEE2431	Embedded System Design	PEC	2	0	2	4	3
2	PEE2432	Embedded C-programming using ARM Cortex-M	PEC	3	0	0	3	3
3	PEE2433	Embedded Processors	PEC	3	0	0	3	3
4	PEE2434	Smart System Automation	PEC	2	0	2	4	3
5	PEE2435	Basics of VLSI Design	PEC	3	0	0	3	3
6	PEE2436	Digital Signal Processing Techniques	PEC	3	0	0	3	3
7	PEE2437	Embedded System for Automotive Applications	PEC	3	0	0	3	3

VERTICAL - V: DIVERSIFIED COURSES

S. No.	Course Code	Course Name	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	PEE2441	Drone Technologies	PEC	3	0	0	3	3
2	PEE2442	Biomedical Instrumentation & Wearables	PEC	3	0	0	3	3
3	PEE2443	Robotics & Autonomous Systems	PEC	3	0	0	3	3
4	PEE2444	AI/ML & Cybersecurity in Electrical Systems	PEC	3	0	0	3	3
5	PEE2445	Electrical Machines for Special Applications	PEC	3	0	0	3	3
6	PEE2446	Energy Management and Auditing	PEC	3	0	0	3	3
7	PEE2447	Electrical Engineering Materials	PEC	3	0	0	3	3

MA24101	Calculus for Engineers	BSC	L	T	P	C
			3	1	0	4

Course Objectives:

- To develop the usage of matrix algebra techniques and its applications, which are essential for engineers.
- To provide the students with the rules of differentiation.
- To impart the students with the concepts of functions of several variables.
- To make the students understand various techniques of integration.
- To acquaint the students with mathematical knowledge in evaluating multiple integrals and their applications.

UNIT I TRANSFORMATIONS 12

Stretching of an elastic membrane - eigenvalues and eigenvectors of a real matrix – properties – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms - Cayley Hamilton Theorem

UNIT II DIFFERENTIAL CALCULUS 12

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

UNIT III FUNCTIONS OF SEVERAL VARIABLES 12

Partial differentiation – Total derivative – Partial differentiation of implicit functions – Jacobians – Taylor's series – Maxima and Minima of a function of two variables - Method of Lagrangian Multipliers - Evaluating extremum of single and two variable functions.

UNIT IV INTEGRAL CALCULUS 12

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

UNIT V MULTIPLE INTEGRALS 12

Double integrals in Cartesian and Polar coordinates – Area enclosed by plane curves - Change of order of integration – Change of variables in double integrals - Triple integrals in Cartesian coordinates – Volume of solids - Change of variables from Cartesian to Spherical polar coordinates and Cylindrical polar coordinates.

Total Periods: 60

Course Outcomes:

On completion of the course, the students will be able to

CO1: To identify the eigenvalues and eigenvectors of a matrix and to execute diagonalization.
CO2: Identify the limit of functions and apply the rules of differentiation to differentiate functions.
CO3: Apply differentiation to functions of several variables
CO4: Evaluate extreme values of functions
CO5: Evaluate integrals using various techniques of integration
CO6: Evaluate multiple integrals in various coordinate systems and applications of multiple integrals

Suggested Activities:

- Evaluation of eigenvalues and eigenvectors using scientific tool
- Plotting and visualizing curves, and extreme values using a scientific tool
- Plotting and visualizing surfaces, and extreme values using a scientific tool
- Evaluation of line integrals using scientific tool
- Evaluation of multiple integrals using a scientific tool
- Visualizing 2D and 3D functions using GeoGebra and Desmos

Text Books:

1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Grewal.B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 44th Edition, 2018.
3. James Stewart, " Calculus: Early Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015.

References:

1. Anton. H, Bivens. I and Davis. S, "Calculus", Wiley, 10th Edition, 2016.
2. Bali.N., Goyal.M. and Watkins. C., “Advanced Engineering Mathematics”, Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
3. Jain.R.K. and Iyengar. S.R.K., “Advanced Engineering Mathematics”, Narosa Publications, New Delhi, 5th Edition, 2016.
4. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
5. Kuldeep Singh, “Engineering Mathematics Through Applications”, 2nd Edition, Bloomsbury Academic.
6. Thomas. G. B., Hass. J, and Weir. M.D, "Thomas Calculus", 14th Edition, Pearson India, 2018.
7. Amos Gilat, “MATLAB: An Introduction with Applications”, 4th Edition, John Wiley.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	-	-	-	2	-	-	-
CO2	3	2	1	1	2	-	-	-	-	-	2	-	-	-
CO3	3	2	1	1	2	-	-	-	-	-	2	-	-	-
CO4	3	2	1	1	2	-	-	-	-	-	2	-	-	-
CO5	3	2	1	1	2	-	-	-	-	-	2	-	-	-
CO6	3	2	1	1	2	-	-	-	-	-	2	-	-	-
Avg.	3	2	1	1	2	-	-	-	-	-	2	-	-	-

BE24102 Basic Civil and Mechanical Engineering ESC L T P C

3 0 0 3

Course Objectives:

- To provide the students an illustration of the significance of the concept of Thermodynamics and IC Engines To provide the students with the rules of differentiation.
- To explain the component of Boilers, Power Plants, Turbines and Pumps
- To explain the Refrigeration & Air-conditioning system.
- To help students acquire knowledge in the basics of surveying and the materials used for construction.
- To provide an insight to the essentials of components of a building and the infrastructure facilities.

UNIT I INTRODUCTION TO THERMODYNAMICS AND IC ENGINES 9

Role of thermodynamics in engineering and science, types of systems, thermodynamic equilibrium, properties, state, process and cycle, introduction to zeroth, first law of thermodynamics – concept of temperature - Steady flow energy equations-Applications - Internal combustion engines - construction – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles-Comparison.

UNIT II BOILERS, POWER PLANTS, TURBINES AND PUMPS 9

Working principle of Boilers- Fire tube boiler, water tube boilers -accessories and mounting. Classification of Power Plants- Working principle of Steam (Thermal), Hydro -electric and Nuclear Power plants- Reciprocating Pumps and Centrifugal Pumps, Turbines-Types-Applications.

UNIT III REFRIGERATION AND AIR CONDITIONING SYSTEM 9

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

UNIT IV SURVEYING AND CIVIL ENGINEERING MATERIALS 9

Surveying Objects – Classification – Principles – Measurements of Distances and angles – Leveling – Determination of areas– Contours. Civil Engineering - Materials: Bricks – Stones – Sand – Cement – Concrete – Steel – Timber – Modern Materials, Thermal and Acoustic Insulating Materials, Decorative Panels, WaterProofing Materials.

UNIT V BUILDING COMPONENTS AND INFRASTRUCTURE 9

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

Total Periods: 45

Course Outcomes:

On completion of the course, the students will be able to

CO1: Illustrate the principles of Thermodynamics and the functioning of IC Engines.
CO2: Summaries the knowledge in the basics of Boilers, Power Plants, Turbines and Pumps
CO3: Apply the knowledge gained in Refrigeration & Air-conditioning systems.
CO4: Appraise the material, Structures, machines and energy.
CO5: Illustrate the essentials of components of a building and the infrastructure facilities.

Suggested Activities:

- Engine Working Animation Study
- Energy Conversion Chart Preparation
- Model Making Activity

Text Books:

1. G Shanmugam, M S Palanichamy, Basic Civil and Mechanical Engineering, McGraw Hill Education; First edition, 2018

References:

1. Palanikumar, K. Basic Mechanical Engineering, ARS Publications, 2018.
2. Ramamrutham S., "Basic Civil Engineering", Dhanpat Rai Publishing Co.(P) Ltd, 2013.
3. Seetharaman S., "Basic Civil Engineering", Anuradha Agencies, 2005.
4. Shantha Kumar SRJ., "Basic Mechanical Engineering", Hi-tech Publications, Mayiladuthurai, 2000.
5. https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ce07

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	1	2	1	2	-	1	-	-	-
CO2	2	-	-	-	-	1	2	1	2	-	2	-	1	-
CO3	2	-	-	-	-	1	2	2	2	-	2	-	-	-
CO4	2	-	-	-	-	1	2	1	2	-	2	-	-	-
CO5	2	-	-	-	-	1	2	1	2	-	2	-	-	-
CO6	2	-	-	-	-	1	2	1.2	2	-	1.8	-	1	-
Avg.	2	-	-	-	-	1	2	1	2	-	1	-	-	-

HS24101	English for Professional Communication	HSMC	L	T	P	C
			3	0	0	3

Course Objectives:

- To develop effective listening, speaking, reading, and writing skills for professional contexts.
- To cultivate formal correspondence skills for workplace communication.
- To analyze and apply rhetorical techniques in writing and speaking.
- To encourage self-expression through storytelling and reflective writing.
- To strengthen grammar and vocabulary for improved language proficiency.

UNIT I COMMUNICATION BASICS **9**

Listening - Link verbal and nonverbal cues and listen to podcasts and news stories.
Reading - Read brochures and running headlines. Social media messages and electronic correspondence relevant to professional advancement
Writing - Formal letters
Speaking - Self-introduction - Dialogues and role plays, discussing news stories, asking doubts (clarification, direction, inquiring details…)
Grammar - Noun, Pronoun, Articles
Vocabulary - one-word substitution, phrasal verbs

UNIT II PROFESSIONAL CORRESPONDENCE **9**

Listening - Listen to voicemails, presentations, and panel discussions
Reading - MoM - minutes of the meeting, memos, business and economic articles
Writing - Respond to Business Emails
Speaking - Inaugural speech, Vote of thanks, and mini-presentation
Grammar - Verb, concord, wh questions, and Yes/no, question tag
Vocabulary - Word forms (Prefix & suffix)

UNIT III RHETORIC COMMUNICATION **9**

Listening - Monologue from plays and movies, and sale pitches (marketing and promotions)
Reading - Looking for ambiguity - Ethos, pathos, and logos (poem or play)
Writing - Essays - problem solution, cause and effect essay
Speaking - Deliver a monologue - situational scenarios
Grammar - Conjunctions, prepositions, interjections
Vocabulary - Discourse markers for contextual essays, idioms, and phrases

UNIT IV EXTENDED NARRATION **9**

Listening - Listen to documentaries, debates, discussions, and Toastmasters speech
Reading - Read professional resumes, LinkedIn profiles, newsletter
Writing - Blog writing, writing reviews
Speaking - Debate, group discussion
Grammar - Mixed tenses, Adverb
Vocabulary - Compound words, Collocation

UNIT V LANGUAGE AND SELF **9**

Listening - Listen to tone, mood, and attitude. Find meanings based on the context, and listen to different accents.
Reading - An excerpt from an autobiography
Writing - Reflective journal and diary entries
Speaking - Narrate stories from personal experience
Grammar - Adjective, direct, and indirect speech
Vocabulary - Contextual meaning of words, Abbreviations, and acronyms

Total Periods: 45

Course Outcomes:

CO1: Demonstrate enhanced listening, speaking, reading, and writing skills tailored for professional environments.
CO2: Compose clear formal emails and letters for workplace communication.
CO3: Analyze and use rhetorical techniques to engage and persuade audiences.
CO4: Develop storytelling and reflective writing skills to share personal experiences.
CO5: Improve grammar and vocabulary for effective communication.
CO6: Foster teamwork and discussion abilities through debates and group presentations.

Suggested Activities:

- Take a set of 15 messages and classify them into spam, alerts, scams, discount texts, news, cautionary, personnel, and informative.
- Reflective journal - write your own personal and learning experience so far at LICET. Page limit: 3 pages.
- Rhetoric Writing - Find a product or create a product and employ ethos, pathos, and logos to persuade the customers to buy your product. Write in 250 words.
- Creative writing - Create your account on Blogger and write reviews, articles, and stories.

Text Books:

1. English for Engineers and Technologists. Volume I by Orient Blackswan, 2022
2. English for Science & Technology - I by Cambridge University Press, 2023

References:

1. Interchange. Cambridge University Press. USA, 2022.
2. Embark. Cambridge University Press. USA, 2016.
3. A course in Technical English. Cambridge University Press. USA, 2023.
4. High School English Grammar & Composition. Wren & Martin's Regular & Multicolour Edition. S.Chand Publishing, 2016.
5. Interchange by Jack C. Richards, Fifth Edition, Cambridge University Press, 2017.
6. English for Academic Correspondence and Socializing. Adrian Wallwork, Springer, 2011.
7. The Study Skills Handbook. Stella Cortrell, Red Globe Press, 2019
8. www.uefap.com

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	2	3	-	3	-	-	-
CO2	-	-	-	-	-	-	-	2	3	-	3	-	-	-
CO3	-	-	-	-	-	-	-	3	3	-	3	-	-	-
CO4	-	-	-	-	-	1	-	1	1	-	3	-	-	-

CO5	-	-	-	-	-	-	-	2	3	-	3	-	-	-
CO6	-	-	-	-	-	-	-	3	3	-	3	-	-	-
Avg.	-	-	-	-	-	1	-	2	3	-	3	-	-	-

PH24101 Physics for Electrical Engineers BSC L T P C

3 0 0 3

Course Objectives:

- To instill knowledge of oscillations and waves and make them able to apply this knowledge in engineering situations.
- To establish a sound grasp of foundational principles of quantum mechanics and enable them to perform basic quantum mechanical calculations.
- To introduce the basics principles of photonics and fibre optic communication to students
- To make students understand the applications of quantum mechanics in solid state physics to decipher the electrical properties of materials.
- To make students understand the quantum mechanical basis of magnetic properties of materials

UNIT I OSCILLATIONS AND WAVES

Simple harmonic motion - Torsional pendulum – Damped oscillations –Shock Absorber -Forced oscillations and Resonance (qualitative)–Applications of resonance - Electrical analogy of mechanical oscillators - waves on a string - progressive waves - stationary waves- Energy transfer of a wave.

UNIT II QUANTUM MECHANICS

Black body radiation – Planck's hypothesis and black body radiation formula (qualitative)- Wave particle duality–de Broglie hypothesis– Uncertainty Principle – The Schrodinger Wave equation (time-dependent and time-independent) – Physical interpretation of wave function - Normalization - Particle in an infinite potential well - Energy values and wavefunctions- Quantum mechanical tunneling. Scanning tunneling microscope.

UNIT III QUANTUM THEORY OF SOLIDS

Particle in a three-dimensional box - Degenerate energy states. Electrons in metals -Classical free electron theory- quantum free electron theory Fermi- Dirac statistics – Density of energy states. Fermi energy and free electron density. Drawbacks of quantum free electron theory- Electrons in a periodic potential- Kronig-Penney Model (qualitative) -Band theory. Classification of solids based on energy band structure.

UNIT IV SEMICONDUCTOR PHYSICS

Intrinsic Semiconductors – Energy band diagram – direct and indirect band gap semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors – Variation of carrier concentration with temperature – Carrier transport in Semiconductors: Drift, mobility and diffusion – Hall effect and devices – Ohmic contacts – Schottky diode

UNIT V MAGNETIC PROPERTIES OF MATERIALS

Magnetization of matter - Magnetic dipole moment- Atomic magnetic moments - Magnetization vector and Magnetizing field - Magnetic permeability and susceptibility- Dia, para, and ferromagnetic materials – paramagnetism in the conduction electrons in metals – exchange interaction and origin of ferromagnetism – Soft and hard magnetic materials - Examples and Uses - Giant magnetoresistance- GMR devices.

Total Periods:45

Course Outcomes:

On completion of the course, the students will be able to

CO1: Express the knowledge of oscillation and wave phenomena.
CO2: Understand basic applications of quantum mechanics and be able to calculate the wave functions and energy values of particles confined to microscopic dimensions by infinite potential wells.
CO3: Describe electrical properties of solids on the basis of quantum mechanical principles
CO4: Describe properties of semiconductors on the basis of quantum mechanical principles
CO5: Describe the transport mechanisms in semiconductors and their applications
CO6: Describe the quantum mechanical origin of magnetic properties of materials and applications of magnetic materials.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)

- Nanostructure Case Study
- Case Study on Magnetic Materials
- Research Assignment

Text Books:

1. Avadhanulu M N, Kshirsagar P G, “A Textbook of Engineering Physics”, S Chand & Co Ltd, Ninth Revised Edition, 2012.
2. Hitendra K Malik, A K Singh " Engineering Physics McGraw Hill Education; Second edition (3 August 2017)
3. Gaur R K, Gupta S L, “Engineering Physics”, Dhanpat Rai Publishers, 2012.

References:

1. S.O. Kasap. Principles of Electronic Materials and Devices, McGraw Hill Education (Indian Edition), 2020.
2. Serway R A, Jewett J W, “Physics for Scientists and Engineers”, Cengage Learning, 2010.
3. Halliday D, Resnick R, Walker J, “Principles of Physics”, Wiley, 2015.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	-	1	-	-	-	-	-	-	-	-	-	-
CO2	2	1	-	1	-	-	-	-	-	-	-	-	-	-
CO3	2	1	-	1	-	-	-	-	-	-	-	-	-	-
CO4	2	1	-	1	-	-	-	-	-	-	-	-	-	-
CO5	2	1	-	1	-	-	-	-	-	-	-	-	-	-
CO6	2	1	-	1	-	-	-	-	-	-	-	-	-	-
Avg.	2	1	-	1	-	-	-	-	-	-	-	-	-	-

GE24101	Heritage of Tamils	HSMC	L	T	P	C
			1	0	0	1

Course Objectives:

This course enables the students to

- provide an insight to the students into the rich culture and heritage of the state
- provide the students with detailed information on the engineering techniques to construct architectural marvels practiced in Tamil Nadu
- make the students connect with their roots, appreciate, and preserve it.

UNIT I LANGUAGE AND LITERATURE

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

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 HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE

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

UNIT IV THINAI CONCEPT OF TAMILS

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

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 Periods:15

Course Outcomes:

On completion of the course, the students will be able to

CO1: Understand the human values and rights in Tamil literature
CO2: Learn the art and culture being practiced by the people of Tamil Nadu
CO3: Understand various games and dance practices by the people of Tamil Nadu
CO4: Understand the Tamil Culture and Customs through Folklore
CO5: Learn the concepts of Sangam Literature and the bravery of Kings
CO6: Learn the life history of freedom fighters Vedic herbs and developments in lifestyle

Suggested Activities:

- Sangam Literature Discussion
- Temple Architecture Study
- Sangam City Mapping Activity

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 சங்ககால 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 Civilization 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.

GE24101	**தமிழர் மரபு**	**HSMC**	**L**	**T**	**P**	**C**
			1	**0**	**0**	**1**

அலகு I 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 பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம்,

ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II 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 III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் **3**

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

அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள் **3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறைமுகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குக் தமிழர்களின் பங்களிப்பு **3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

Total Periods:15

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 சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
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12. Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by: RMRL) – Reference Book.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	2	-	3	-	2	-	-	-	1
CO2	-	-	-	-	-	3	-	2	1	2	-	-	-	1
CO3	-	-	-	-	-	2	-	1	3	2	-	-	-	1
CO4	-	-	-	-	-	3	1	2	1	2	-	-	-	1
CO5	-	-	-	-	-	2	-	3	-	2	-	-	-	1
CO6	-	-	-	-	-	3	2	2	1	2	1	-	-	1
Avg.	-	-	-	-	-	2.5	1.5	2.16	1.5	2	1	-	-	1

GE24111 Engineering Graphics ESC L T P C

2 0 4 4

Course Objectives:

- To draw engineering curves and freehand sketch of simple objects.
- To draw orthographic projection of solids and sections of solids.
- To draw development of solids
- To draw isometric and perspective projections of simple solids.

CONVENTIONS AND GEOMETRIC CONSTRUCTION (Not for examinations)

Importance of graphics in engineering applications - Use of drafting instruments - BIS conventions and specifications - Size, layout and folding of drawing sheets - Lettering and dimensioning.

UNIT I PLANE CURVES AND FREEHAND SKETCHING

Basic curves used in engineering practices: Construction of conic sections by eccentricity method - Construction of cycloidal curves - Construction of involutes of square and circle - Drawing of tangents and normal to the above curves.

Visualization concepts and Free Hand sketching: Visualization principles - Layout of views- Freehand sketching of multiple views from pictorial views of objects.

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE

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. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III 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.

UNIT IV SECTION AND DEVELOPMENT OF SOLIDS

Sectioning of simple solids like prisms, pyramids, cylinders, and cone in a simple vertical position when the cutting plane is inclined to one of the principal planes and perpendicular to the other - obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids - Prisms, pyramids cylinders and cones.

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS

Principles of isometric projection - isometric scale - isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones - Perspective projection of simple solids - Prisms, pyramids and cylinders by visual ray method.

COMPUTER AIDED DRAFTING (Demonstration Only, Not for Exam)

The Concepts of Computer Aided Drafting for Engineering drawing, Computer graphics & Geometrical modelling (2D Orthographic Views) and 3D drafting (Isometric Views) using design software.

Total Periods: 90

Course Outcomes:

On completion of the course, the students will be able to

CO1: Construct the conic curves, involutes and cycloids.
CO2: Visualize and construct multiple views of solid.
CO3: Solve practical problems involving projection of lines and planes.
CO4: Draw the projection of simple solids.
CO5: Draw the sectional views of simple solids, obtain true shape and develop sectioned solids.
CO6: Draw the isometric and perspective projections of simple solids.

Suggested Activities:

- Build paper/cardboard models and generate front, top, and side views.

Text Books:

1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 53rd Edition, 2019.

2. Jayapoovan T, “Engineering Graphics using AUTOCAD”, Vikas Publishing ,7 th Edition.
3. Natrajan K.V., “A Text Book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2018.

References:

1. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, McGraw Hill, 2nd Edition, 2019.
2. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Publications, Bangalore, 27th Edition, 2017.
3. Luzzader, Warren.J. and Duff, John M., “Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4. Shah M.B., and Rana B.C., “Engineering Drawing”, Pearson Education India, 2nd Edition, 2009.

Publication of Bureau of Indian Standards:

1. IS10711 — 2001: Technical products Documentation — Size and layout of drawing sheets.
2. IS 9609 (Parts 0 & 1) — 2001: Technical products Documentation —Lettering.
3. IS 10714 (Part 20) — 2001 & SP 46 — 2003: Lines for technical drawings.IS 11669 — 1986 & SP 46 —2003: Dimensioning of Technical Drawings.
4. 5. IS 15021 (Parts 1 to 4) — 2001: Technical drawings — Projection Methods.

Special points applicable to Semester End Examinations on Engineering Graphics:

1. There will be five questions, each of either-or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	2	-	2	-	-	-	3	-	2	2	-	-
CO2	3	1	2	-	2	-	-	-	3	-	2	2	-	-
CO3	3	1	2	-	2	-	-	-	3	-	2	2	-	-
CO4	3	1	2	-	2	-	-	-	3	-	2	2	-	-
CO5	3	1	2	-	2	-	-	-	3	-	2	2	-	-
CO6	3	1	2	-	2	-	-	-	3	-	2	2	-	-
Avg.	3	1	2	-	2	-	-	-	3	-	2	2	-	-

GE24122 Engineering Practices Laboratory – Electrical and Electronics

ESC | L 0 | T 0 | P 2 | C 1

Course Objectives:

- To learn the basics of electronic components.
- To understand the internal structure and working of the measuring instruments.
- To construct a prototype circuit on a breadboard and verify.
- To understand the process behind the PCB fabrication.

- To introduce the functionality of various electrical components namely switches, fuse, and meters to perform wiring various electrical joints in common household electrical wire work.
- To introduce the methods for measuring electrical quantities

LIST OF EXPERIMENTS:

Electrical

1. Introduction to Electrical Components switches, fuses, indicators, and lamps
2. Basic switchboard wiring with lamp, fan, three-pin socket, and energy meter
3. Staircase wiring
4. Fluorescent Lamp wiring with introduction to CFL and LED types
5. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit

Electronics

1. Study of electronic components resistor, capacitor, inductor, transistor and diode.
2. Introduction to CRO, DSO, MSO, FG and their working principles.
3. Circuit prototyping and verification.
4. Build a printed circuit board and verify the desired output.

Total Periods:30

Course Outcomes:

On completion of the course, the students will be able to

CO1: Identify and describe the function of various electronic components, leading to successful application in circuit design.
CO2: Accurately interpret and apply measurement data in practical scenarios.
CO3: Build a prototype of a circuit and validate its output.
CO4: Gain knowledge of PCB fabrication processes, including design, etching, and assembly.
CO5: Understand the working of electrical switches, measuring instruments, and wiring layouts used in domestic applications and carry out basic electrical wiring work.
CO6: Comprehend the concepts of current, voltage, power, and power factor using various measuring instruments

Laboratory requirements:

S. No.	Description of equipment	Required numbers (for a batch of 30 students)
1.	Resistors, Capacitors, Inductors – sufficient quantities. Bread Boards	15 nos.
2.	CRO, MSO, DSO, FG, Power Supply	5 Nos.
3.	PCB etching kit (Ferric Chloride, Drilling machine, Layout design)	15 kits
4.	Soldering iron, paste, lead, desoldering pump	15 nos. each

5.	Single way switch, Two way switch, fuses, indicators, 230 V -60W incandescent lamp	5 nos each
6.	Basic switchboard wiring kit and ,Energy meter	5 nos each
7.	Staircase wiring kit	5 nos each
8.	Fluorescent Lamp wiring kit, CFL and LED lamps	5 nos each
9	1φ Auto Transformer, Voltmeter, Ammeter, Rheostat, Capacitor, Choke	5 nos each
10.	Multimeters	6 nos

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	2	1	2	1	-	-	-	-	-
CO2	2	1	1	2	1	-	-	2	1	-	-	-	-	-
CO3	2	1	1	1	1	-	-	2	1	-	-	-	-	-
CO4	2	1	1	1	1	-	-	2	1	-	-	-	-	-
CO5	2	1	1	1	1	-	1	2	1	-	-	-	-	-
CO6	2	1	1	2	1	2	-	2	1	-	-	-	-	-
Avg.	2	1	1	1	1	1	1	2	1	-	-	-	-	-

PH24121 Physics Laboratory **BSC** **L T P C**

0 0 2 1

Course Objectives:

- To learn the measurements of various elastic moduli of materials
- To learn determination of thermal properties of materials.
- To study different optical phenomena involving ordinary light.
- To measure the characteristic properties of lasers.
- To understand the characteristics of oscillatory motion.
- To learn measurement of rigid body moment of inertia.

LIST OF EXPERIMENTS (any six experiments):

1 Non-uniform bending - Determination of Young's modulus

2 Uniform bending – Determination of Young's modulus

3 Lee's Disc Experiment - Determination of thermal conductivity of bad conductors.

4 Torsional pendulum - Determination moment of inertia of regular and irregular objects.

5 Simple harmonic oscillations of cantilever

6 Ultrasonic interferometer – determination of sound velocity and liquids compressibility

7 Viscosity of Liquids

8 Air wedge - Determination of thickness of a thin sheet/wire

9 Optical fibre -Determination of Numerical Aperture and acceptance angle

10 Spectrometer-Determination of the wavelength of light using grating

11 (a) Laser- Determination of the wavelength of the laser using grating
(b) Compact disc- Determination of width of the groove using laser.

Total Periods: 30

Laboratory Requirements:

Sl No.	LIST OF THE EXPERIMENTS	REQIURED QTY
1	Non-uniform bending - Determination of Young's modulus	5
2	Uniform bending – Determination of Young's modulus	5
3	Lee's Disc Experiment - Determination of thermal conductivity of bad conductors.	5
4	Torsional pendulum - Determination moment of inertia of regular and irregular objects.	5
5	Simple harmonic oscillations of cantilever	5
6	Ultrasonic interferometer – determination of sound velocity and liquids compressibility	5
7	Viscosity of Liquids	5
8	Air wedge - Determination of thickness of a thin sheet/wire	5
9	Optical fiber -Determination of Numerical Aperture and acceptance angle	5
10	Spectrometer-Determination of the wavelength of light using grating	5
11	1. Laser- Determination of the wavelength of the laser using grating 2. Compact disc- Determination of width of the groove using laser.	5

Course Outcomes:

On completion of the course, the students will be able to

CO1: Determine various moduli of elasticity of materials
CO2: Determine thermal properties of solids
CO3: Analyze various optical phenomena involving ordinary light.
CO4: Determine the characteristic properties of lasers.
CO5: Measure characteristic properties of systems executing oscillatory motion.
CO6: Determine the moment of inertia of rigid bodies

Text Books:

1. Engineering Physics Practicals by Dr. P. Mani, Dhanam Publications, 2023
2. Practical Physics by Gordon L Squires, Cambridge University Press; 4th edition, 2001

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	-	3	-	-	-	2	-	-	-	-	-	-
CO2	2	2	-	3	-	-	-	2	-	-	-	-	-	-
CO3	2	2	-	3	-	-	-	2	-	-	-	-	-	-
CO4	2	2	-	3	-	-	-	2	-	-	-	-	-	-
CO5	2	2	-	3	-	-	-	2	-	-	-	-	-	-
CO6	2	2	-	3	-	-	-	2	-	-	-	-	-	-
CO7	2	2	-	3	-	-	-	2	-	-	-	-	-	-
Avg.	2	2	-	3	-	-	-	2	-	-	-	-	-	-

GE24123 **Design Thinking** **HSMC** **L T P C**

0 0 2 1

Course Objectives:

- Students will understand the different learning methodologies
- Students will learn the art of observation and visualization
- Students will understand the need for empathy in problem-solving
- Students will learn how to work in a team
- Students will learn to use different design thinking tools to solve problems

Module 1	An Insight to Learning: Understanding the Learning Process and Kolb's Learning Styles	2
Module 2	Journey of my life: Visualization and Wheel of Life. *Introduction to project*	4
Module 3	Observation: Listening vs hearing, Beyond observations and Mind maps	2
Module 4	Teamwork: Divergent thinking and Brainstorming	2
Module 5	Customer Journey: Journey mapping	2
Module 6	Conflict management: Balancing priorities, Reacting and Responding, Constraints to opportunities	2
Module 7	Empathy: Persona and Empathy map	2
Module 8	Design Thinking Model: 5-step process: Empathize, define, ideate, prototype, and scale	2
Module 9	Appreciation: The wonder of recognition, Articulation and Influence	2
Module 10	Project presentation	10

Total Periods: 30

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

CO1: To interpret various learning processes and stages
CO2: To observe and visualize different scenarios
CO3: To empathize with a customer
CO4:To develop a journey map based on experiences
CO5: To acknowledge the art of conflict management
CO6: To use design thinking as a tool to solve problems

Suggested Activities:

- Solve real-life problems using Design Thinking

Text Books:

1. Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solving, Pavan Soni, Penguin Random House India, Pvt. Ltd. 2020
2. Developing Thinking Skills (The Way to Success), E. Balagurusamy, 2024, Khanna Publishing House
3. The Design Thinking Toolbox: A Guide to Mastering the Most Popular and Valuable Innovation Methods, Michael Lewrick, Patrick Link, Larry Leifer, Wiley, March 2020.

References:

1. Internet Reference: https://www.interaction-design.org/
2. Internet Reference: https://online.hbs.edu/
3. Internet Reference: https://dschool.stanford.edu/

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	2	1	1	-	-	3	-	-	-
CO2	-	-	-	-	-	2	-	-	-	-	3	-	-	-
CO3	-	-	-	-	-	2	2	2	2	-	3	-	-	-
CO4	-	-	-	-	-	2	-	-	-	-	3	-	-	-
CO5	-	-	-	-	-	2	2	2	2	-	3	-	-	-
CO6	-	-	-	-	-	3	2	3	2	2	3	-	-	-
Avg.	-	-	-	-	-	2.1	1.7	2	2	2	3	-	-	-

FC24102 Cultural Identities and Globalisation — HSMC — L T P C: 2 0 0 0

Course Objectives:

- To enable students to reflect on their own cultural identity in relation to their socialisation.
- To encourage cultural diversity that underpins the formation of identity and social behaviours.
- To give exposure to the varied cultural influences on the parent culture.
- To prepare to address the challenges and tensions in the globalised society.

UNIT I EXPLORING SOCIAL AND CULTURAL IDENTITY **5**

Identity formation & environmental interaction

- Race/ethnicity
- Gender
- Language
- Religion
- Socialisation (contact with different cultures)

UNIT II REGIONAL AND CULTURAL INFLUENCE ON SOCIAL BEHAVIOUR AND IDENTITY 6

- Assimilation, Amalgamation and Hybridisation
- Cultural Behaviour - dialect, traditions, social behaviour (customs), etiquette (work culture), habits, cuisine and regional variation

UNIT III DISSEMINATION OF MASS CULTURE PRACTICES 6

- Cultural Imperialism
- Colonisation and Globalization - Cultural turn
- Manufacturing pop culture - Language, food, movies, music, fashion, cosmetics.

UNIT IV SOCIO-CULTURAL CHANGES VIA GLOBALISATION 6

- Indian globalisation through trade liberalisation
- Increased migration flow with economic opportunities
- Cultural exchange, global networks
- Urbanisation - impact on family ideology and social structure

UNIT V EMBRACING GLOBAL IDENTITIES 7

- Challenges and tension
- Adaptable to changing society - etiquettes (in cross-cultural workspace) and social behaviours
- Building understanding and tolerance

Total Periods: 30

Course Outcomes:

On completion of the course, the students will be able to

CO1: Engage in conversations with themselves in relation to their local culture and society.
CO2: Realise the nuances of identity formation through various means of socialisation.
CO3: Critically assess the countless social and cultural behaviours that influence their identity and behaviour.
CO4: Examine the role of globalisation and liberalisation in urbanisation and cultural imperialism.
CO5: Adapt to the cross-cultural changes and engage in global networking.

CO6: Respond appropriately in a multicultural space by building tolerance and understanding.

Suggested Activities:

- Exercise on identity formation - creation of mind maps / storyboards
- A mini presentation on "Identifying one's own culture amidst the influence of the diverse cultural environment" - expressing only one cultural aspect (language, attire, habits, food, …)
- Opinion piece speech - Deliver a short speech expressing personal opinions
- Survey report - Comparison chart (5 exchanges) by engaging conversations with a elderly stranger or grandparents
- Produce a 30-second reel showcasing their understanding of the social etiquette of a specific country.

Text Books:

1. Worksheets and activity sheets.

References:

1. Brooks, Ann. Popular Culture: Global Intercultural Perspectives. United Kingdom, Bloomsbury Publishing, 2014.
2. Verkuyten, Maykel. Identity and Cultural Diversity: What Social Psychology Can Teach Us. United Kingdom, Taylor & Francis, 2013, pp. 1-27.
3. Savage, Michael, et al. Globalization and Belonging. United Kingdom, SAGE Publications, 2004, pp. 29-77.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	2	-	2	1	-	2	-	-	-
CO2	-	-	-	-	-	2	-	-	1	-	-	-	-	-
CO3	-	-	-	-	-	2	-	-	1	-	2	-	-	-
CO4	-	-	-	-	-	2	-	2	1	-	2	-	-	-
CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO6	-	-	-	-	-	2	-	`2	1	-	2	-	-	-
Avg.	-	-	-	-	-	2	-	2	1	-	2	-	-	-

EE24201 Circuit Theory **PCC** **L T P C**

3 1 0 4

Course Objectives:

- To introduce electric circuits and their analysis
- To provide key concepts to analyze and understand electrical circuits

- To impart knowledge on solving circuit equations using network theorems
- To introduce Phasor diagrams and analysis of single & three phase circuits
- To educate on obtaining the transient response of circuits.
- To introduce the phenomenon of resonance in coupled circuits.

UNIT I DC CIRCUIT ANALYSIS

Fundamentals concepts of R, L, and C elements - Basic concepts - Charge, current, voltage, and Power - Energy Sources- Nodes, Branches, Loops - Ohm's law, Kirchoff's Law- Series resistor and voltage division- Parallel resistor and current division- source transformation - wye-delta transformation - Mesh current and node voltage methods of analysis for D.C circuits – Applications

UNIT II AC CIRCUIT ANALYSIS

A.C Circuits – Average and RMS Value – Complex Impedance – Phasor diagram - Real and Reactive Power, Power Factor, Energy- Phasor relationship for circuit elements- impedance, admittance- impedance combinations - Mesh current and node voltage methods of analysis for A.C circuits - Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced and unbalanced

UNIT III NETWORK THEOREMS FOR DC AND AC CIRCUITS

Theorems – Superposition, Thevenin's and Norton's Theorem – Maximum power transfer theorem – Reciprocity Theorem – Millman's theorem- Tellegen's Theorem-Statement, application to DC and AC Circuits

UNIT IV TRANSIENT RESPONSE ANALYSIS

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

UNIT V RESONANCE AND COUPLED CIRCUITS

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

Total Periods:60

Course Outcomes:

On completion of the course, the students will be able to

CO1: Apply circuit laws and network analysis techniques to analyze DC circuits. *(K3)*

CO2: Analyze single-phase and three-phase AC circuits using phasor concepts and network analysis methods. *(K4)*

CO3: Apply network theorems to simplify and analyze DC and AC electrical circuits. *(K3)*
CO4: Analyze the transient response of RL, RC, and RLC circuits using Laplace transform techniques. *(K4)*
CO5: Analyze resonance and coupled circuits for electrical engineering applications. *(K4)*
CO6: Analyze electrical networks using appropriate analytical methods for steady-state and transient conditions. *(K4)*

Suggested Activities:

- MATLAB/Simulink modeling of circuits.
- Virtual Labs

Text Books:

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

References:

1. Chakrabarti A, "Circuits Theory (Analysis and synthesis), Dhanpat Rai& Sons, New Delhi, 2020.
2. Joseph A. Edminister, Mahmood Nahvi, "Electric circuits", Schaum's series, McGraw-Hill, First Edition, 2019.
3. M E Van Valkenburg, "Network Analysis", Prentice-Hall of India Pvt Ltd, New Delhi, 2015.
4. Richard C. Dorf and James A. Svoboda, "Introduction to Electric Circuits", 7th Edition, John Wiley Sons, Inc. 2018.
5. Sudhakar A and Shyam Mohan SP, "Circuits and Networks Analysis and Synthesis", McGraw-Hill, 2015

Web References:

1. https://people.iith.ac.in/seshadri/Courses/Circuits/CA-2024.html
2. https://ec-amrt.vlabs.ac.in/List%20of%20experiments.html
3. https://nptel.ac.in/courses/108105112

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	-	1	1	-	-	-	-	1	2	1	-
CO2	3	2	2	-	1	1	-	-	-	-	1	2	1	-
CO3	3	2	2	-	1	1	-	-	-	-	1	2	1	-
CO4	3	2	2	-	1	1	-	-	-	-	1	2	1	-
CO5	3	2	2	-	1	1	-	-	-	-	1	2	1	-
CO6	3	2	2	-	1	1	-	-	-	-	1	2	1	-
Avg.	3	2	2	-	1	1	-	-	-	-	1	2	1	-

MA24202 Laplace Transforms and Complex Variables BSC L T P C

3 1 0 4

Course Objectives:

The objective of this course is to enable the student to

- Find the Laplace transforms of standard functions
- Find the inverse Laplace transform of a function and use it in solving differential equations
- To introduce vector differential operator and evaluation of sine, surface and volume integrals
- To introduce the basic understanding and application of the concepts of divergence and curl
- Enhance the understanding of Cauchy-Reimann equations and it's usage in the construction of analytic functions
- Familiarise the methods of complex integration, series expansion of functions

UNIT I ORDINARY DIFFERENTIAL EQUATIONS 12

Higher order linear differential equations with constant coefficients - Method of variation of parameters – Euler's and Legendre's Homogeneous equation – System of simultaneous linear differential equations with constant coefficients.

UNIT II LAPLACE TRANSFORMS 12

Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Transform of periodic functions - Initial and final value theorems – Inverse Laplace transforms – Convolution theorem – Application to solution of linear second order ordinary differential equations with constant coefficients.

UNIT III VECTOR CALCULUS 12

Gradient and directional derivative – Divergence and curl – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's, Gauss divergence and Stoke's theorems (without proof).

UNIT IV ANALYTIC FUNCTIONS 12

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping: $w=z+c$, cz, $1/z$, z^2, Bilinear transformation.

UNIT V COMPLEX INTEGRATION 12

Line integral - Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals

Total Periods: 60

Course Outcomes:

On completion of the course, the students will be able to

CO1: Use Laplace transforms to compute transformations of functions
CO2: Solve higher-order linear differential equations with constant coefficients
CO3: Solve higher-order linear equations with variable coefficients
CO4: Compute vector differential quantities and vector integrals
CO5: Summarize the principles of complex variable theory related to analytic functions.

CO6: To familiarise with complex integration techniques

Suggested Activities:

- Evaluation of Laplace transforms using scientific tool
- Evaluation of Inverse Laplace transforms using scientific tool
- Evaluation of higher order ODE using scientific tool
- Visualizing complex analytic function using scientific tool
- Visualizing complex line integrals using scientific tool

Text Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons Publishers, 10th Edition, 2014.
2. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 42nd Edition, 2012.
3. S. Arumugam., A. Thangapandian Issac and A. Somasundaram, Complex Analysis, SCITECH Publications Private Limited, 2004.

References:

1. Churchill, R.V. and Brown, J.W, Complex Variables and Applications, Tata Mc Graw-Hill, 8th Edition, 2012.
2. Murray Spiegel, John Schiller, Probability and Statistics, Schaum's Outline Series, 3rd Edition, 2010.
3. Conway J.B., "Functions of one Complex variables", Springer International Student Edition, Second Edition, New York, 2000.
4. Lars V. Ahlfors, "Complex Analysis", McGraw Hill International, Indian Edition, 2017.
5. Kumaresan, S. A Pathway to Complex Analysis, Techno Wold Publication, Kolkata, 2022
6. Ponnusamy S., Foundations of Complex Analysis, Narosa Publishing House, Second Edition, New Delhi, 2018.
7. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	-	-	-	-	-	2	-	-	-
CO2	3	2	2	2	2	-	-	-	-	-	2	-	-	-
CO3	3	2	2	2	2	-	-	-	-	-	2	-	-	-
CO4	3	2	2	2	2	-	-	-	-	-	2	-	-	-
CO5	3	2	2	2	2	-	-	-	-	-	2	-	-	-
CO6	3	2	2	2	2	-	-	-	-	-	2	-	-	-
Avg.	3	2	2	2	2	-	-	-	-	-	2	-	-	-

CS24201 Programming in C

ESC	L	T	P	C
	3	0	0	3

Course Objectives:

- To understand the constructs of C Language.
- To develop C Programs using basic programming constructs
- To develop C programs using arrays and strings
- To develop modular applications in C using functions

- To develop applications in C using pointers and structures
- To do input/output and file handling in C

UNIT I BASICS OF C PROGRAMMING 9

Introduction to programming paradigms – Applications of C Language - Structure of C program - C programming: Data Types - Constants – Enumeration Constants - Keywords – Operators: Precedence and Associativity - Expressions - Input/Output statements, Assignment statements – Decision making statements - Switch statement - Looping statements – Preprocessor directives - Compilation process

UNIT II ARRAYS AND STRINGS 9

Introduction to Arrays: Declaration, Initialization – One dimensional array –Two dimensional arrays - String operations: length, compare, concatenate, copy – Selection sort, linear and binary search.

UNIT III FUNCTIONS AND POINTERS 9

Modular programming - Function prototype, function definition, function call, Built-in functions (string functions, math functions) – Recursion, Binary Search using recursive functions –Pointers – Pointer operators – Pointer arithmetic -Function pointers– Arrays and pointers – Array of pointers – Parameter passing: Pass by value, Pass by reference.

UNIT IV STRUCTURES AND UNION 9

Structure - Nested structures – Pointer and Structures – Array of structures – Self-referential structures – Dynamic memory allocation - Singly linked list – typedef – Union - Storage classes and Visibility.

UNIT V FILE PROCESSING 9

Files – Types of file processing: Sequential access, Random access – Sequential access file - Random access file - Command line arguments.

Total Periods: 45

Course Outcomes:

On completion of the course, the students will be able to
CO1: Demonstrate knowledge on C Programming constructs
CO2: Develop simple applications in C using basic constructs
CO3: Design and implement applications using arrays and strings
CO4: Develop and implement modular applications in C using functions
CO5: Develop applications in C using structures and pointers
CO6: Design applications using sequential and random-access file processing

Suggested Activities:

- Create exercises where students write their own macros and use preprocessor directives like #define, #include, etc., in various scenarios.
- Quizzes on Code Snippets
- Assignment on numerical problems
- Present real-world problem scenarios that can be solved using C. For example, writing a simple command-line calculator, implementing sorting algorithms, or creating a small text-based game.
- External Learning – Graphics in C

Text Books:

1. Reema Thareja, "Programming in C", Oxford University Press, Second Edition, 2016.
2. Kernighan, B.W and Ritchie, D.M, "The C Programming language", Second Edition, Pearson Education, 2015.

References:

1. Paul Deitel and Harvey Deitel, "C How to Program with an Introduction to C++", Eighth edition, Pearson Education, 2018.
2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.
3. Byron S. Gottfried, "Schaum's Outline of Theory and Problems of Programming with C", McGraw-Hill Education, 1996.
4. Pradip Dey, Manas Ghosh, "Computer Fundamentals and Programming in C", Second Edition, Oxford University Press, 2013.
5. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", 1st Edition, Pearson Education, 2013.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	3	1	-	-	-	2	-
CO2	3	2	1	-	-	-	-	3	1	-	-	-	2	-
CO3	3	2	1	-	-	-	-	3	1	-	-	-	2	-
CO4	3	2	2	-	-	-	-	3	1	-	-	-	2	-
CO5	3	2	3	1	-	-	-	3	1	-	-	-	2	-
CO6	3	2	3	1	-	-	-	3	1	-	-	-	2	-
Avg.	3	2	2	1	-	-	-	3	1	-	-	-	2	-

CY24201 Chemistry for Electronic Engineering BSC L T P C

3 0 0 3

Course Objectives:

- To understand the fundamental concepts of electrochemical cells, redox reactions, and their applications in various chemical processes.
- To introduce the principles of corrosion, including the types, factors influencing corrosion, and methods for corrosion control.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.
- To impart knowledge on the basic principles and preparatory methods of nano-materials.
- To learn the techniques of instrumental analysis for the characterization of materials.
- To explore the properties and applications of smart materials in engineering.

UNIT I ELECTROCHEMISTRY AND CORROSION 9

Electrochemical Cell, Redox Reaction, Electrode Potential - Oxidation and Reduction Potential. Nernst Equation and Applications. Emf series.
Introduction to Corrosion - Chemical and Electrochemical Corrosion (Galvanic Corrosion, Concentration Cell Corrosion), Galvanic series - Factors Influencing Corrosion. Corrosion Control - Material Selection and Design - Electrochemical Protection - Sacrificial Anodic Protection and Impressed Current Cathodic Protection. Protective Coatings - Metallic Coatings (Galvanizing, Tinning), Organic Coatings (Paints). Paints: Constituents and Functions.

UNIT II STORAGE DEVICES AND ENERGY SOURCES 9

Batteries - Characteristics - Types of Batteries – Primary Battery (Alkaline Battery), Secondary Battery (Lead Acid, Lithium - Ion - Battery) - Emerging Batteries – Nickel - Metal Hydride Battery, Aluminium Air Battery, Batteries for Automobiles and Satellites - Fuel Cells (Types) – H2-O2 Fuel Cell – Super capacitors - Types and Applications,
Nuclear Energy – Nuclear Fission, Fusion, Differences, Characteristics – Nuclear Chain Reactions – Light Water Nuclear Reactor – Breeder Reactor.
Renewable Energy: Solar energy - Solar Cells, DSSC

UNIT III NANO CHEMISTRY 9

Basics: Distinction Between Molecules, Nanomaterials and Bulk materials; Size - Dependent Properties (Optical, Electrical, Mechanical, Magnetic and Catalytic). Types of Nanomaterials: Definition, Properties and Uses of - Nanoparticle, Nanocluster, Nanorod, Nanowire and Nanotube. Preparation of Nanomaterials: Sol-Gel, Solvothermal, Laser Ablation, Chemical Vapour Deposition, Electrochemical Deposition and Electro Spinning. Applications of Nanomaterials in Medicine, Agriculture, Energy, Electronics and Catalysis.

UNIT IV INSTRUMENTAL METHODS AND ANALYSIS 9

Introduction, Absorption of Radiation, Types of Spectra, UV-Visible and IR Spectrophotometer: Instrumentation and Applications, Cyclic Voltammetry for Redox System. Thermal Methods of Analysis TGA, DTA, DSC. Sensors: Oxygen, Pulse Oximeter, Biometrics, and Glucose Sensor.

UNIT V SMART MATERIALS FOR ENGINEERING APPLICATIONS 9

Polymers – Definition – Classification – Smart Polymeric Materials - Preparation, Properties and Applications of Piezoelectric Polymer - Polyvinylidene Fluoride (PVDF), Electroactive Polymer - Polyaniline (PANI) and Biodegradable Polymer - Polylactic acid (PLA). Polymer Composites: Definition, Classification – FRP's – Kevlar.
Shape Memory Alloys: Introduction, Shape Memory Effect – Functional Properties of SMAs – Types of SMA - Nitinol (Ni-Ti) Alloys - Applications.
Chromogenic Materials: Introduction – Types - Applications.

Total Periods: 45

Course Outcomes:

On completion of the course, the students will be able to

CO1: Explain the electrochemical cells, electrode potential and its applications.
CO2: Analyze the factors leading to corrosion for corrosion prevention and control in engineering materials.
CO3: Explain the operating principles, working processes and applications of energy conversion and storage devices.
CO4: Apply the basic concepts of Nano chemistry in designing the synthesis of nanomaterials for engineering applications.
CO5: Analyze materials using various instrumental techniques and sensors.
CO6: Demonstrate the application of smart materials in advanced engineering systems.

Suggested Activities:

- Quiz
- Mind Mapping on Types of Nanomaterials
- Seminar

- Animated videos on Nuclear Power Plant
- Electroplating process by group of students
- Demonstration of sensors

Text Books:

1. Jain P. C. & Monica Jain., "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi,2012.
3. Dara S.S., "A Textbook of Engineering Chemistry", Chand Publications, 2004.
4. B.K.Sharma, "Instrumental Methods of Chemical Analysis" , 28th Edition, Goel Publishing House. 2012.

References:

1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Text Book of Nanoscience and Nanotechnology", Universities Press - IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
4. ShikhaAgarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019.
5. O.V. Roussak and H.D. Gesser, Applied Chemistry - A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013.
6. Gowariker V.R., Viswanathan N.V. and Jayadev Sreedhar, "Polymer Science", New AGE International Publishers, 2009.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	-	2	-	-	-	-	2	1	-	-
CO2	3	2	2	1	-	2	-	-	-	-	2	1	-	-
CO3	3	1	2	1	-	2	-	-	-	-	2	1	-	-
CO4	2	1	-	-	-	-	-	-	-	-	1	1	-	-
CO5	2	1	1	-	-	1	-	-	-	-	1	1	-	-
CO6	3	1	2	-	-	2	-	-	-	-	1	1	-	-
Avg.	2.7	1.3	1.5	1	-	1.5	-	-	-	-	1.5	1	-	-

GE24201 Tamils and Technology HSMC L T P C

1 0 0 1

Course Objectives:

This course enables the students to

- Understand the art of making things and developments in the lifestyle of people

- Understand the various methods of constructing buildings
- Understand the techniques being used in Architecture by Tamils
- Understand and apply the concepts of Tamils with modern technology

UNIT I WEAVING AND CERAMIC TECHNOLOGY

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

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY

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

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

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

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 Periods:15

Course Outcomes:

On completion of the course, the students will be able to

CO1: Know the gradual improvement in the life history of Tamils
CO2: Construct buildings with the impact of the past with the present
CO3: Learn to manufacture remarkable things with the help of technology
CO4: Apply new Concepts in agriculture to the upliftment of the future society
CO5: Apply the ancient skills to find out the measurements of oceans
CO6: Apply the concepts of Tamil with modern technology

Suggested Activities:

Timeline Creation Activity

Case Study on Ancient Metallurgy

Maritime Heritage Study

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 சங்ககால 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 Civilization 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.

GE24201	தமிழரும் தொழில்நுட்பமும்	HSMC	L	T	P	C
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அலகு I நெசவு மற்றும் பானைத் தொழில்நுட்பம்

சங்க காலத்தில் நெசவு தொழில் – பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு - சங்க காலத்தில் கட்டுமான 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 இந்தொ-சாரோசெனிக் கட்டிடக் கலை.

அலகு III உற்பத்தித் தொழில் நுட்பம்

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 – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மை சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு V அறிவியல் தமிழ் மற்றும் கணித்தமிழ்

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

Total Periods:15

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 சங்ககால 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 Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

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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.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	3	1	2	-	2	-	-	-	1
CO2	-	1	2	-	1	2	2	-	1	1	-	-	1	1
CO3	1	2	2	-	1	2	1	-	1	1	-	1	1	1
CO4	-	2	2	1	1	3	3	1	-	1	-	1	1	1
CO5	-	2	1	1	1	3	2	-	-	1	-	1	1	1
CO6	1	2	2	1	3	2	1	-	1	2	1	1	2	3
Avg.	1	1.5	1.5	1	1.16	2.5	1.7	1.5	1.5	1.3	1	1	1	1.33

CS24221 C Programming Laboratory ESC L T P C

0 0 4 2

Course Objectives:

- To familiarise with C programming constructs.
- To develop programs in C using basic constructs.
- To develop programs in C using arrays.
- To develop applications in C using strings, pointers, functions.
- To develop applications in C using structures.
- To develop applications in C using file processing.

LIST OF EXPERIMENTS:

Note: The lab instructor is expected to design problems based on the topics listed.

1. I/O statements, operators, expressions
2. Decision-making constructs: if-else, goto, switch-case, break-continue
3. Loops: for, while, do-while
4. Arrays: 1D and 2D, multi-dimensional arrays, traversal
5. Strings: operations
6. Functions: call, return, passing parameters by (value, reference), passing arrays to function.
7. Recursion
8. Pointers: Pointers to functions, Arrays, Strings, Pointers to Pointers, Array of Pointers
9. Structures: Nested Structures, Pointers to Structures, Arrays of Structures and Unions.
10. Files: reading and writing, File pointers, file operations, random access, processor directives.

Total Periods: 60

Course Outcomes:

On completion of the course, the students will be able to

CO1: Develop simple applications in C using basic constructs
CO2: Develop simple applications in C using control flow constructs
CO3: Design and implement applications using arrays and strings
CO4: Develop and implement modular applications in C using functions
CO5: Develop applications in C using structures and pointers
CO6: Design applications using sequential and random access file processing

References:

1. Kernighan, B.W and Ritchie,D.M, “The C Programming language”, Second Edition, Pearson Education, 2015.
2. Anita Goel and Ajay Mittal, “Computer Fundamentals and Programming in C”, 1st Edition, Pearson Education, 2013.
3. Paul Deitel and Harvey Deitel, “C How to Program with an Introduction to C++”, Eighth edition, Pearson Education, 2018.
4. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.
5. Byron S. Gottfried, "Schaum's Outline of Theory and Problems of Programming with C", McGraw-Hill Education, 1996.
6. Pradip Dey, Manas Ghosh, “Computer Fundamentals and Programming in C”, Second Edition, Oxford University Press, 2013.

Laboratory Requirements:

Sl. No	Description of Equipment	Required numbers (for batch of 30 Students)
1	INTEL based desktop PC with min. 8GB RAM and 500 GB HDD, 17” or higher TFT Monitor, Keyboard and mouse	30
2	Windows 10 or higher operating system / Linux Ubuntu 20 or higher	30
3	Dev C++ / Linux Operating System with GNU compiler / equivalent open-source IDE	30

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	3	3	1	1	1	-	2	-	2	2	-	2	-
CO2	2	3	3	2	1	1	-	2	-	2	2	-	2	-
CO3	2	2	2	1	1	2	-	2	-	2	2	-	2	-
CO4	2	2	2	2	1	2	-	3	-	3	3	-	2	-
CO5	2	2	3	2	3	2	-	3	-	3	3	-	2	-
CO6	2	2	3	2	1	2	-	2	-	2	2	-	2	-
Avg.	1.8	2.3	2.7	1.7	1.3	1.7	-	2.3	-	2.3	2.3	-	2	-

EE24221	Circuit Theory Laboratory	PCC	L	T	P	C
			0	0	4	2

Course Objectives:

- To simulate various electric circuits using Pspice/ Matlab/e-Sim / Scilab
- To gain practical experience in electric circuits and verification of theorems

LIST OF EXPERIMENTS:

Familiarization with various electrical components, sources, and measuring instruments

1. Simulation and experimental verification of series and parallel electrical circuits using fundamental laws.
2. Simulation of three-phase balanced and unbalanced star, delta networks circuit (Power and Power factor calculations).
3. Simulation and experimental verification of electrical circuit problems using Thevenin's theorem.
4. Simulation and experimental verification of electrical circuit problems using Norton's theorem.
5. Simulation and experimental verification of electrical circuit problems using the Superposition theorem.
6. Simulation and experimental verification of Maximum Power transfer theorem.
7. Simulation and Experimental validation of R-C, R-L and RLC electric circuit transients
8. Simulation and Experimental validation of frequency response of series RLC electric circuit.
9. Simulation and Experimental validation of frequency response of parallel RLC electric circuit.

Total Periods: 60

Course Outcomes:

On completion of the course, the students will be able to

CO1: Demonstrate knowledge on realising circuits on breadboard and select appropriate electrical components, sources, and measuring instruments for the given circuit

CO2: Use simulation and experimental methods to verify the fundamental electrical laws for the given circuit

CO3: Use simulation and experimental methods to verify the various electrical theorems (Superposition, Thevenin, Norton, and Maximum power transfer theorems) for the given circuit.

CO4: Analyse the transient behaviour of the given RL/RC/RLC circuit using simulation and experimental methods

CO5: Analyse the frequency response of the given series and parallel RLC circuit using simulation and experimentation methods

CO6: Analyse the performance of the given three-phase circuit using simulation and experimental methods

Laboratory Requirements:

S. No.	Description of equipment	Required numbers (for a batch of 30 students)
1.	10 Nos of PC loaded with Pspice/ Matlab/e-Sim / Scilab/ Equivalent Software Package	Minimum 10 Users
2.	Printer	1
3.	Regulated Power Supply (0-30V)	15 Nos
4.	Function Generators (MHz Range)	5 Nos
5	Oscilloscope (20MHz)	10 Nos
6	Digital Storage Oscilloscope (20MHz)	2 Nos
7	AC/DC - Voltmeter of required rating	10 Nos
8	AC/DC - Ammeters of required rating	10 Nos
9	Multimeters	10 Nos
10	Decade Resistance Box, Decade Inductance Box, Decade Capacitance Box	6 Nos each
11	Single Phase Wattmeter of suitable rating	5 Nos
12	Circuit Connection Boards	20 Nos
13	Connecting Wires	Necessary Quantity
14	Necessary quantities of resistors, Inductors, and Capacitors of various capacitance (Quarter Watt to 10 Watt)	

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	1	-	2	1	-	2	3	2	3
CO2	3	3	3	3	3	1	-	2	1	-	2	3	2	3
CO3	3	3	3	3	3	1	-	2	1	-	2	3	2	3
CO4	3	3	3	3	3	1	-	2	1	-	2	3	2	3
CO5	3	3	3	3	3	1	-	2	1	-	2	3	2	3
CO6	3	3	3	3	3	1	-	2	1	-	2	3	2	3
Avg.	3	3	3	3	3	1	-	2	1	-	2	3	2	3

CY24121	Engineering Chemistry Laboratory	BSC	L	T	P	C
			0	0	2	1

Course Objectives:

- To inculcate experimental skills to test basic understanding of water quality parameters, such as acidity, alkalinity, hardness, DO, TDS, and Chloride.
- To demonstrate the synthesis of nanoparticles.
- To familiarize the students with the determination of the molecular weight of a polymer by a viscometer.
- To familiarize the students with electroanalytical techniques such as pH metry, Potentiometry, and Conductometry to determine impurities in aqueous solutions.
- To understand the factors influencing corrosion.

LIST OF EXPERIMENTS:(Minimum of 7 experiments to be conducted)

1. Estimation of HCl using Na2CO3 as primary standard
2. Determination of alkalinity in water sample.
3. Determination of total, temporary & permanent hardness of water by EDTA method.
4. Determination of DO content of water sample by Winkler's method.
5. Determination of chloride content of water sample by Argentometric method.
6. Estimation of copper content of the given solution by Iodometry.
7. Determination of strength of given hydrochloric acid using pH meter.
8. Conductometric titration of strong acid vs strong base.
9. Estimation of iron content of the given solution using potentiometer.
10. Estimation of iron content of the water sample using spectrophotometer (1, 10-Phenanthroline/thiocyanate method).

0. Estimation of sodium and potassium present in water using a flame photometer.
0. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.
0. Determination of Glass transition temperature of a polymer.
0. Preparation of nanoparticles (TiO2/ZnO/CuO) by Sol-Gel method.
0. Corrosion experiment-weight loss method.
0. Conductometric titration of barium chloride Vs Sodium Sulphate - Precipitation method.

Total Periods: 30

Course Outcomes:

On completion of the course, the students will be able to

- Analyse the quality of water samples with respect to their acidity, alkalinity, hardness and chloride.
- Comprehend the factors influencing corrosion in domestic and industrial applications.
- Demonstrate precipitation method for synthesis of nanoparticles
- Determine the molecular weight of the polymer.
- Estimate the amount of analyte by conductometry.
- Quantitatively analyse the impurities in solution by electroanalytical techniques.

References:

1. Engineering Chemistry Laboratory Manual – Department of SH-CHEMISTRY, LICET,2024.
2. Vogel's Textbook of Quantitative Chemical Analysis (8th edition, 2014).

Laboratory Requirements:

1.Conductivity meter – 15 Nos.
2. pH meter - 15 Nos.
3. Potentiometer - 15 Nos.
4.Viscometer - 35 Nos.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	2	-	-	-	-	2	-	-	-
CO2	3	2	1	-	-	2	-	-	-	-	2	-	-	-
CO3	2	1	2	-	-	2	-	-	-	-	-	-	-	-
CO4	2	1	2	-	-	1	-	-	-	-	1	-	-	-
CO5	3	1	2	-	1	2	-	-	-	-	2	-	-	-
CO6	3	1	2	-	1	2	-	-	-	-	2	-	-	-
Avg.	2.7	1.3	1.7	-	1	1.8	-	-	-	-	1.8	-	-	-

GE24121	Engineering Practices Laboratory - Civil and Mechanical	ESC	L	T	P	C
			0	0	2	1

Course Objectives:

- Familiarize students with basic tools and equipment used in engineering.
- Develop practical skills in Mechanical, Civil and 3D Printing practices.
- Encourage teamwork and collaboration in a lab environment.
- Foster an understanding of safety protocols and procedures.

INTRODUCTION AND SAFETY PRACTICES

Overview of lab rules, expectations, and safety protocols**,** Personal Protective Equipment (PPE), handling tools and equipment safely, emergency procedures.

MECHANICAL PRACTICES

Workshop Tools: Identification and usage of basic mechanical tools (hammers, wrenches, screwdrivers, etc.). **Basic Machining:** Introduction to lathe and drilling machines. Practicing Facing, Turning, and Drilling. **Sheet Metal Works:** Making a dustpan and funnel.

CIVIL PRACTICES

Plumbing: Exposure to different plumbing components. Exposure to plumbing repair methods and troubleshooting of existing connections. Practicing pipe connection to the wash basin from the water tank. **Carpentry:** A study on carpentry procedure. Making joints like the Tee joint and the Dovetail joint. Exposure and usage of power tools.

ADDITIVE MANUFACTURING PRACTICES

Welding: Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding, CO2, gas, and MIG welding techniques. **Foundry:** Introduction to the foundry process and tools. Mold preparation for solid and split patterns. **3D Printing:** Basics of 3D printing and simple projects.

ASSEMBLING AND FITTING

Introduction to Systems - Dismantling and Assembling of Mixer/IC Engines/Refrigerator and Air Conditioner

Total Periods: 30

Course Outcomes:

On completion of the course, the students will be able to

CO1: To perform basic machining operations
CO2: To perform operations on the given sheet metal
CO3: To understand the concepts of additive manufacturing methods like Welding, Moulding and 3D Printing
CO4: To understand the rudimentary concepts of refrigeration and air conditioning systems
CO5: To do basic household works like Plumbing, Carpentry Joints
CO6: To identify the components of Mixer/IC Engines/Refrigerator/AC.

Text Books:

1.Workshop Technology by W.A.J. Chapman
2.Electrical Engineering Fundamentals by Vincent Del Toro
3.Basic Civil Engineering by M.S. Palanichamy

Laboratory Requirements:

S.NO	Name of the Equipment / Software	Required
1	Welding Transformer	1
2	Gas Welding Tank With Accessories	1
3	Smithy Furnace Blower	1
4	Hand Shear Cutter	1
5	Carpentry Vice	1
6	Plumbing Vice	1
7	Sheet Metal Bench Vice	1

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	2	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	2	-	-	-	-	-	-
CO3	2	-	-	-	2	-	-	2	-	-	-	-	-	-
CO4	2	-	-	-	1	-	-	2	-	-	-	-	-	-
CO5	1	-	-	-	-	-	-	2	-	-	-	-	-	-
CO6	1	-	-	-	-	-	-	2	-	-	-	-	-	-
Avg.	1.6	-	-	-	1.5	-	-	2	-	-	-	-	-	-

FC24101	Life Skills	HSMC	L	T	P	C
			2	0	0	1

Course Objectives:

- To enhance self-awareness and understanding of personal strengths, weaknesses, and potential.
- To develop mechanisms to navigate through emotions and stress.
- To build effective interpersonal skills and maintain healthy social relationships.
- To foster and develop strategies for holistic well-being.
- To reflect on personal growth.

UNIT I KNOWING THYSELF **6**

Knowing Thyself - Strengths, Limitations, Characteristics, Habits and Experiences; Sense of SELF - Self Awareness, Self Image, Self Esteem, Self Love, Self Respect; Three Dimensions of SELF: Ideal Self, Social Self and Real Self; Personality Types:Introvert, Extrovert and Ambivert

UNIT II EMOTIONAL COMPETENCE **6**

Understanding emotions - Understanding the patterns of thoughts, feelings, and behaviors (Cognitive Behavior Theory) - Handling stress, anxiety, and fear (flight mode) / anger (fright mode) - Happy chemicals (4 chemicals - Dopamine, Oxytocin, etc) - Positive Thinking

UNIT III INTERPERSONAL SKILLS **6**

Interpersonal relationships - Communicating Positive Expressions (Empathy, Trust, Forgiveness, Gratitude, Compassion) - Personal and Social Associations - Family systems, Relationship management - Building personal, social, and digital intelligence - Sense of OTHERS - Gender Equity

UNIT IV DIMENSIONS OF WELL-BEING **6**

Intellectual Well-being - Emotional Well-being - Spiritual Well-being - Physical Well-being - Social Well-being

UNIT V LIFE TO THE FULLEST **6**

Happiness v/s Having fun - Self Retrospection and Positive Transformation - Synthesis, Personal Reflection, and Way Forward

Total Periods: 30

Course Outcomes:

CO1: Identify their strengths and weaknesses and demonstrate self-awareness through reflective practices.
CO2: Demonstrate the ability to recognize emotions and handle stress.
CO3: Enhance interpersonal skills to build strong and positive relationships.
CO4: Adapt to a comprehensive understanding of well-being, and be able to implement strategies for maintaining mental health.

CO5: Develop a deeper understanding of personal and social relationships, and identify areas for growth.
CO6: Synthesize learning into a cohesive life plan for future growth.

Suggested Activities:

- Cognitive behaviour therapy
- PLOT
- SLOT
- SWOT
- Johari Window

References:

1. Bradberry, Travis, and Jean Greaves. Emotional Intelligence 2.0. TalentSmart,2009.
2. Republic of Philippines, Department of Education. K to 12 Senior High School Core Curriculum. - Personal Development , May 2016.
3. US Department of Education, Career Guidance and Counselling Programs. Rich South High School Horizon Program: (Rich Town Park Illinois: Rich South High School, 1998)

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	3	-	-	-	-	-	-	-
CO2	-	-	-	-	-	2	3	-	-	-	-	-	-	-
CO3	-	-	-	-	-	3	3	3	3	-	-	-	-	-
CO4	-	-	-	-	-	3	3	-	3	-	3	-	-	-
CO5	-	-	-	-	-	3	3	-	-	-	3	-	-	-
CO6	-	-	-	-	-	-	3	-	-	-	-	-	-	-
Avg.	-	-	-	-	-	2.2	3	0.6	1.2	-	1.2	-	-	-

MA24302 Statistics and Numerical Methods **BSC** **L T P C**

3 1 0 4

Course Objectives:

- To acquaint the students with the knowledge of testing hypotheses for small and large samples in real life problems
- To provide a foundation in the design and analysis of experiments using various statistical techniques
- To introduce the basic concepts of solving algebraic and transcendental equations, simultaneous equations and determine eigenvalues of a matrix using numerical techniques
- To introduce the numerical techniques of interpolation, differentiation and integration which plays an important role in engineering and technology disciplines
- To familiarise various numerical techniques of solving ordinary differential equations

UNIT I TESTING OF HYPOTHESIS 9+3

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

UNIT II DESIGN OF EXPERIMENTS 9+3

One way and two-way classifications - Completely randomized design – Randomized block design – Latin square design - factorial design (introduction only).

UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9+3

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

UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION 9+3

Lagrange's and Newton's divided difference interpolation – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Gaussian Quadrature formulae - Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 9+3

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

Total Periods: 60

Course Outcomes:

On completion of the course, the students will be able to

CO1: Apply the concept of testing of hypotheses for large and small samples in real life problems
CO2: Analyse the design of experiments using ANOVA techniques
CO3: Utilise numerical techniques in solving algebraic and transcendental equations, simultaneous equations and determine eigenvalues
CO4: Interpolate values and approximate derivatives for equal and unequal intervals of discrete data using numerical techniques
CO5: Evaluate single and double integrals using numerical techniques

CO6: Compute solutions to initial value problems for ordinary differential equations

Suggested Activities:

- Conduct a survey (e.g., student attendance, mobile usage, energy consumption) and perform hypothesis testing.
- Analyze publicly available datasets and draw statistical conclusions.

Text Books:

1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
2. Johnson, R.A., Miller, I and Freund J., “Miller and Freund’s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

References:

1. Burden, R.L and Faires, J.D, "Numerical Analysis”, 9th Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences”, Cengage Learning, New Delhi, 8th Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis” Pearson Education, Asia, New Delhi, 7th Edition, 2007.
4. Gupta S.C. and Kapoor V. K., “Fundamentals of Mathematical Statistics”, Sultan Chand & Sons, New Delhi, 12th Edition, 2020.
5. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum’s Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 4th Edition, 2012.
6. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., “Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, Asia, 2010.
7. Sastry, S.S, "Introductory Methods of Numerical Analysis", PHI Learning Pvt. Ltd, 5th Edition, 2015.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	2	-	-	-	-	-	-	-	-	2	-
CO2	3	3	-	2	-	-	-	-	-	-	-	-	2	-
CO3	3	3	-	2	-	-	-	-	-	-	-	-	2	-
CO4	3	3	-	2	-	-	-	-	-	-	-	-	2	-
CO5	3	3	-	2	-	-	-	-	-	-	-	-	2	-
CO6	3	3	-	2	-	-	-	-	-	-	-	-	2	-
Avg.	3	3	-	2	-	-	-	-	-	-	-	-	2	-

Analog Electronics	PCC	L	T	P	C
		3	0	0	3

Course Objectives:

- To be familiar with the structure of basic semiconductor devices.
- To be exposed to the operation and application of electronic devices and their circuits.
- To analyze circuit characteristics with signal analysis using Op-amp IC's.
- To learn design, testing and characterizing of circuit behaviour with analog IC's like 555 timer.
- To study internal functional blocks and the applications of special IC's like Timers..

UNIT I ELECTRONIC DEVICES WITH CHARACTERISTICS 9

PN junction diodes: structure, operation and VI characteristics, drift and diffusion current, transient capacitance - BJT: structure, operation and characteristics, biasing - Introduction to: JFET, MOSFET and UJT - Applications.

UNIT II AMPLIFIER CIRCUITS 9

BJT small signal model: Analysis of CE amplifier, Gain and Frequency response - Differential Amplifier - Two-stage amplifier: Common mode and Differential mode analysis - Introduction to: Feedback amplifiers, Power amplifiers - Types (Qualitative analysis). Operation and analysis of RC phase shift, Hartley and Crystal oscillators.

UNIT III IC FABRICATION AND CHARACTERISTICS OF OP AMP 9

Fundamental of Monolithic IC technology - Ideal OP AMP characteristics - DC characteristics - AC characteristics - Basic applications: Inverting - Non- inverting - Adder - Subtractor.

UNIT IV APPLICATION OF OP AMPS 9

Differentiator - Integrator - Instrumentation amplifiers - Comparators - Schmitt Trigger - D/A converters - Weighted resistance type and R-2R ladder type - A/D converters - Flash type - Dual slope type - Successive Approximation type.

UNIT V SPECIAL IC'S 9

555 Timer circuit: Functional block diagram - Characteristics & applications – Astable and Monostable multivibrator - 566 Voltage Controlled Oscillator circuits - PLL Phase Locked Loop applications - IC Voltage regulators –LM78XX, LM79XX.

Total Periods: 45

Course Outcomes:

On completion of the course, the students will be able to

CO1 Develop a thorough understanding of semiconductor structure and underlying physics.
CO2 Develop and implement circuits using electronic devices.
CO3 Use the principles of Monolithic IC fabrication and OP-AMP characteristics to analyze electronic circuits.
CO4 Analyze, comprehend and design of analog electronic circuits involving OP-AMP.
CO5 Explain functional blocks, characteristics and applications of 555 Timer and Multivibrators.
CO6 Analyze, comprehend and design of analog electronic circuits involving PLL, voltage regulator & other special ICs.

Suggested Activities:

- Group Seminar/Assignment/Video Presentation/Content Preparation / Quiz/ Surprise Test /etc
- Design and implement a Adder/Subtractor/Inverting/Non-inverting circuit using IC 741
- Design and implement a system using 555 timer IC
- Design and implement a system using 565 PLL IC

Text Books:

1. David A bell, " Electronic circuits" , Oxford University Press, 2011.
2. Donald A Neamen, “Electronic Circuits”, McGraw Hill, edition,2007.
3. Roy Choudhary, Sheil B. Jani, ‘Linear Integrated Circuits’, , New Age, Fourth Edition, 2018.
4. Ramakant A.Gayakward, ‘Op-amps and Linear Integrated Circuits’, IV edition, Pearson Education, PHI 2021

References:

1. Millman and Halkias, " Integrated Electronics", McGraw Hill Publications, 2010.
2. Thomas L.Floyd, “Electronic devices” Conventional current version, Pearson prentice hall, 10th Edition, 2017.
3. Muhammad H. Rashid, " Linear Integrated Circuits", Cengage Learning, 2014.
4. David A. Bell, ‘Op-amp & Linear ICs’, Oxford, Third Edition, 2011.
5. Jacob Millman, Christos C.Halkias, ‘Integrated Electronics - Analog and Digital circuits system’, McGraw Hill, 2nd Edition, 2017.
6. Sergio Franco, ‘Design with Operational Amplifiers and Analog Integrated Circuits’, McGraw Hill, 2016 – Fourth Edition.

Web References:

- https://web.mit.edu/6.101/www/reference/op_amps_everyone.pdf
- https://www.analog.com/media/en/training-seminars/design-handbooks/basic-linear-design/chapter1.pdf
- https://www.microchip.com/en-us/products/amplifiers-and-linear-ics/operational-amplifier-ics
- https://circuitdigest.com/555-timer-circuits
- https://www.electronicsforu.com/electronics-projects/555-timer-circuits

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2	-	-	-	2	3	3	2	2
CO2	3	3	3	2	2	2	-	-	-	2	3	3	2	2
CO3	3	3	3	2	2	2	-	-	-	2	3	3	2	2
CO4	3	3	3	2	2	2	-	-	-	2	3	3	2	2
CO5	3	3	3	2	2	2	-	-	-	2	3	3	2	2
CO6	3	3	3	2	2	2	-	-	-	2	3	3	2	2
Avg.	3	3	3	2	2	2	-	-	-	2	3	3	2	2

EE24302	DC Machines and Transformers	PCC	L	T	P	C
			3	0	0	3

Course Objectives:

- Tothe concept of an electromechanical energy conversion system.
- To identify the appropriate machine for a given application based on its characteristics.
- To identify the appropriate test to determine the performance parameters of a given machine.
- To familiarize with the procedure for parallel operation of generators and transformers.
- To deliberate the working of autotransformers and three-phase transformers.

UNIT I ELECTROMECHANICAL ENERGY CONVERSION 9

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

UNIT II TRANSFORMERS 9

Types of transformers and constructional details - EMF equation - Phasor representation on no load and on load - Equivalent circuit - losses, and efficiency – regulation - All day efficiency - OC and SC tests - Sumpner's test - separation of losses test-parallel operation with equal and unequal voltage ratios

UNIT III AUTO TRANSFORMERS AND THREE-PHASE TRANSFORMERS 9

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

UNIT IV DC GENERATORS 9

Principle of operation, constructional details, armature windings and their types, EMF equation, armature reaction, demagnetizing, and cross magnetizing Ampere turns, commutation, OCC and load characteristics of different types of DC Generators - applications of DC Generators.

UNIT V DC MOTORS 9

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

Total Periods: 45

Course Outcomes:

On completion of the course, the students will be able to

CO1: Apply the laws governing the electromechanical energy conversion for singly and multiple excited systems.

CO2: Explain the construction and working principle of DC machines.
CO3: Interpret various characteristics of DC machines.
CO4: Compute various performance parameters of the machine by conducting suitable tests.
CO5: Draw the equivalent circuit of the transformer and predetermine the efficiency and regulation.
CO6: Describe the working principle of transformers, autotransformers, three phase transformers with different types of connections

Suggested Activities:

- Industrial Visists/Video Analysis
- Seminars
- Mind Mapping

Text Books:

1. I. J. Nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 5th Edition, 2017.
2. P. S. Bimbhra, “Electric Machinery”, Khanna Publishers, 2nd Edition, 2021.
3. J B Gupta, “Theory & Performance of Electrical Machines”,S.K. Kataria &Sons,2013.

References:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery”, New York, McGraw Hill Education, 6th Edition 2017.
2. A Textbook of Electrical Technology by B.L.Theraja & A.L.Theraja, Volume-2, Schand Publishing.
3. Sahdev S. K. “Electrical Machines”, Cambridge University Press, 2018.
4. A. E. Clayton and N. N. Hancock, “Performance and design of DC machines”, CBS Publishers, 2004.
5.M. G. Say, “Performance and Design of AC Machines”, CBS Publishers, 3rd Edition, 2002

Web References:

1. Lecture Series on Electrical Machines - I by Prof. Tapas Kumar Bhattacharya , Department of Electrical Engineering, Indian Institute of Technology, Kharagpur NPTEL: Electrical Engineering - NOC: Electrical Machines - I
2. Lecture Series on Electrical Machines by Professor G. Bhuvaneswari , Department of Electrical Engineering, Indian Institute of Technology, Delhi. NPTEL :: Electrical Engineering - NOC: Electrical Machines
3. Lecture Series on Electrical Machines-1 by Prof. Suman Maiti, Indian Institute of Technology, Kharagpur NPTEL: Electrical Engineering - Electrical Machines -I

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	-	-	-	-	-	1	3	2	2
CO2	3	2	1	1	1	-	-	-	-	-	1	3	2	2
CO3	3	2	1	1	1	-	-	-	-	-	1	3	2	2
CO4	3	2	1	1	1	-	-	-	-	-	1	3	2	2
CO5	3	2	1	1	1	-	-	-	-	-	1	3	2	2
CO6	3	2	1	1	1	-	-	-	-	-	1	3	1	1
Avg.	3	2	1	1	1	-	-	-	-	-	1	3	1.8	1.8

EE24303	Electromagnetic Theory	PCC	L	T	P	C
			3	0	0	3

Course Objectives:

- To apply Vector calculus and Coordinate Transformation to static electric and magnetic fields in different Engineering situations.
- To apply Coulomb's law and Gauss's law to determine the electric field intensity, potential and capacitance for various configurations of charge distributions and for various dielectric materials
- To analyze and classify magnetic materials and solve magnetic field problems using Biot Savart's law and Ampere's circuit law with the associated boundary conditions
- To analyze Maxwell's equation in different forms and apply them to diverse engineering problems
- To analyze the behavior of electromagnetic wave propagation in different media, reflection and refraction at their interface by applying Maxwell's equation.

UNIT I VECTOR ANALYSIS 9

Vector fields – Various coordinate systems: Cartesian, Cylindrical, and Spherical – Gradient, Divergence, and Curl operations – Gauss's Divergence Theorem – Stokes' Theorem.

UNIT II ELECTROSTATICS – I 9

Sources and effects of electromagnetic fields – Coulomb's Law – Electric field intensity – Field generated by point and continuous charge distributions – Gauss's Law and its applications – Electric potential – Energy density.

UNIT III ELECTROSTATICS – II 9

Electric field behaviour in free space, conductors, and dielectrics – Dielectric polarization and strength – Electric field distribution in multiple dielectrics – Boundary conditions – Capacitance – Coaxial cable, Two parallel wires.

UNIT IV MAGNETOSTATICS 9

Magnetic field intensity – Biot-Savart Law – Ampere's Law and applications – Magnetic field due to straight conductors, circular loop, infinite sheet of current – Magnetic flux density (B) – Magnetization – Boundary conditions – Inductance – Solenoid, Coaxial cable, Two wire Transmission line – Energy density.

UNIT V ELECTRODYNAMIC FIELDS 9

Magnetic force – Lorentz Law of force – Torque – Faraday's laws, induced emf – Transformer and motional EMF – Maxwell's equations (differential and integral forms) – Displacement current – Derivation of generalized Wave Equations from Maxwell's equations.

Total Periods: 45

Course Outcomes:

On completion of the course, the students will be able to

- Utilize fundamental mathematical principles of electromagnetic vector fields for field calculations.

- Implement electrostatic concepts to determine electric field intensity, electrical potential, and energy density.
- Analyse electric fields in free space, conductors, and dielectrics, including multiple dielectrics, and apply fundamental capacitance principles.
- Apply magnetostatic concepts to compute magnetic flux density, and energy density.
- Explain various methods of electromagnetic force (emf) generation and the fundamentals of Maxwell's equations.
- Interpret and apply Maxwell's equations in differential and integral forms, wave equations to analyse electromagnetic fields.

Suggested Activities:

1.Assignments for Teamwork and Adaptive Learning

2.Mindmap

3.Animated Videos

Text Books:

1. Mathew N. O. Sadiku, "Elements of Electromagnetics", Oxford University Press Inc., Seventh Edition, 2018.
2. William H. Hayt, "Engineering Electromagnetics", McGraw Hill, Indian Edition, 2014.
3. Y. Mallikarjuna Reddy , " Electromagnetic Fields" ,Universities Press Private Limited, 2013.

References:

1. Joseph A. Edminister, "Theory and Problems of Electromagnetics", Second Edition, Schaum Series, McGraw Hill, 1993.
2. Kraus and Fleish, "Electromagnetics with Applications", McGraw Hill International Editions, Fifth Edition, 2010.
3. Ashutosh Pramanik, "Electromagnetism – Theory and Applications", Prentice-Hall of India Private Limited.,2008.

Web References:

- **https://youtu.be/G5P6dInMTFg?si=setApxvk-n1Q64oU**
- **https://youtu.be/JhTT-wew-OE?si=eF9kOGLinWarxPmK**
- **https://youtu.be/cLxprlOsUVg?si=ovpbArMB7jmZz7Mg**

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	-	-	-	1	-	-	-	3	2	2
CO2	3	2	1	2	-	-	1	1	-	-	-	3	2	2
CO3	3	2	1	2	-	-	1	1	-	-	-	3	2	2
CO4	3	2	1	2	-	-	1	1	-	-	-	3	2	2
CO5	3	2	1	2	-	-	2	1	-	-	-	3	2	2
CO6	3	2	1	2	-	-	2	1	-	-	-	3	2	2
Avg.	3	2	1	2	-	-	1.4	1	-	-	-	3	2	2

EE24311	Digital Logic Circuits	PCC	L	T	P	C
			3	0	2	4

Course Objectives:

- To understand the fundamental concepts of number systems, Boolean algebra, and digital logic families.
- To design and implement combinational and sequential circuits using minimization techniques and flip-flops.
- To analyze asynchronous circuits and understand the working of programmable logic devices.
- To provide foundational knowledge of VHDL programming.
- To develop skills in configuring and testing combinational circuits such as multiplexers and code converters.
- To provide hands-on experience designing and implementing sequential circuits such as counters, and shift registers.

UNIT I NUMBER SYSTEMS AND DIGITAL LOGIC FAMILIES 9

Number system, error detection, corrections & code conversions, Boolean algebra: De-Morgan's theorem, representation of logic functions - SOP and POS form, switching functions, Digital Logic Families -comparison of RTL, DTL, TTL, ECL families.

UNIT II COMBINATIONAL CIRCUITS 9

Combinational logic - K-map representations - minimization using K maps and implementation of combinational logic - code converters (gray to binary, Excess-3 to BCD and vice-versa), adders, subtractors, Encoders and Decoders.

UNIT III SYNCHRONOUS SEQUENTIAL CIRCUITS 9

Sequential logic- SR, JK, D, and T flip flops - level triggering and edge triggering - Shift registers - Counters (4-bit binary up counter) - design of synchronous sequential circuits – Moore and Mealy models- state diagram; state reduction; state assignment.

UNIT IV ASYNCHRONOUS SEQUENTIAL CIRCUITS AND PROGRAMMABLE LOGIC DEVICES 9

Asynchronous sequential logic Circuits -race conditions, hazards & errors in digital circuits; analysis of asynchronous sequential logic circuits. Programmability Logic Devices: PROM – PLA –PAL, CPLD-FPGA.

UNIT V VHDL 9

VHDL: Introduction to program structures, Packages – Operators - Subprograms (Simulation /Tutorial Examples: Adders, subtractors, Multiplexers & De-multiplexers .)

Periods: 45

Lab Components:

1. Implementation of Boolean Functions.

2. Implementation of Full Adder and Full Subtractor circuits.
3. Implementation of multiplexers and de multiplexers.
4. Code converters: Binary to Gray code and vice versa
5. Shift Registers: Design and implementation of 4-bit shift registers in SISO, SIPO, PISO, PIPO modes using suitability IC's.
6. Counters: Design and implementation of mod10 counters as synchronous types using FF in Matlab
7. Counters: Design and implementation of sequence counters as synchronous types using FF in Matlab

Periods: 30

Total Periods:75

Laboratory Requirements:

Sl.No.	Description of Equipment	Required numbers (for batch of 30 students)
1	Regulated Power supply +12/-12V,5V	10 nos.
2	Digital Multimeter	10 nos.
3	Analog and Digital IC Tester	1 nos.
4	Consumables: Breadboard, Digital IC Types	Sufficient number
5	Digital Trainer Kit	8 nos
6	Single strand wire	Sufficient number

Course Outcomes:

CO1 To perform number system conversions, simplify Boolean expression, and differentiate between common digital logic families.

CO2 Design combinational circuits using Boolean algebra principles and Karnaugh maps.

CO3 Design sequential circuits using flip flops.

CO4 Analyze the asynchronous circuits and explain the programmable logic devices.

CO5 Explain the structure, operators, and subprograms of VHDL and develop coding for basic combinational and sequential circuits.

CO6 Implement, test, and analyze various combinational and sequential digital circuits, including arithmetic circuits, data selectors, code converters, shift registers, and counters using both discrete ICs and simulation tools.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)

MAPPING OF COs WITH POs AND PSOs

CO	POs											PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	1	-	-	1	1	1	-	1	2	2	1
CO2	3	3	3	1	-	-	1	1	1	-	1	2	2	1
CO3	3	3	3	1	-	-	1	1	1	-	1	2	2	1
CO4	3	3	3	1	-	-	1	1	1	-	1	2	2	1
CO5	3	3	3	1	2	-	1	1	1	-	1	2	2	1
CO6	3	3	3	1	2	-	1	1	1	-	1	2	2	1
Avg	3	3	3	1	2	-	1	1	1	-	1	2	2	1

EE24312 Object Oriented Programming Using C++ PCC L T P C

2 0 2 3

Course Objectives:

- To use C++ programming elements like data types, loops, and functions in simple programs.
- To work with classes and objects to create programs that solve basic problems.
- To create programs that use inheritance between classes.
- To use virtual functions and abstract classes in programs.
- To handle file input/output operations and use Standard Template Library components in programs.
- To understand exception handling

UNIT I INTRODUCTION TO C++ 7

OOPS concepts - Procedural Vs Object oriented programming – objects - classes – methods and messages - abstraction and encapsulation – Inheritance - Polymorphism.
Introduction to C++: Data types - Declaration of variables – Expressions – Operators - Type conversions – Control flow – Conditional and looping statements

UNIT II CLASSES AND DATA ABSTRACTION 6

Functions: Declaration, Definition, Parameter Passing, Default Arguments, Inline Functions, Recursion – Function Overloading - Pointers and Arrays - Classes – Members and Member Functions - Access Specifiers - Objects - Constructors and Destructors - this pointer - Static Members, Constant Members

UNIT III INHERITANCE AND POLYMORPHISM 6

Class hierarchy – Inheritance - Types of Inheritance - Access to the base class members, Base and Derived class construction, Destructors, Polymorphism - Static binding: Operator overloading - Dynamic binding: Virtual base class - Virtual functions, Overriding – Pure virtual functions, Abstract classes – Interfaces

UNIT IV FILE HANDLING AND GENERIC PROGRAMMING 6

File handling – Sequential and Random access – Generic Programming - Function Templates and Class Templates

UNIT V EXCEPTIONS 5

Benefits of exception handling, Throwing an exception, Try and catch - Exception objects -Exception specifications - Rethrowing an exception – user defined exceptions

Periods:30

LIST OF EXPERIMENTS

1) Write basic C++ programs
2) Write programs for linear search and binary search
3) Write a program to demonstrate functions: call by value and reference
4) Write a program to demonstrate recursion
5) Write a program to demonstrate class encapsulation using a Student class with private data (name, rollNo).
6) Write a program to demonstrate constructors and destructors by simulating a Bank Account.
7) Write a program to demonstrate static members by tracking object count in a Counter class.
8) Write a program to demonstrate single inheritance using a Vehicle → Car hierarchy.
9) Write a program to demonstrate virtual base class to resolve the diamond problem (Person → Student/Employee → TeachingAssistant).
10) Write a program to demonstrate runtime polymorphism using Shape → Circle/Rectangle with virtual area().
11) Write a program to demonstrate abstract classes using Shape with pure virtual printArea() and derived Rectangle/Circle.
12) Write a program to demonstrate interfaces.
13) Write a program to demonstrate file handing by reading/writing student records to a text file.
14) Write a program to demonstrate templates.

Write a program to demonstrate exception handling for division-by-zero and file-not-found errors.

Periods:30

Total Periods:60

Course Outcomes:

On completion of the course, the students will be able to

CO1: Implement C++ programs using fundamental concepts
CO2: Apply the concepts of classes and objects to solve simple problems
CO3: Develop applications using concept of inheritance
CO4: Apply polymorphism through virtual functions and abstract classes
CO5: Build applications with I/O and File handling
CO6: Apply STL for data manipulations
CO7: Handle Exceptions in programming

Suggested Activities:

1. Mini Project

Text Books:

1. Ira Pohl, "Object-Oriented Programming Using C++", Pearson Education Asia, 2003.
2. B. Trivedi, Programming with ANSI C++, Oxford University Press. 2007.

References:

1. Bjarne Stroustrup, "The C++ Programming Language", Pearson Education, 2004.
2. H.M.Deitel, P.J.Deitel, "Java : how to program", Fifth edition, Prentice Hall of India private limited, 2003.

Laboratory Requirements:

S. No	Name of the Equipment/Software	Required
1	INTEL based desktop PC with min. 8GB RAM and 500 GB HDD, 17" or higher TFT Monitor, Keyboard and mouse	30
2	Windows 10 or higher operating system / Linux Ubuntu 20 or higher	30
3	Dev C++ / Eclipse CDT / Code Blocks / CodeLite / equivalent open source IDE	30

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	3	-	2	-	-	-	-	-	1	-	2	-
CO2	3	2	3	-	2	-	-	-	-	-	1	-	2	-
CO3	3	3	3	-	2	-	-	-	-	-	1	-	2	-
CO4	3	3	3	-	2	-	-	-	-	-	1	-	2	-
CO5	3	2	3	-	2	-	-	-	-	-	1	-	2	-
CO6	2	3	3	-	2	-	-	-	-	-	1	-	2	-
CO7	2	2	3	-	2	-	-	-	-	-	1	-	2	-
Avg.	3	3	2	2	2	-	-	-	-	-	1	-	2	-

EE24321	Analog Electronics Laboratory	PCC	L	T	P	C
			0	0	3	1.5

Course Objectives:

- To be familiar with the structure of basic semiconductor devices.
- To be exposed to the operation and application of electronic devices and their circuits.
- To analyse circuit characteristics with signal analysis using Op-amp IC's.
- To learn design, testing and characterizing of circuit behaviour with analog IC's like 555 timer.
- To study internal functional blocks and the applications of special IC's like Timers.

List of Experiments:

I. **Experiments on Basic Electronic Devices**
   1. Characteristics of Semiconductor diode and Zener diode.
   2. Common Emitter input-output characteristics.
   3. Transistor-based RC phase shift oscillator.
   4. Transistor-based Hartley oscillator.

II. Differential amplifiers using FET.

III. **Experiments using Linear Integrated Circuits (ICs)**

1. Op-Amp based amplifier circuits Inverting amplifier and Non-Inverting amplifier.
2. Design of Adder-Subtractor circuits using Op-Amp.
3. Application of Op-Amp: Differentiator.
4. Op-Amp-based Analog Integrator.
5. IC 555 – timer based Astable and Monostable Multi-Vibrator.

Total Periods: 45

Course Outcomes:

On completion of the course, the students will be able to

CO1 Ability to acquire knowledge on the structure and underlying semiconductor physics concepts.
CO2 Ability to design circuits employing electronic devices.
CO3 Ability to acquire knowledge on the IC fabrication process.
CO4 Ability to acquire knowledge on Application of Op-Amp.
CO5 Analyze, comprehend and design of analog electronic circuits involving OP-AMP.
CO6 Analyze, comprehend and design of analog electronic circuits involving timer 555.

Lab Requirements:

S.No	Description of Equipment	Required numbers
1	Semiconductor devices like Diode, Zener Diode, NPN Transistors, JFET, UJT, Photo diode, Photo Transistor	10
2	Resistors, Capacitors and inductors	10
3	Necessary digital IC	10
4	Function Generators	10
5	Regulated 3 output Power Supply 5, ± 15V	10
6	CRO	10
7	Storage Oscilloscope	1
8	Bread boards	10
9	Regulated Power supply +12/-12V,5V	15 nos.
10	Cathode Ray Oscilloscope (CRO) 50 Mhz	10 nos.
11	Digital Multimeter	10 nos.
12	Function Generator	5 nos.
13	Analog and Digital IC Tester	2 nos. each
14	Bread Board	Sufficient number
15	IC 741/ICNE555	Sufficient number
16	Digital IC Types	Sufficient number
17	LED	Sufficient number
18	Transistor	Sufficient number
19	Diodes, IN4001	Sufficient number
20	Zener diodes	Sufficient number
21	Potentiometer	Sufficient number
22	Step-down Transformer 230V/12-0-12V	Sufficient number
23	Capacitor	Sufficient number
24	Resistors ¼ Watt Assorted	Sufficient number
25	Single strand wire	Sufficient number

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	-	-	-	3	2	2	2	2
CO2	3	3	3	3	3	3	-	-	-	3	2	2	2	2
CO3	3	3	3	3	3	3	-	-	-	3	2	2	2	2
CO4	3	3	3	3	3	3	-	-	-	3	2	2	2	2
CO5	3	3	3	3	3	3	-	-	-	3	2	2	2	2
CO6	3	3	3	3	3	3	-	-	-	3	2	2	2	2
Avg.	3	3	3	3	3	3	-	-	-	3	2	2	2	2

EE24322	DC Machines and Transformers Laboratory	PCC	L	T	P	C
			0	0	3	1.5

Course Objectives:

- To familiarize students with the determination of characteristics of DC machines and transformers through hands-on experimentation.
- To provide practical experience in evaluating the performance parameters of DC machines and transformers by conducting appropriate tests.
- To develop students' proficiency in utilizing simulation tools for analyzing and interpreting the behavior of DC machines and transformers.

List of Experiments:

1. Open circuit and load characteristics of DC shunt generator- calculation of critical resistance and critical speed.
2. Load characteristics of DC compound generator with differential and cumulative connections.
3. Load test on DC shunt and series motor.
4. Swinburne’s test on DC Shunt motor
5. Speed control of the DC shunt motor.
6. Hopkinson’s test on DC motor–generator set.
7. Load test on single-phase transformer.
8. Open circuit and short circuit tests on the single-phase transformer.
9. Analysis of Load Characteristics and Performance Variations in a DC Machine using MATLAB Simulation
10. Load test of three-phase transformers using MATLAB

Total Periods: 45

Course Outcomes:

On completion of the course, the students will be able to

CO1: Demonstrate the ability to evaluate the characteristics and performance of DC shunt and compound generators under varying conditions.
CO2: Gain hands-on experience in testing and analyzing the performance of DC shunt and series motors.
CO3: Perform and interpret open circuit, short circuit, and load tests on single-phase transformers to assess efficiency and regulation.
CO4: Conduct Swinburne's and Hopkinson's tests to evaluate DC machine efficiency and master various speed control techniques.
CO5: Utilize MATLAB simulations for load characteristics of DC machines, analyzing performance deviations under varying operating conditions..
CO6: Interpret machine behavior using both hands-on experiments and simulations.

Laboratory Requirements :

Sl.No.	Description of Equipment	Required numbers (for batch of 30 students)
1	DC Shunt Motor with Loading Arrangement	3
2	DC Shunt Motor Coupled With Three phase Alternator	1
3	Single Phase Transformer	4
4	DC Series Motor with Loading Arrangement	1
5	DC Compound motor with loading arrangement	1
6	DC Shunt Motor Coupled With DC Compound Generator	2
7	DC Shunt Motor Coupled With DC Shunt Generator	1
8	Tachometer -Digital/Analog	8
9	Single Phase Auto Transformer	2
10	Three Phase Auto Transformer	1
11	Single Phase Resistive Loading Bank	2
12	Three Phase Resistive Loading Bank	2
13	Rheostats	As per the requirement for the machines

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	-	2	-	2	3	2	2
CO2	3	3	3	3	3	-	-	-	2	-	2	3	2	2
CO3	3	3	3	3	3	-	-	-	2	-	2	3	2	2
CO4	3	3	3	3	3	-	-	-	2	-	2	3	2	2
CO5	3	3	3	3	3	-	-	-	2	-	2	3	2	2
CO6	3	3	3	3	3	-	-	-	2	-	2	3	2	2
Avg.	3	3	3	3	3	-	-	-	2	-	2	3	2	2

HS24321	Communication Skills Building Laboratory	HSMC	L	T	P	C
			0	0	2	1

Course Objectives:

- Develop the ability to construct grammatically correct and contextually appropriate sentences
- Enhance critical thinking skills for analyzing and interpreting texts, media, and experiences
- Strengthen comprehension, summarization, and documentation skills for professional contexts
- Improve verbal and non-verbal communication for effective interaction in diverse professional settings
- Equip learners with teamwork, networking, and interview skills essential for career advancement
- Enable the creation of a professional digital identity through resumes, LinkedIn profiles, and self-presentation techniques

UNIT I THE ART OF DISCOURSE 6

Listening: Listen to stand-up comedy, political commentaries, and campaigns for appreciative listening.
Reading: Read and evaluate business and economic news articles; determine tone (neutral, positive, negative) and fact-check.
Writing: Craft commentary and opinion pieces to persuade or provoke discussion.
Speaking: Explain satire comic strips (e.g., Amul advertisements, political cartoons)

UNIT II PROFESSIONAL COMMUNICATION ESSENTIALS 6

Listening: Listen to voicemail, messages, and fill out forms.
Reading: Compare products & services; analyze advertisements.
Writing: Draft meeting agendas and minutes.
Speaking: Engage in open-field group discussions.

UNIT III DOCUMENTATION AND SUMMATION 6

Listening: Listen to documentaries, book summaries, and movie summaries for comprehensive understanding.
Reading: Read and analyze reports on significant events (e.g., environmental disasters, economic downturns).
Writing: Write survey reports and paraphrase key information.
Speaking: Report news, weather forecasts, and predictions.

UNIT IV REFINING PROFESSIONAL COMPETENCE 6

Listening: Translate informal language into formal business communication (Contextual translation)
Reading: Read and interpret technical texts and industry-specific jargon.

Writing: Write cover letters and statements of purpose.
Speaking: Role-play professional etiquette in workplace scenarios (e.g., expressing empathy, kindness, courtesy).

UNIT V DEVELOPING A PROFESSIONAL PROFILE 6

Listening: Listen to podcasts, Josh Talks, and professional interviews.
Reading: Analyze professional resumes and LinkedIn profiles.
Writing: Set up a LinkedIn profile and write engaging posts.
Speaking: Conduct mock interviews and deliver an effective elevator pitch.

Total Periods: 30

Course Outcomes:

On completion of the course, the students will be able to
C01: Construct coherent and professional sentences tailored to various workplace scenarios
C02: Analyze and critically interpret professional texts and multimedia content
C03: Document, summarize, and report information effectively across multiple formats
C04: Communicate effectively in professional and social interactions
C05: Demonstrate teamwork, networking, and interview skills relevant to career development
C06: Curate a professional online presence through resume development - LinkedIn, Indeed,

Suggested Activities:

1. Documentation and Summation

Assignment: Newsroom Simulation (20 Marks)

- Students record a 2-minute news report on an environmental/economic issue.
- Must include paraphrased content from real news reports (cite sources).
- Submission: Video + written news script.

2. Group Discussion (30 Marks)
3. Refining Professional Competence

Assignment: Corporate Dilemma Roleplay (20 Marks)

- Scenario-based role play on professional etiquette (handling client complaints, rejecting proposals kindly, etc.).
- Each student submits a formal email responding to the scenario professionally.

4. Developing a Professional Profile

Assignment: LinkedIn Challenge (30 Marks)

- Students create or optimize their LinkedIn profile and write a compelling post (e.g., career reflections, lessons from a recent project).
- Submit a screenshot of updated profile + link to post.

Optional: Engage with at least three classmates' posts with meaningful comments.

Text Books:

1. English for Engineers and Technologists. Volume I by Orient Blackswan, 2022
2. English for Science & Technology - I by Cambridge University Press, 2023

References:

1. Seely, John. Oxford Guide to Effective Writing and Speaking: How to Communicate Clearly. Oxford University Press, 2013.
2. Cottrell, Stella. Critical Thinking Skills: Developing Effective Analysis and Argument. Bloomsbury Academic, 2017.
3. Bhatnagar, Nitin. Communicative English for Professional Courses. Pearson, 2010.

4. Guffey, Mary Ellen, and Dana Loewy. Essentials of Business Communication. Cengage Learning, 2021.
5. Collins, Patrick. Speak with Power and Confidence: Tested Ideas for Becoming a More Powerful Communicator. Prentice Hall, 2009.
6. Locker, Kitty O., and Stephen Kyo Kaczmarek. Business Communication: Building Critical Skills. McGraw-Hill, 2020.

MAPPING OF COs WITH POs AND PSOs

Cos	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	-	-		-	1	1	1	1	1	-	_	_	_
CO2	-	1	-	1	-	-	-	1	1	-	1	_	_	_
CO3	-	-	-		-	-	-	-	1	-	1	_	_	_
CO4	-	-	-		-	-	1	1	1	-	-	_	_	_
CO5	-	-	-		-	-	-	1	1	-	1	_	_	_
CO6	-	-	-		-	-	-	-	-	-	1	_	_	_
Avg.	-	1	-	1	-	1	1	1	1	1	1	-	-	-

FC24301 Soft Skills HSMC L T P C

2 0 0 1

Course Objectives:

- Understand and apply proper etiquette in social, corporate, and online interactions
- Develop effective verbal and nonverbal communication skills, including body language and posture
- Enhance participation in group discussions and structured professional conversations
- Prepare for job interviews with appropriate etiquette, research, and response techniques
- Communicate professionally in written formats such as emails, inquiries, and job offer letters
- Deliver structured and engaging presentations using storytelling and persuasive techniques

UNIT I ETIQUETTE 6

Definition
- Social
- Corporate/Business - Meeting
- Telephone
- Netiquette

UNIT II BODY LANGUAGE AND NONVERBAL COMMUNICATION 6

- Posture
- Personal grooming
- Facial expression/ gesture/eye contact

UNIT III GROUP DISCUSSION 6

- Etiquette - Rules of conduct
- GD flow
- Pestel - Political, economic, social, tech, legal, environmental

- Handling unpredictable situation

UNIT IV JOB INTERVIEW – ETIQUETTE 6

- Pre-interview prep and research
- Responding to non-technical questions (star model - situation/task/ action plan/ result)
- Speaking your resume
- Writing inquiries and responding to job offer letters

UNIT V PRESENTATION SKILLS 6

- Setting the tone/ storytelling
- JAM/ Turn your Court

Total Periods:30

Course Outcomes:

On completion of the course, the students will be able to

1. Demonstrate professionalism in meetings, telephone calls, and digital communication
2. Use appropriate body language, facial expressions, and gestures to enhance communication
3. Participate effectively in group discussions, debates, and structured dialogues
4. Apply job interview strategies, including answering behavioural questions using the STAR model
5. Write clear and professional business correspondence, including inquiries and job offers
6. Present ideas confidently with a structured approach, engaging tone, and strong delivery

Suggested Activities:

1. **Role-Playing Business Meetings** – Students are assigned different corporate roles (CEO, Manager, Employee) and have them conduct a mock meeting with proper etiquette.
2. Group Discussion
3. **PESTEL Case Study** – Students analyze a real-world company using PESTEL factors and present their findings.
4. **Resume Pitching** – Students present their resumes as a story, explaining their achievements in an engaging way.
5. **Turn the Court Debate Organizer** – Students list arguments for and against a topic to prepare for persuasive speaking.

Work Sheets:

1. Business Meeting Etiquette Checklist – A checklist where students identify correct/incorrect meeting behaviors.
2. PESTEL Case Study Template – A table where students analyze a company using Political, Economic, Social, Technological, Environmental, and Legal factors.
3. STAR Method Interview Worksheet – Students write answers to common behavioral questions using the situation, Task, Action, Result format.

References:

1. Pachter, Barbara. The Essentials of Business Etiquette: How to Greet, Eat, and Tweet Your Way to Success. McGraw-Hill, 2013.
2. Pease, Allan, and Barbara Pease. The Definitive Book of Body Language. Bantam, 2004.

3. Gage, Martha. The Power of STAR Method: How to Succeed at Behavioral Job Interviews. Independently published, 2019.

MAPPING OF COs WITH POs AND PSOs

Cos	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	1	1	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO3	-	-	-	-	-	-	-	1	1	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO6	-	-	-	-	-	-	-	1	1	-	-	-	-	-
Avg.	-	-	-	-	-	-	-	-	-	-	-	-	-	-

BS24301	Environmental Science and Sustainability	BSC	L	T	P	C
			3	0	0	3

Course Objectives:

- To introduce the basic concepts of environment, ecosystems.
- To emphasize on the biodiversity of India and its conservation.
- To familiarise with the causes and effects of different types of pollution in the environment.
- To familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability**.**
- To impart knowledge about waste management and their recovery methods.
- To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles.

UNIT I ENVIRONMENT AND BIODIVERSITY 9

Definition, scope and importance of environment – need for public awareness. Ecosystem and Energy flow – food chain, food web, ecological pyramids-ecological succession. Types of biodiversity: genetic, species and ecosystem diversity – values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – endangered and endemic species of India, Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, conservation of biodiversity: In-situ and ex-situ.

UNIT II ENVIRONMENTAL POLLUTION 9

Causes, Effects and Preventive measures of Air, Water, Soil, Thermal and Noise Pollutions. Nuclear hazards and human health risks-case study. Case studies on Occupational Health and Safety

Management system (OHASMS). Environmental protection-Air act, Water act, Environmental protection act. Role of an individual in prevention of pollution.

UNIT III SUSTAINABILITY AND MANAGEMENT 9

Development, GDP, Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals - intervention areas- Climate change-global warming, acid rain, Ozone layer depletion- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon credit, Carbon Footprint. Environmental management in industry-A case study.

UNIT IV WASTE MANAGEMENT AND RESOURCE RECOVERY 9

Biodegradable, non-biodegradable wastes, Solid, Hazardous and E-Waste management.
Bio-medical waste management, Concept of waste to energy processes (WTE) - Combustion, Pyrolysis, Landfill gas (LFG) recovery. Recycling of spent batteries, end-of- life vehicle (ELV) recycling-Waste engine oil recycling-Solvent recovery, Barriers for material recycling-social, legal and economic factors-Environment impact of waste recycling.

UNIT V SUSTAINABILITY PRACTICES 9

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources-Ocean energy sources, Geothermal energy, Energy Cycles- carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio- economical and technological change.

Total Periods:45

Course Outcomes:

On completion of the course, the students will be able to
CO1 To be aware of the functions of the environment, ecosystems.
CO2 To analyse the threats of biodiversity and their conservation.
CO3 To explain the types of environmental pollution and environment protection acts.
CO4 To recognize the different goals of sustainable development and environmental standards.
CO5 To correlate the different types of waste management and possible resource recovery methods.
CO6 To explain the sustainability practices pertaining to sustainable energy, sustainable habitat and sustainable urbanization.

Suggested Activities:
- Quiz
- Mind Mapping
- Group discussion
- Seminar
- Animated videos

Text Books:
1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.

2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M. Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998

References:

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38. edition 2010.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice Hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition, 2015.
5. Erach Bharucha "Text book of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	-	-	-	3	-	-	-	-	2	-	-	1
CO2	2	1	-	-	-	3	-	-	-	-	2	-	-	1
CO3	3	2	-	-	-	3	-	1	-	-	2	-	-	1
CO4	3	2	1	-	-	2	-	1	-	-	2	-	-	1
CO5	3	2	1	-	-	2	-	-	-	-	2	-	-	1
CO6	3	2	1	-	-	2	-	1	-	-	2	-	-	1
Avg.	2.7	1.6	1	-	-	2.5	-	1	-	-	2	-	-	1

EE24401 Measurements and Instrumentation PCC L T P C

3 0 0 3

Course Objectives:

- To educate the fundamental concepts and characteristics of measurement and errors
- To impart the knowledge on the functional aspects of measuring instruments
- To infer the importance of various bridge circuits used with measuring instruments.
- To educate the fundamental working of sensors and transducers and their applications
- To summarize the overall measurement and instrumentation with the knowledge on digital instrumentation principles.
- To educate the basics of PLC Programming

UNIT I CONCEPTS OF MEASUREMENTS 9

Instruments: classification, applications – Elements of a generalized measurement system - Static and dynamic characteristics - Errors in measurement -Statistical evaluation of measurement data.

UNIT II MEASUREMENT OF PARAMETERS IN ELECTRICAL SYSTEMS 9

Classification of instruments – moving coil and moving iron meters – Induction type, dynamometer type watt meters – Energy meter – Megger – Instrument transformers (CT & PT).

UNIT III AC/DC BRIDGES AND INSTRUMENTATION AMPLIFIERS 9

Wheatstone bridge, Kelvin double bridge - Maxwell, Hay, Wien and Schering bridges – Errors and compensation in A.C. bridges - Instrumentation Amplifiers

UNIT IV TRANSDUCERS FOR MEASUREMENT OF NON- ELECTRICAL PARAMETERS 9

Classification of transducers – Measurement of pressure, temperature, displacement, flow, angular velocity – Digital transducers – Characteristics of Sensors - Infrared and ultrasonic sensors.

UNIT V DIGITAL INSTRUMENTATION 9

A/D converters: types and characteristics – Sampling, Errors- Measurement of voltage, Current, frequency and phase - D/A converters: types and characteristics- DSO- Data Loggers – Basics of PLC programming and Introduction to Virtual Instrumentation - Instrument standards.

Total Periods:45

Course Outcomes:

On completion of the course, the students will be able to

CO1: Ability to comprehend the structural elements of various measuring instruments
CO2: Ability to apply appropriate techniques in the measurement of parameters in Electrical System
CO3: Ability to use the bridge circuit for measurement of unknown electrical quantities,
CO4: Ability to perform experiments using various transducers and their characteristics.
CO5: Ability to analyze the performance of digital and virtual instrumentation systems through experimental investigations and interpretation of measurement data.
CO6: Ability to develop PLC programs for basic automation and control applications.

Suggested Activities:

- Industrial Instrumentation Survey
- Simulation of AC and DC Bridges

Text Books:

1. A.K. Sawhney, Puneet Sawhney ‘A Course in Electrical & Electronic Measurements & Instrumentation’, Dhanpat Rai and Co, New Delhi, Edition 2011.
2. H.S. Kalsi, ‘Electronic Instrumentation’, Tata McGraw-Hill, New Delhi, 2010

References:

1. J.J. Carr, ‘Elements of Electronic Instrumentation and Measurement’, Pearson Education India, New Delhi, 2011.
2. W.Bolton, Programmable Logic Controllers, 6th Edition, Elseiver, 2015.

3. R.B. Northrop, 'Introduction to Instrumentation and Measurements', Taylor & Francis, New Delhi, 3rd Edition 2014.
4. E. O. Doebelin and D. N. Manik, "Measurement Systems – Application and Design", Tata McGraw-Hill, New Delhi, 6th Edition 2017.
5. R. K. Rajput, "Electrical and Electronics Measurements and Instrumentation", Chand Pub, 2016.

Web References:

- https://nptel.ac.in/courses/108103862
- **https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ee107**

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	1	1	-	-	-	-	-	3	2	2	1
CO2	3	3	1	1	1	-	-	-	-	-	3	2	2	1
CO3	3	2	3	-	3	2	-	-	-	-	3	2	2	1
CO4	3	2	3	-	-	-	2	-	-	-	-	2	2	1
CO5	3	2	3	2	3	-	-	-	3	-	3	2	2	1
CO6	3	3	1	2	3	-	-	-	-	-	3	2	2	1
Avg.	3	2.5	2	1.5	2.2	2	2	-	3	-	3	2	2	1

EE24402 Synchronous and Induction Machines

PCC	L	T	P	C
	3	0	0	3

Course Objectives:

- To provide a comprehensive understanding of the construction, operation, performance, and control of synchronous machines, three-phase and single-phase induction motors, and special electrical machines.
- To analyze their characteristics, conduct tests to determine parameters, explore starting and speed control techniques, and understand the operation of special machines.

UNIT I SYNCHRONOUS GENERATOR 9

Constructional details – Types of rotors –winding factors- EMF equation – Synchronous reactance – Armature reaction – Phasor diagrams of synchronous generator - Synchronizing and parallel operation – Voltage regulation – EMF, MMF, ZPF method – steady state power- angle characteristics– Two reaction theory –slip test - Capability Curves.

UNIT II SYNCHRONOUS MOTOR 9

Principle of operation – Torque equation – Operation on infinite bus bars - V and Inverted V curves – Power input and power developed equations – Starting methods –Effect of change in excitation and load on motor --Hunting – damper windings- synchronous condenser.

UNIT III THREE PHASE INDUCTION MOTOR 9

Constructional details – Types of rotors –- Principle of operation – Slip –cogging and crawling- Equivalent circuit – Torque-Slip characteristics - Condition for maximum torque – Losses and

efficiency – Load test - No load and blocked rotor tests - Circle diagram – Separation of losses – Double cage induction motors – Induction generators.

UNIT IV STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR 9

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

UNIT V SINGLE PHASE INDUCTION MOTORS AND SPECIAL ELECTRIC MOTORS 9

Constructional details of single phase induction motor – Double field revolving theory and operation – Equivalent circuit – No load and blocked rotor test – Starting methods of single-phase induction motors – Capacitor-start capacitor run Induction motor- Shaded pole induction motor – Construction and Working Principle of PMSM, BLDC and Stepper motors– Introduction to magnetic levitation systems-Linear induction motor.

Total Periods:45

Course Outcomes:

On completion of the course, the students will be able to

CO1: Analyze the construction, performance, and voltage regulation of synchronous generators through tests and theoretical methods like EMF, MMF, and ZPF.

CO2: Examine the operation and characteristics of synchronous motors, including V and inverted V curves, torque equations, and starting methods.

CO3: Understand the working principles, torque-slip characteristics, and efficiency of three-phase induction motors through practical tests and loss analysis.

CO4: Demonstrate the ability to start and control the speed of three-phase induction motors using various methods, including V/f control and slip power recovery schemes.

CO5: Conduct tests on single-phase induction motors to analyze their starting methods, performance characteristics, and equivalent circuits.

CO6: Explore the construction, operation, and applications of special machines.

Numerical Assignment: Calculate voltage regulation under different load conditions. Compare results using the ZPF method.

Technical Analysis Assignment: Analyze synchronous motor operating data. Evaluate the impact of reactive power compensation on efficiency.

Circle Diagram Exercise: Construct circle diagrams from test data. Determine efficiency, slip, torque, and power factor.

Journal Review Activity: Review articles on V/f, Vector Control, and DTC techniques. Summarize and compare their key features.

Seminar Presentation: Present on BLDC, PMSM, SRM, and Stepper Motors. Discuss operation and applications.

Text Books:

1. B.R.Gupta, 'Fundamental of Electric Machines' New age International Publishers,3rd Edition, Reprint 2015.
2. A.E. Fitzgerald, Charles Kingsley, Stephen. D. Umans, 'Electric Machinery', Mc Graw Hill publishing Company Ltd, 6th Education 2017.
3. Stephen J. Chapman, 'Electric Machinery Fundamentals'4th edition, McGraw Hill Education Pvt. Ltd, 4th Edition 2017.
4. D.P. Kothari and I.J. Nagrath, 'Electric Machines', McGraw Hill Publishing Company Ltd, 5th Edition 2017
5. P.S. Bhimbhra, 'Electrical Machinery', Khanna Publishers, edition 2, 2021.

References:

1. Vincent Del Toro, 'Basic Electric Machines' Pearson India Education, 2016.
2. M.N. Bandyo padhyay, Electrical Machines Theory and Practice, PHI Learning PVT LTD., New Delhi, 2011.
3. Murugesh Kumar, 'Electric Machines', Vikas Publishing House Pvt. Ltd, First edition 2010.
4. Alexander S. Langsdorf, 'Theory of Alternating-Current Machinery', McGraw Hill Publications, 2001.
5. https://archive.nptel.ac.in/courses/108/105/108105131/

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	-	-	-	1	2	-	2	3	-	1
CO2	3	3	2	2	-	-	-	1	2	-	2	3	-	1
CO3	3	3	2	2	-	-	-	1	2	-	2	3	-	1
CO4	3	3	2	2	-	-	-	1	2	-	2	3	-	1
CO5	3	3	2	2	-	-	-	1	2	-	2	3	-	1
CO6	3	3	2	2	-	-	-	1	2	-	2	3	-	1
Avg.	3	3	2	2	-	-	-	1	2	-	2	3	-	1

EE24411 CONTROL SYSTEMS DESIGN PCC L T P C

3 0 2 4

Course Objectives:

- To understand the fundamentals of Control Systems.
- To develop Mathematical Models of Dynamic Systems.
- To analyze System performance in the Time Domain.
- To analyze System behavior in the Frequency Domain.
- To explore State-Space Analysis Techniques.
- Design and implement feedback Control Systems.

UNIT I MODELING OF LINEAR TIME INVARIANT (LTIV) SYSTEMS 9

Open loop and Closed loop systems – Feedback control system characteristics – First principle modeling: Mechanical, Electrical and Electromechanical systems – Transfer function representations: Block diagram and Signal flow graph.

UNIT II TIME DOMAIN ANALYSIS 9

Standard test inputs – Time responses for First order and Second order systems – Time domain specifications –Time domain parameters for second order systems - Stability analysis: Concept of stability – Routh Hurwitz stability criterion – Root locus: Construction and Interpretation.

UNIT III FREQUENCY DOMAIN ANALYSIS 9

Frequency domain specifications - Bode plot and Polar plot - Introduction to closed loop Frequency Response.

UNIT IV DESIGN OF FEEDBACK CONTROL SYSTEM 9

Design specifications - Lead, Lag and Lag-lead compensators using Bode plot – Design of P, PI, PD and PID controllers.

UNIT V STATE VARIABLE ANALYSIS 9

State variable formulation – State transition matrix – Eigen values – Eigen vectors – Controllability – Observability.

Periods:45

LIST OF EXPERIMENTS

1. Mathematical modelling and analysis of Mechanical and Electrical systems using transfer function approach.
2. Time domain analysis of second order system.
3. Root locus technique-based stability analysis.
4. Frequency response and stability analysis using Bode plot.
5. Frequency response and stability analysis using Polar plot.
6. Test of controllability and observability of a state space model.
7. Design of PID controllers and evaluation of closed loop performance.

Periods:30

Total Periods:75

Suggested Activities:

- Tinkercad Arduino Control Projects
- PLC-based process control demonstrations
- Case study on control systems used in electric vehicles and robotics

Course Outcomes:

On completion of the course, the students will be able to

CO1: Represent simple systems in transfer function and state variable forms.
CO2: Analyze and evaluate the performance of systems in time domain
CO3: Infer the stability of systems in time and frequency domain.
CO4: Analyze and evaluate the performance of systems in frequency domain.
CO5: Design and evaluate the performance of closed loop systems with compensators
CO6: Analyze the simple systems using state space approach

Text Books:

1. Nagrath.I.J & Gopal.M, "Control Systems Engineering", New Age International Pvt. Ltd., 7th Edition, 2021.
2. Katsuhiko Ogata, "Modern Control Engineering", Pearson, 5th Edition, 2015.

References:

1. Benjamin C. Kuo and Farid Golnaraghi, "Automatic Control Systems", McGraw Hill, 10th Edition, 2017.
2. Richard C.Dorf and Bishop, R.H., "Modern Control Systems", Education Pearson, 13th Edition, 2017.
3. S.K.Bhattacharya, "Control System Engineering", Pearson, 3rd Edition, 2013.
4. John J.D., Azzo Constantine, H. and Houpis Sttuart, N Sheldon, "Linear Control System Analysis and Design with MATLAB", CRC Taylor & Francis, 6th, 2013.
5. NPTEL Video Lecture Notes on "Control Engineering" by Prof.S.D.Agashe, IIT Bombay

Laboratory Requirements:

Sl. No.	Description of Equipment	Required numbers
1	Desktop (Intel i5 or equivalent, 8GB RAM, 256GB SSD)	30 Nos.
2	MatLab Latest Version with Control System Tool Box	30 User

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	-	2	3	-	-	2	2	2	3
CO2	3	3	2	2	3	-	2	3	-	-	2	2	2	3
CO3	3	3	2	2	3	-	2	3	-	-	2	2	2	3
CO4	3	3	2	2	3	-	2	3	-	-	2	2	2	3
CO5	3	3	2	2	3	-	2	3	-	-	2	2	2	3
CO6	3	3	2	2	3	-	2	3	-	-	2	2	2	3
Avg.	3	3	2	2	3	-	2	3	-	-	2	2	2	3

EE24412	Transmission and Distribution	PCC	L	T	P	C
			3	0	2	4

Course Objectives:

- To explain the structure of electric power system and compute transmission line parameters.
- To draw equivalent circuits for transmission lines. Compute sending end and receiving end power, voltage regulation and efficiency.

- To explain the types of towers and determine sag and tension on electric lines for environmental conditions and analyse the voltage distribution in insulator strings to improve the efficiency.
- To analyse dielectric stress in underground cables and methods to improve efficiency of cables.
- To explain types of substations, methods of grounding, EHVAC, HVDC and FACTS
- To calculate voltage drop, power loss and currents in a distributor.

UNIT I TRANSMISSION LINE PARAMETERS 9

Structure of electric power system: generation, transmission and distribution - Parameters of single and three phase transmission lines with single and double circuits - Resistance, inductance and capacitance of solid, stranded and bundled conductors, conductor types - symmetrical and unsymmetrical spacing and transposition-application of self and mutual GMD; skin and proximity effects - Effects of earth on capacitance of transmission line- corona discharge, factors affecting corona-advantages and disadvantages.

UNIT II MODELLING AND PERFORMANCE OF TRANSMISSION LINES 9

Classification of lines–short line, medium line and long line-Evaluation of A, B, C, D constants-equivalent circuits, phasor diagram, attenuation constant, phase constant, surge impedance and surge impedance loading; transmission efficiency and voltage regulation, real and reactive power flow in lines, Power-circle diagrams (with receiving end voltage as reference), methods of voltage control; Ferranti effect. Charging current and losses in an open circuited line.

UNIT III INSULATORS AND CABLES 9

Main components of overhead lines-Insulators-Types, voltage distribution in insulator string, improvement of string efficiency, Underground cables - Types of cables, insulation materials, Parameters of cable, Grading of cables, Capacitance of 3-core cable, heating, thermal resistance of cables.

UNIT IV SUBSTATIONS AND MECHANICAL DESIGN OF LINES 9

Mechanical design of transmission line, sag and tension calculations for different weather conditions, Tower spotting, Types of towers, Sub-station Layout (AIS, GIS). Trends in Transmission and Distribution: EHVAC and HVDC transmission - Introduction to FACTS devices.

UNIT V DISTRIBUTION SYSTEMS 9

Choice of transmission voltage, overhead and underground systems, Types of AC and DC distributors–distributed and concentrated loads–voltage tolerances, interconnection - advantages and limitations.

Periods:45

List of Experiments:

1. Computation of Transmission Line Parameter of three phase lines with single circuit
2. Computation of Transmission Line Parameter Calculation of three phase lines with double circuit
3. Modelling of Transmission Lines, Calculation of transmission efficiency and voltage regulation
4. Calculation of String efficiency of insulator string with and without guard ring
5. Calculation of Voltage drop in DC distribution system fed at one end and both ends

6. Calculation of Voltage drop in DC ring main distribution system with and without interconnector.

Periods:30

Total Periods:75

Outcomes:

On completion of the course, the students will be able to

CO1: Explain the structure of electric power system and compute transmission line parameters (Resistance, Inductance and Capacitance).
CO2: Draw equivalent circuits for transmission lines and Compute sending end and receiving end power, voltage regulation and efficiency.
CO3: Describe the different types of towers and determine sag and tension on electric lines for environmental conditions. Analyze the voltage distribution in insulator string to improve the efficiency.
CO4: Explain the construction of different types of cables, effect of dielectric stress and compute capacitance and voltage distribution in cables to improve efficiency.
CO5: Explain the concept of distribution systems, substations, use of appropriate method of grounding, EHVAC, HVDC, FACTS and recent trends in transmission and distribution.
CO6: Identify the type of loading in a distributor and calculate voltage drop, power loss and currents in a distributor.

Text Books:

1. D.P.Kothari, I.J. Nagarath, 'Power System Engineering', Mc Graw-Hill Publishing Co. limited, New Delhi, Second Edition, 2008.
2. C.L.Wadhwa, 'Electrical Power Systems', New Academic Science Ltd, 2009.
3. S.N. Singh, 'Electric Power Generation, Transmission and Distribution', PH of India Pvt. Ltd,
4. New Delhi,2 nd Edition, 2011.

References:

1. B.R.Gupta, 'Power System Analysis and Design' S. Chand, New Delhi, Sixth Edition, 2011.
2. 2.Luces M.Fualken berry, Walter Coffer, 'Electrical Power Distribution and Transmission', Pearson Education, 2007.
3. Arun Ingole, "Power transmission and distribution" Pearson Education, first edition, 2018
4. J.Brian Hardy and Colin R.Bayliss 'Transmission and Distribution in Electrical Engineering',Newnes; Fourth Edition, 2011.
5. G.Ramamurthy, "Handbook of Electrical power Distribution," Universities Press, 2013.
6. V.K.Mehta, Rohit Mehta, 'Principles of power system', S. Chand & Company Ltd, New Delhi,2013
7. Hadi Saadat, 'Power System Analysis', McGraw Hill Education Pvt. Ltd., New Delhi, 3rd Edition, 23rd reprint, 2015.
8. R.K.Rajput, 'A Text Book of Power System Engineering' 2nd edition, Laxmi Publications (P) Ltd, New Delhi, 2016.
   https://nptel.ac.in/courses/108/108/108108099/

Standards:

1. IS 5613-1-1 (1985): Code of Practice for Design, Installation and Maintenance of Overhead Power Lines, Part 1: Lines Up to and Including 11 kV, Section 1: Design [ETD 37: Conductors and Accessories for Overhead Lines]

2. IS 12360:1988 - Voltage Bands For Electrical Installations Including Preferred Voltages And Frequency
3. 141-1993 - IEEE Recommended Practice for Electric Power Distribution for Industrial Plants.
4. IS 1885-71 (1993): Electrotechnical Vocabulary, Part 71: Generation, transmission and distribution of electricity Substations [ETD 1: Basic Electrotechnical Standards]
5. Draft Indian Standard Voltage Bands for Electrical Installations including preferred Voltage and Frequency (First Revision)

Laboratory Requirements:

Sl.No.	Description of Equipment	Required numbers (for batch of 30 students)
1.	Personal Computers (Intel Core i5 or i7, 500 GB, 8 GB RAM)	30
2.	Laser Printer	1
3.	Software: MATLAB/ EMTP / ETAP / CYME / MIPOWER / any Power system simulation software	8
4.	Testing of String insulator – Simulator Model	1
5.	DC Distribution System – Test setup	1

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	-	1	3	3	-	2	3	1	1
CO2	3	2	1	1	1	-	1	3	3	-	2	3	2	1
CO3	3	2	1	1	1	1	1	3	3	-	2	3	3	1
CO4	3	2	1	1	1	1	1	3	3	-	2	3	3	1
CO5	3	2	1	1	1	1	1	3	3	-	2	3	3	1
CO6	3	2	1	1	1	1	1	3	3	-	2	3	3	1
Avg.	3	2	1	1	1	1	1	3	3	-	2	3	2.5	1

EE24413 Python Programming and Data Structures PCC L T P C

2 0 2 3

Course Objectives:

- To introduce the fundamental concepts of Python programming
- To enable students to use Python's built-in data structures
- To provide an understanding of Abstract Data Types (ADTs)
- To develop problem-solving skills using stack and queue data structures
- To familiarize students with fundamental searching, sorting, and hashing techniques

UNIT I INTRODUCTION TO PYTHON PROGRAMMING 6

Introduction to Python – Literals – Variables and Identifiers -Comments- Reserved words – Data Types - Operators and Expressions - Input and Output: Working with user input, displaying output, and formatting - Conditional if - alternative if - chained conditional - Iteration: state, while, for, break, continue, pass

UNIT II DATA STRUCTURES, FUNCTIONS AND FILES IN PYTHON 6

Lists – Operations, Tuples – Assignment, return values. Dictionaries – Operations and methods. Sets – Creation, operations. Function: Definition, usage and types. Strings , Text file handling – Read/write, command-line arguments. Errors and exception handling

UNIT III ABSTRACT DATA TYPES AND LIST 6

Abstract Data Types (ADTs) – List ADT – Array-based implementation – Linked list implementation – Singly linked lists – Circularly linked lists – Doubly-linked lists – Applications of lists

UNIT IV STACKS AND QUEUES 6

Stack ADT – Operations – Applications – Balancing Symbols – Evaluating arithmetic expressions – Infix to Postfix conversion – Queue ADT – Operations – Circular Queue – Applications of Queues.

UNIT V SEARCHING, SORTING AND HASHING TECHNIQUES 6

Searching – Linear Search – Binary Search. Sorting – Bubble sort – Selection sort – Quick Sort – Insertion sort – Merge Sort – Hashing – Hash Functions – Separate Chaining – Open Addressing – Rehashing – Extendible Hashing. **Periods:30**

LIST OF EXPERIMENTS:

1. Solving problems using iterative loops (Palindrome, Factorial, Prime Numbers).
2. Implementing real-time/technical applications using List, Tuples, Dictionary, Set.
3. Implementing programs using functions.
4. Implementing programs using strings.
5. Implementation of Singly and doubly linked list.
6. Array/linked list implementation of Stack and Queue ADTs.
7. Implementation of Linear and Binary Search.
8. Implementation of any one Sorting technique.

Periods:30

Total Periods:60

Course Outcomes:

On completion of the course, the students will be able to

CO1: Apply Python syntax and semantics to write and debug basic programs.

CO2: Use Python data structures and functions to build modular programs.

CO3: Implement lists using array and linked list representations.

CO4: Apply stacks and queues to solve computational problems.

CO5: Analyze and implement basic searching and sorting algorithms.
CO6: Apply hashing techniques for efficient data access.

Suggested Activities:

1. Assign a project to create a small application that uses various Python data structures (lists, tuples, dictionaries, and sets) to manage and process a dataset.
2. Create exercises where students write their own macros and use preprocessor directives like #define, #include, etc., in various scenarios.
3. Quizzes on Code Snippets
4. Assignment on numerical problems
5. Present real-world problem scenarios that can be solved using C.
6. Flipped Learning
7. Mini Project

Text Books:

1. Allen B. Downey, “Think Python: How to Think like a Computer Scientist”, 2nd Edition, O’Reilly Publishers, 2016.
2. Karl Beecher, “Computational Thinking: A Beginner's Guide to Problem Solving and Programming”, 1st Edition, BCS Learning & Development Limited, 2017.
3. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, Pearson Education, 2005.
4. Kamthane, Introduction to Data Structures in C, 1st Edition, Pearson Education, 2007.

References:

1. Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, “Computational Thinking: A Primer for Programmers and Data Scientists”, 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data”, Third Edition, MIT Press, 2021.
4. Eric Matthes, “Python Crash Course, A Hands - on Project Based Introduction to Programming”, 2nd Edition, No Starch Press, 2019.
5. https://www.python.org/
6. Martin C. Brown, “Python: The Complete Reference”, 4th Edition, Mc-Graw Hill, 2018.
7. Langsam, Augenstein and Tanenbaum, “Data Structures Using C and C++”, 2nd Edition, Pearson Education, 2015.
8. Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest, Clifford Stein, “Introduction to Algorithms", Fourth Edition, Mcgraw Hill/ MIT Press, 2022.
9. Alfred V. Aho, Jeffrey D. Ullman,John E. Hopcroft ,”Data Structures and Algorithms”, 1st edition, Pearson, 2002.
10. Kruse, “Data Structures and Program Design in C”, 2nd Edition, Pearson Education, 2006.

Laboratory Requirements:

S. No	Name of the Equipment/Software	Required
1	INTEL based desktop PC with min. 8GB RAM and 500 GB HDD, 17" or higher TFT Monitor, Keyboard and mouse	30
2	Windows 10 or higher operating system / Linux Ubuntu 20 or higher	30
3	Dev C++ / Eclipse CDT / Code Blocks / CodeLite / equivalent open source IDE	30
4	Python 3 installed on standalone desktops (Windows/Linux)	30

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	-	-	-	-	-	-	-	2	-
CO2	3	2	2	-	2	-	-	-	-	-	-	-	2	-
CO3	3	2	2	-	2	-	-	-	-	-	-	-	2	-
CO4	3	3	2	-	2	-	-	-	-	-	-	-	2	-
CO5	3	3	2	2	2	-	-	-	-	-	-	-	2	-
CO6	3	2	2	-	3	-	-	-	-	-	-	-	2	-
Avg.	3	2.33	2	2	2.16	-	-	-	-	-	-	-	2	-

EE24421	Synchronous and Induction Machines Laboratory	PCC	L	T	P	C
			0	0	3	1.5

Course Objectives:

- To provide students with hands-on experience in analyzing the performance of electrical machines such as alternators, synchronous motors, and induction motors.
- To conduct various tests, study motor characteristics, and explore techniques for induction motor control.

LIST OF EXPERIMENTS

1. Regulation of three-phase alternator by EMF and MMF methods.
2. Regulation of three-phase alternator by ZPF methods.
3. Regulation of three-phase salient pole alternator by slip test.
4. Measurements of negative sequence and zero sequence impedance of alternators.
5. V and Inverted V curves of Three Phase Synchronous Motor.
6. Load test on three-phase induction motor.

7. No load and blocked rotor tests on three-phase induction motor (Determination of equivalent circuit parameters).
8. Separation of No-load losses of three-phase induction motor.
9. Load test on single-phase induction motor.
10. No load and blocked rotor test on single-phase induction motor.
11. Speed control of Slip Ring Induction Motor.
12. Study of Induction Motor Starters

Total Periods:45

Course Outcomes:

On completion of the course, the students will be able to

CO1: Demonstrate proficiency in determining the voltage regulation of three-phase alternators using EMF, MMF, and ZPF methods and conduct slip tests on salient pole alternators.

CO2: Evaluate negative sequence and zero sequence impedances of alternators to understand their behavior under unbalanced load conditions.

CO3: Plot and interpret V and inverted V curves of three-phase synchronous motors to understand their performance under varying excitation and load conditions.

CO4: Perform load tests, no-load tests, and blocked rotor tests on single-phase and three-phase induction motors to determine equivalent circuit parameters and evaluate motor efficiency and performance.

CO5: Separate and analyze the no-load losses of three-phase induction motors to assess their efficiency and power loss distribution.

CO6: Apply speed control techniques for slip-ring induction motors and study various starter mechanisms to understand their role in ensuring safe and efficient motor operation.

Laboratory Requirements:

Sl. No.	Description of Equipment	Required numbers (for batch of 30 students)
1	DC Shunt Motor Coupled With Three phase Salient Pole Alternator	1
2	DC Shunt Motor Coupled With Three phase non-salient pole Alternator	3
3	DC Shunt Motor Coupled With Three phase Slip ring Induction motor	1
4	Three Phase Induction Motor with Loading Arrangement	2
5	Single Phase Induction Motor with Loading Arrangement	2
6	Tachometer -Digital/Analog	8
7	Single Phase Auto Transformer	2
8	Three Phase Auto Transformer	3
9	Single Phase Resistive Loading Bank	2
10	Three Phase Resistive Loading Bank	2
11	Capacitor Bank	1
12	Three phase inductive load	1
13	Rheostats	As per the requirement for the machines

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	-	-	3	3	-	3	3	3	3
CO2	3	3	3	3	-	-	-	3	3	-	3	3	3	3
CO3	3	3	3	3	-	-	-	3	3	-	3	3	3	3
CO4	3	3	3	3	-	-	-	3	3	-	3	3	3	3
CO5	3	3	3	3	-	-	-	3	3	-	3	3	3	3
CO6	3	3	3	3	-	-	-	3	3	-	3	3	3	3
Avg.	3	3	3	3	-	-	-	3	3	-	3	3	3	3

EE24422 Measurements and Instrumentation Laboratory **PCC** **L T P C**

0 0 3 1.5

Course Objectives:

- To analyse AC and DC bridges and determining the unknown values of resistance , inductance and capacitance
- To understand and evaluate the bridge balancing conditions
- To understand how physical quantities are measured and how they are converted to electrical forms.
- To infer and measure the physical quantities such as pressure, temperature, flow, displacement.
- To measure the power and energy using wattmeter and energy meter.
- To implement a simple logic for industrial applications using PLC programming language.

List of Experiments:

Bridge Networks –AC and DC Bridges

1. Measurement of medium resistance using Wheatstone bridge
2. Measurement of low resistance using Kelvin's Bridge
3. Measurement of unknown inductance using Maxwell's Inductance Bridge
4. Measurement of unknown capacitance using Schering Bridge

Dynamics of Sensors/Transducers

5. Measurement of Temperature
   a) RTD b) Thermistor c)Thermocouple
6. Measurement of pressure using Bourdon Gauge
7. Measurement of Displacement using LVDT
8. Measurement of speed using Optical sensor
9. Measurement of weight using Strain gauge
10. Measurement of Flow using orifice meter
11. Implementation of a simple ladder logic program using PLC.

Total Periods:45

Course Outcomes:

On completion of the course, the students will be able to
CO1: Analyze the bridges for the measurement of low, medium resistance
CO2: Analyze the bridges for the measurement of inductance and capacitance measurement
CO3: Gain knowledge about the principle of operation and characteristics of different types of temperature and pressure transducers.
CO4: Gain knowledge about the principle of operation and characteristics of different types of Optical, Flow and Displacement transducers.
CO5: Measurement of power and energy using wattmeter and energy meter.
CO6: Implement a simple logic for industrial applications using PLC programming language

Laboratory Requirements:

Sl. No.	Description of Equipment	Required numbers (for batch of 30 students)
1	Position Control Systems Kit	1
2	R, L, C Bridge kit	1
3	Electric heater	1
4	Thermometer	1
5	Thermistor (silicon type) RTD nickel type	1
6	30 psi Pressure chamber (complete set)	1
7	Air foot pump (with necessary connecting tubes)	1
8	LVDT20mm core length movable type	1
9	Flow measurement Trainer kit (1/2 HP Motor, Water tank, Digital Milliammeter, complete set)	1
10	IC trainer kit	1
11	Strain Gauge Kit with Handy lever beam	1
12	100gm weights	10

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	2	3	-	-	1.5	-	-	-	3	3	1	3
CO2	2	1	2	3	-	-	1.5	-	-	-	3	3	1	3
CO3	2	1	2	3	-	-	1.5	-	-	-	3	3	1	3
CO4	2	1	2	3	-	-	1.5	-	-	-	3	3	1	3
CO5	2	1	2	3	-	-	1.5	-	-	-	3	3	1	3
CO6	2	1	2	3	-	-	1.5	-	-	-	3	3	1	3
Avg.	2	1	2	3	-	-	1.5	-	-	-	3	3	1	3

EE24423 Project Driven Learning EEC L T P C

0 0 2 1

Course Objectives:

- Apply Design Thinking & Problem-Solving Techniques
- Develop and Implement a Structured Project Plan
- Build Functional Prototypes & Minimum Viable Products (MVPs)
- Evaluate Performance & Optimize Solutions
- Present and Deploy Innovative Solutions

UNIT I IDEATION & PROBLEM IDENTIFICATION 6

Icebreaker & Team Formation - Brainstorming Sessions (Design Thinking, Mind Mapping) - Understanding User Needs & Problem Validation - Conducting Market Research & Competitor Analysis

UNIT II SOLUTION CONCEPTUALIZATION & PLANNING 6

Exploring Feasible Solutions (Convergent Thinking) - Selecting the Tech Stack & Tools - Creating a Project Timeline (Agile/Scrum Basics) - Sketching Wireframes, Flowcharts, or System Diagrams - Risk Analysis & Contingency Planning

UNIT III PROTOTYPING & IMPLEMENTATION 6

Creating a Low-Fidelity Prototype (Paper/Digital Mockups) - Building a Minimum Viable Product (MVP) - Testing & Refining the Prototype Based on Feedback - Implementing Core Functionalities of the Solution - Code/Design Review & Iteration

UNIT IV PERFORMANCE METRICS, BENCHMARKING & OPTIMIZATION 6

Defining Key Performance Metrics (KPIs) for the Project - Setting Industry Benchmarks & Performance Goals - Conducting Functional & Usability Testing - Analyzing System Performance & Bottleneck Detection - Optimizing Code, UI/UX, and Resource Utilization

UNIT V PRESENTATION & DEPLOYMENT 6

Crafting a Compelling Pitch (Storytelling, Business Model) - Tools: Business Model Canvas, Pitch Deck Templates (Canva, Google Slides) - Creating a Demo - Pitching & Receiving Feedback from Mentors/Peers - Deploying/Publishing the Project - Tools: GitHub Pages - Showcasing the Final Product & Reflection

Total Periods:30

Course Outcomes:

On completion of the course, the students will be able to

- Finalize a well-defined problem statement and identify key stakeholders
- Develop a structured project plan, defining goals, tech stack, and execution roadmap
- Build a functional prototype with key features working
- Establish clear performance benchmarks, conduct thorough testing, and optimize their project for efficiency, usability, and scalability.
- Successfully present and deploy their projects
- Demonstrate end-to-end project development skills, integrating problem-solving, technical implementation, optimization, and presentation to create impactful solutions

Learning Links:

1. Miro Basics
2. Lucidchart Tutorials
3. Figma Wireframing Guide
4. Trello Agile Basics
5. GitHub Basics
6. GitHub Pages Deployment

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	1	2	-
CO3	3	3	3	3	3	-	-	-	-	-	-	1	2	-
CO4	3	3	3	3	3	2	-	-	-	-	-	1	2	-
CO5	-	-	-	-	3	-	-	3	-	-	-	-	2	2
CO6	-	-	-	3	-	-	3	3	3	3	3	1	-	2
Avg.	3	2.7	3	3	3	2	3	3	3	3	3	1	2	2

BS24321	System Discovery and Analysis	BSC	L	T	P	C
			0	0	2	0

Course Objectives:

- To identify key components of any hardware.
- To analyse individual components and its working.
- To understand how data and control flows within a system
- To identify the need, the user, and functional specifications of the system
- To understand the evolution of an electronic system through study and presentation

List of Components:

Any two components can be selected per semester

1) Miniature Circuit Breaker
2) Wiper motor
3) Centrifugal pump
4) Electric Fan
5) Starter Motor

6) Inverter
7) Mosquito bat
8) Raspberry Pi/ Arduino Board

System Discovery (6 periods)
System Analysis (18 periods)
Presentation + Documentation (6 periods)

Total Periods:30

Course Outcomes:

On completion of the course, the students will be able to

1. Identify and describe the essential components and architecture of commonly used hardware systems.
2. Evaluate and document system design requirements, including end-user needs, functional goals, constraints, and standards.
3. Use project management tools, bull and octopus diagrams to understand the existing system.
4. Disassemble and analyze systems to distinguish between hardware, software, and network components
5. To articulate how information is processed, transmitted, and stored.
6. Propose an improvisation of any existing system by adopting a new design and technology.

Text Books:

Laboratory Manual

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	-	1	-	-	-	3	1	-	1	1	-	-
CO2	2	2	-	1	-	-	-	3	1	1	1	1	-	-
CO3	2	2	-	1	-	-	-	3	1	1	1	1	-	-
CO4	2	2	-	2	-	-	-	3	1	-	1	1	-	-
CO5	2	2	-	2	-	-	-	3	1	-	1	1	-	-
CO6	2	2	-	1	-	-	-	3	1	-	1	1	-	-
Avg.	2	2	-	1	-	-	-	3	1	1	1	1	-	-

EE24501	Power Electronics	power	L	T	P	C
			3	0	0	3

Course Objectives

The course aims to:

- Understand the characteristics and operation of power semiconductor devices.
- Analyze the performance of power electronic converter circuits.
- Study the operating principles of AC–DC, DC–DC, DC–AC, and AC–AC converters.
- Understand PWM techniques and converter control methods.
- Apply power electronic converters in industrial and renewable energy systems.

UNIT I Power Semiconductor Devices and Circuits 9

Study of switching devices and their VI and switching characteristics: SCR, TRIAC, MOSFET, IGBT.Construction and working of GaN HEMT and SiC MOSFET.Introduction to driver and snubber circuits.

UNIT II Phase-Controlled Converters 9

Single-phase full converter bridge rectifier and three-phase full converter bridge rectifier with R, RL, and RLE loads – Performance parameters – Effect of source inductance in single phase full bridge converter- Dual converters. Applications: Light dimmers, excitation systems, and solar PV systems.

UNIT III DC–DC Converters 9

Step-down and step-up chopper control strategies. Switched-mode regulators – Buck, Boost, Buck-Boost, Cuk and SEPIC regulators. Applications in battery-operated vehicles, Full-Bridge Converter for High-Power SMPS.

UNIT IV Inverters 9

Single-phase and three-phase voltage source inverters – Voltage and harmonic control – PWM Techniques: Multiple PWM, sinusoidal PWM, and modified sinusoidal PWM – Introduction to space vector modulation – Current source inverter. Applications: Induction heating and uninterruptible power supply (UPS) systems.

UNIT V AC to AC Converters 9

Single-phase and three-phase AC voltage controllers – Control strategies – Power factor control – Multistage sequence control – Single-phase cycloconverters – Introduction to matrix converters. Applications: Welding.

Periods:45

Suggested Activities:

Descriptive – Summarize the characteristics, operation, and applications of power semiconductor devices.

Scaffolding – Develop and explain the operation of a single-phase converter with relevant waveforms.

Design-Based Assignment – Design a DC–DC converter for given specifications and evaluate its performance.

Descriptive – Describe the operation, advantages, and applications of resonant inverters.

Applications of Power Electronics: Seminar – Present power electronics applications in motor drives, and power supplies.

Course Outcomes:

On completion of the course, the students will be able to

CO1: Explain the characteristics and control of power semiconductor devices.

CO2: Analyze the performance of phase-controlled converters.

CO3: Evaluate the operation of DC–DC converters.

CO4: Analyze the performance of PWM inverter circuits.

CO5: Examine the operation of AC voltage controllers and cycloconverters.

CO6: Select suitable power electronic converters for industrial and renewable energy applications.

TEXTBOOKS:

1. Rashid M.H., Power Electronics Circuits, Devices and Applications, Prentice Hall India, 3rd Edition, New Delhi, 2004.
2. P.S.Bimbhra, Power Electronics, Khanna Publishers, Third Edition 2003.

REFERENCES:

1. Ned Mohan, T.M.Undeland, W.P.Robbins, "Power Electronics: Converters, applications and design", John Wiley and Sons, 3rd Edition (reprint), 2009.
2. Philip T.Krein, Elements of Power Electronics, Oxford University Press, 2013.
3. P.C.Sen, Power Electronics, Tata McGraw-Hill, 30th reprint, 2008.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	-	-	2	2	-	1	2	-	2
CO2	3	2	1	1	-	-	-	2	2	-	1	2	-	2
CO3	3	2	1	1	-	-	-	2	2	-	1	2	-	2
CO4	3	2	1	1	-	-	-	2	2	-	1	2	-	2
CO5	3	2	1	1	-	-	-	2	2	-	1	2	-	2
CO6	3	2	1	1	-	-	-	2	2	-	1	2	-	2
Avg.	3	2	1	1	-	-	-	2	2	-	1	2	-	2

EE24502 Microprocessor and Microcontroller PCC L T P C

3 0 0 3

COURSE OBJECTIVES:

- To study the addressing modes & instruction set of 8086 &8051
- To develop skills in simple program writing in assembly languages
- To introduce commonly used peripheral/interfacing ICs.
- To study and understand typical applications of microcontrollers.
- To study and understand the basics of ESP32 and its application

Unit I **THE 8086 MICROPROCESSOR** **9**

Introduction to Microprocessor - Basic architecture of Microprocessor– 8086 Architecture -Memeory Segmentation- 8086 Signals-8086 Interrupts- Memory and I/O Interfacing.

Unit II **8086 PROGRAMMING AND MULTIPROCESSOR CONFIGURATION** **9**

8086 Addressing modes - Instruction set and assembler directives – Assembly language programming –Subroutines and Interrupt Service Routines-Basic configurations – System bus timing-Multiprocessor configurations – Coprocessor, Closely coupled and loosely Coupled configurations.

UNIT III **INTERFACING BASICS AND ICS** **9**

Study of Architecture and programming of ICs: 8255 PPI, 8259PIC, 8251USART, 8279 Keyboard display controller and 8254 Timer/Counter – Interfacing with 8086 -A/D and D/A converter interfacing.

UNIT IV **8051 MICROCONTROLLER** **9**

Introduction to Microcontroller- Functional block diagram -Architecture of 8051- Special Function Registers (SFRs)- Interrupts –Timer – I/O ports – Serial communication.

UNIT V **8051 PROGRAMMING & APPLICATIONS** **9**

8051 Addressing modes - Instruction Set and Programming - Applications: Keyboard and Display interface, Control of servo motor, Stepper motor Control, - Introduction to Node MCU: ESP32 Basics- Application to smart energy monitoring system.

Periods:45

Suggested Activities:

- Usage of IDE for assembly language programming
- Design and implement an electrical system using 8051
- Design and implement an electrical system using ESP32

Web References:

- https://www.sciencedirect.com/science/article/pii/S2772671124002468
- https://dl.acm.org/doi/10.5555/536953
- https://web.mit.edu/6.115/www/document/8051.pdf
- https://www.espressif.com/en/products/socs/esp32

COURSE OUTCOMES:

Upon successful completion of the course, the students should have the:

CO1:Ability to discuss the 8086 Architecture, interrupts, memory and I/O interfacing
CO2:Ability to develop skills in 8086 programming and multiprocessor configurations
CO3:Ability to analyse the importance of peripheral interfacing ICs

CO4:Ability to discuss the 8051 Architecture and Special Function Registers
CO5:Ability to develop skills in 8051 programming and analyze the applications
CO6:Ability to outline the ESP32 and its application

TEXT BOOKS:

1) Lyla B.Das, "The x86 Microprocessors: Architecture, Programming and Interfacing (8086 to Pentium), Pearson, 2010.
2) Yu-Cheng Liu, Glenn A.Gibson, "Microcomputer Systems: The 8086 / 8088 Family - Architecture, Programming and Design", Second Edition, Prentice Hall of India, 2007.
3) Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson education, 2011
4) Ramesh S. Gaonkar, 'Microprocessor Architecture Programming and Application', Pen ram International (P)ltd., Mumbai, 6th Education, 2013.

REFERENCES:

1. Douglas V. Hall, "Micro-processors & Interfacing", Tata McGraw Hill 3rd Edition, 2017.
2. Krishna Kant, "Micro-processors & Micro-controllers", Prentice Hall of India, 2007.
3. Kenneth Ayala, 'The 8051 Microcontroller', Thomson, 3rd Edition 2004.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	2	3	-	-	-	1.5	-	-	3	3	1	3
CO2	2	1	2	3	-	-	-	1.5	-	-	3	3	1	3
CO3	2	1	2	3	-	-	-	1.5	-	-	3	3	1	3
CO4	2	1	2	3	-	-	-	1.5	-	-	3	3	1	3
CO5	2	1	2	3	-	-	-	1.5	-	-	3	3	1	3
CO6	2	1	2	3	-	-	-	1.5	-	-	3	3	1	3
Avg.	2	1	2	3	-	-	-	1.5	-	-	3	3	1	3

GE24502 ENTREPRENEURSHIP AND INTERNATIONAL BUSINESS MARKET **HSMC L T P C**

Course Objectives: 2

- Introduce the fundamental concepts of entrepreneurship, entrepreneurial traits, creativity and innovation.
- Develop the ability to generate, evaluate and transform innovative ideas into feasible business plans.
- Explain the legal forms of business organization and the importance of intellectual property rights for entrepreneurs.
- Impart knowledge on the nature of international entrepreneurship and strategies for entering and operating in global markets.
- Explain the principles of international entrepreneurship and the dynamics of international trade and foreign exchange markets.

UNIT I Fundamentals of Entrepreneurship 6

Concept and importance of entrepreneurship - Characteristics and types of entrepreneurs - Entrepreneurship vs. Intrapreneurship - Creativity and Entrepreneurship - Innovation - Types of Innovation - Entrepreneurial innovation. Entrepreneurial ecosystem – Components: Angels, Venture Capitalists, Maker Spaces, Incubators, Accelerators, Investors; Sources of finance – bootstrapping, venture capital, angel investors, government grants, crowdfunding; Stages of entrepreneurial process.

UNIT II Idea to Business Plan 6

Sources of new ideas - Techniques for generating ideas - Steps involved in assessing the business potential of an idea - Preparing a Business Plan - Pitching a Business Plan - Steps in Setting up a Small Business Enterprise.

UNIT III Legal Aspects of Business 6

Forms of Business Entity - Requirements for incorporation of a private or a public limited company - Introduction to Intellectual Property Rights: Patents, Trademarks, Copyright, Geographical Indication (GI), International Patents - IPRs and their importance - Importance of IP for start-ups. Patents - Types of Patents - Criteria for Patentability - Patent Process - Patent Infringement.

UNIT IV International Entrepreneurship 6

Nature of International Entrepreneurship - International Vs Domestic Entrepreneurship - Foreign Market Selection - Entrepreneurial Entry Strategies - Barriers to International Trade.

UNIT V International Trade and Foreign Exchange Markets 6

Interventionist and Free Trade Theories - Foreign Exchange - Aspects of Foreign Exchange Market - Major Foreign Exchange Markets - Foreign Exchange Trading Process.

Periods: 30 PERIODS

Course Outcomes:

On completion of the course, the students will be able to

CO1: Analyze entrepreneurial traits and apply creativity and innovation in entrepreneurial contexts.
CO2: Create viable business plans by generating, evaluating and developing entrepreneurial ideas.
CO3: Apply knowledge of business structures and protect innovations using intellectual property rights.
CO4: Analyze international business environments and formulate strategies for entering and sustaining in global markets.
CO5: Interpret trade theories, explain foreign exchange market operations and evaluate their impact on international business decisions.
CO6: Understand entrepreneurship concepts and apply them in domestic and international business contexts

Suggested Activities

- Business Ideation using Design Thinking/ Brainstorming innovative product/service ideas using mind-mapping or SCAMPER technique.
- Develop a mini business plan and pitch the plan/ Review and critique of a real-world business plan (available from start-up incubators).
- Patent infringement case study/ Role-play on registering a company and selecting appropriate legal structure.
- Study of an Indian company's international expansion/ Market research exercise: Identify potential foreign markets for a product/service.
- Analysis of real-world trade agreements and their impact on a business (e.g., India–US trade relations)/ Study of a company affected by currency fluctuations in international operations.

Text Books:

1. Arya Kumar (2012). *Entrepreneurship: Creating and leading an entrepreneurial organization*. Pearson Education, Inc.
2. Khanka, S. S. (2026). *Entrepreneurial development*. S. Chand & Company Ltd.
3. Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2020). Entrepreneurship. McGraw Hill Education.
4. Daniels, J. D., Radebaugh, L. H., & Sullivan, D. P. (2021). International Business: Environments and Operations. Pearson Education.
5. Kuratko, D. F. (2019). Entrepreneurship: Theory, Process and Practice. Cengage Learning.

References:

1. Rajeev Roy, Entrepreneurship, 3rd Edition Oxford

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	1	1	-	-	-	1	-	1	1	1	-	-	-
CO2	-	1	1	-	-	-	-	-	1	2	1	-	-	-
CO3	-	1		-	-	1	3	-	1	-	1	-	-	-
CO4	-	1	1	-	-	1	-	-	1	2	1	-	-	-
CO5	-	1		-	-	1	-	-	1	2	1	-	-	-
CO6	-	1	1	-	-	1	1	-	1	2	1	-	-	-
Avg.	-	1	1	-	-	1	1.667	-	1	1.8	1	-	-	-

EE24511 Power System Analysis **PCC** **L T P C**

3 0 2 4

Course Objectives:

- To introduce per-unit representation and network modelling techniques for power systems.
- To present the principles and methods of power flow analysis in electrical networks.
- To provide knowledge of symmetrical and unsymmetrical fault analysis in power systems.
- To familiarise students with steady-state and transient stability concepts of power systems.
- To expose students to analytical techniques used in power system operation, fault analysis, and stability studies.
- To develop the analytical ability required for solving power system engineering problems.

UNIT I INTRODUCTION **9**

Need for system planning and operational studies - Power system components, Representation - Single line diagram - per unit quantities - p.u. impedance diagram - p.u. reactance diagram, Network graph Theory - Bus incidence matrices, Primitive parameters, Formation of bus admittance matrix – Direct inspection method – Singular Transformation method.

UNIT II POWER FLOW ANALYSIS 9

Bus classification - Formulation of Power Flow problem in polar coordinates - Analytical formulation of Power flow solution using Gauss Seidel method - Handling of Voltage controlled buses - Analytical formulation of Power Flow Solution by Newton Raphson method – Flow charts – Comparison of methods.

UNIT III SYMMETRICAL FAULT ANALYSIS 9

Assumptions in short circuit analysis - Symmetrical short circuit analysis using Thevenin's theorem - Bus Impedance matrix building algorithm (without mutual coupling) - Symmetrical fault analysis through bus impedance matrix - Post fault bus voltages - Fault level - Current limiting reactors.

UNIT IV UNSYMMETRICAL FAULT ANALYSIS 9

Symmetrical components - Sequence impedances - Sequence networks - Analysis of unsymmetrical faults at generator terminals: LG, LL and LLG - unsymmetrical fault occurring at any point in a power system.

UNIT V STABILITY ANALYSIS 9

Classification of power system stability – Rotor angle stability - Power-Angle equation – Steady state stability - Swing equation – Solution of swing equation by step by step method - Swing curve, Equal area criterion - Critical clearing angle and time, Multi-machine stability analysis – Analytical formulation of Modified Euler method.

Periods:45

LIST OF EXPERIMENTS:

1. Formation of Bus Admittance and Impedance Matrices.
2. Power Flow Analysis using Gauss-Seidel Method.
3. Power Flow Analysis using Newton Raphson Method.
4. Symmetric and Unsymmetrical Fault Analysis.
5. Transient Stability Analysis of SMIB System.

Periods:30

Total Periods:75

Laboratory Requirements:

Sl. No.	Description of Equipment	Required numbers (for batch of 30 students)
1	Personal Computers (Intel Core i5 or i7, 500 GB, 8 GB RAM)	30 Nos.
2	Laser Printer	1
3	Software: MATLAB/ EMTP / ETAP / CYME / MiPOWER / any Power system simulation software	8

Course Outcomes:

On completion of the course, the students will be able to

CO1: Model power systems using per-unit representation, single-line diagrams and bus admittance matrices.

CO2: Analyse power flow in power systems using the Gauss–Seidel and Newton–Raphson methods.

CO3: Evaluate symmetrical fault currents, fault levels and post-fault bus voltages using network theorems and bus impedance matrices.

CO4: Model power system using symmetrical components theory and analyse unsymmetrical faults.

CO5: Assess the steady-state and transient stability of power systems and determine critical clearing angle and time.

CO6: Model power system and apply mathematical techniques to solve problems related to power flow, fault analysis and system stability..

Suggested Activities:

- Power scenario in India [Map the Indian power grid structure and Collect data on generation capacity, regional grid interconnections, and energy mix (thermal, hydro, renewable, nuclear).
- Case-based learning: Analyse 2012 Indian Power Grid Blackout and highlight the need for power system operational studies.

Text Books:

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

References:

1. Pai M A, 'Computer Techniques in Power System Analysis', Tata Mc Graw-Hill Publishing Company Ltd., New Delhi, Second Edition, 2007.
2. 2. J. Duncan Glover, Mulukutla S.Sarma, Thomas J. Overbye, 'Power System Analysis & Design', Cengage Learning, Fifth Edition, 2012.
3. 3. P. Venkatesh, B. V. Manikandan, A. Srinivasan, S. Charles Raja, "Electrical Power Systems: Analysis, Security and Deregulation" Prentice Hall India (PHI), second edition - 2017
4. 4. Gupta B.R., 'Power System - Analysis and Design', S. Chand Publishing, Reissue edition 2005.
5. 5. Kundur P., 'Power System Stability and Control', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2013
6. https://nptel.ac.in/courses/117105140

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	1			1				2	3	1
CO2	3	3	3	3	1			1				3	3	3
CO3	3	3	3	3	1			1			1	3	3	3

CO4	3	2	2	3	2			1			1	3	3	3
CO5	3	3	2	3	2			1			1	3	3	3
CO6	3	3	3	3	2			1			1	2	3	3
Avg.	3	2.667	2.5	2.67	1.5			1			1	2.67	3	2.667

EE24522 POWER ELECTRONICS LABORATORY PCC L T P C

0 0 3 1.5

Course Objectives:

- Understand the operation, triggering methods, and switching characteristics of power semiconductor devices such as SCR, TRIAC, MOSFET, and IGBT.
- Develop practical skills in the implementation and performance evaluation of AC–DC, DC–DC, DC–AC, and AC–AC power converter circuits.
- Gain hands-on experience in testing, and analyzing PWM-based inverter circuits and switched-mode power converters.
- Apply simulation tools to model, analyze, and validate the performance of power electronic circuits.

List of Experiments:

1. Gate Pulse Generation using R, RC and UJT.
2. Characteristics of SCR and TRIAC
3. Characteristics of MOSFET and IGBT
4. AC to DC half controlled converter
5. AC to DC fully controlled Converter
6. Step down and step up MOSFET based choppers
7. IGBT based single phase PWM inverter
8. IGBT based three phase PWM inverter
9. AC Voltage controller
10. Switched mode power converter.
11. Simulation of PE circuits (1Φ & 3Φ full converters, DC-DC converters, AC voltage ontrollers).

12. Four Quadrant Chopper

TOTAL: 45 PERIODS

Course Outcomes:

On completion of the course, the students will be able to

CO1: Generate gate pulses and analyze the characteristics of SCR, TRIAC, MOSFET, and

IGBT.

CO2: Analyze the performance of single-phase AC–DC converter circuits.

CO3: Implement and evaluate the operation of DC–DC converters.

CO4: Analyze the performance of single-phase and three-phase PWM inverter circuits.

CO5: Investigate the operation of AC voltage controllers and AC–AC converters.

CO6: Simulate and validate power electronic converter circuits using software tools.

Laboratory Requirements

1. Device characteristics(for SCR, MOSFET, TRIAC, and IGBT kit with built-in / discrete power supply and meters) - 2 each

2. Single phase SCR based half controlled converter and fully controlled converter along with built-in/separate/firing circuit/module and meter – 2 each

3. MOSFET based step up and step down choppers (Built in/ Discrete) – 1 each

4. IGBT based single phase PWM inverter module/Discrete Component – 2

5. IGBT based three phase PWM inverter module/Discrete Component – 2

6. Switched mode power converter module/Discrete Component – 2

7. SCR &TRIAC based 1 phase AC controller along with lamp or rheostat load - 2

8. Cyclo converter kit with firing module – 1

9. Dual regulated DC power supply with common ground

10. Cathode ray Oscilloscope/ Digital Storage Oscilloscope –10

11. Isolation Transformer – 5

12. Single phase Auto transformer –3

13. Components (Inductance, Capacitance) 3 set for each

14. Multimeter – 5

15. LCR meter – 3

16. Rheostats of various ranges – 2 sets of 10 value

17. Work tables – 10

18. DC and AC meters of required ranges – 20

19. Component data sheets to be provided

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	-	-	-	3	2	-	1	2	2	1
CO2	3	3	3	3	-	-	-	3	2	-	1	2	2	1
CO3	3	3	3	3	-	-	-	3	2	-	1	2	2	1
CO4	3	3	3	3	–	–	–	3	2	-	1	2	2	1
CO5	3	3	3	3	-	-	-	3	2	-	1	2	2	1
CO6	3	3	3	3	3	-	-	3	2	-	1	2	2	1
Avg.	3	3	3	3	3	-	-	3	2	-	1	2	2	1

EE24521 Microprocessor and Microcontroller Laboratory PCC L T P C

0 0 3 1.5

COURSE OBJECTIVES:

● To perform simple arithmetic operations using assembly language program and study the addressing modes & instruction set of 8086 & 8051

● To develop skills in simple program writing in assembly languages

● To write an assembly language program to convert Analog input to Digital output and Digital input to Analog output.

● To perform interfacing experiments with µP8086

● To perform interfacing experiments with µC8051.

PROGRAMMING EXERCISES / EXPERIMENTS WITH µP8086:

1) Simple arithmetic operations: Addition / Subtraction /Multiplication /Division.

2) Logical operations, Code conversions, BCD Operations, String Manipulation, Search a byte of data and position of the

data and Sorting (Ascending/Descending).

3) ADC Interfacing and DAC Interfacing.

4) Serial Communication between two 8086 kits using 8251 USART

5) Parallel Communication between two 8086 kits using 8255 PPI

6) Square Wave Generation using 8253 (Mode 3)

7) Keyboard and Display Controller Interfacing (8279)

PROGRAMMING EXERCISES / EXPERIMENTS WITH µC8051

1) Simple arithmetic operations: Addition / Subtraction /Multiplication/ Division.

2) Square of the number, Cube of the number, Unpacked BCD to ASCII and Logical operations

3) Stepper motor controller interface.

4) Traffic light controller interface.

Total Periods: 45

Laboratory Requirements:

SI.No	Description of Equipment	Quantity required
1	8086 trainer kit with power supply	15
2	8051 Microcontroller trainer kit	15
3	Traffic light control interface board	5
4	Stepper motor interface board	5
5	A/D and D/A interface boards	5
6	Software tool for 8086, 8051 loaded in computers	5 nos. PC with software license

Course Outcomes:

After studying the above subject, students should have the:

CO1: Ability to write assembly language program for 8086 microprocessor.

CO2: Ability to write assembly language program for 8051 microcontroller

CO3: Ability to design and implement interfacing of peripheral with microprocessor and microcontroller

CO4: Ability to analyze, comprehend, design and implement microprocessor based systems used for control and monitoring.

CO5: Ability to analyze, comprehend, design and implement microcontroller-based systems used for control and monitoring.

CO6: Integrate microcontroller with various peripherals to solve complex problems and demonstrate real-time system design and implementation.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	2	3	-	-	-	1.5	-	-	3	3	1	3
CO2	2	1	2	3	-	-	-	1.5	-	-	3	3	1	3
CO3	2	1	2	3	-	-	-	1.5	-	-	3	3	1	3
CO4	2	1	2	3	-	-	-	1.5	-	-	3	3	1	3
CO5	2	1	2	3	-	-	-	1.5	-	-	3	3	1	3
CO6	2	1	2	3	-	-	-	1.5	-	-	3	3	1	3
Avg.	2	1	2	3	-	-	-	1.5	-	-	3	3	1	3

			L	T	P	C
FC24501	**Universal Human Values and Service Learning**	**HSMC**	**1**	**0**	**1**	**2**

Course Objectives:

- To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
- To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.

UNIT I **Introduction-Basic Human Aspiration, its fulfillment through All-encompassing Resolution** **3**

The basic human aspirations and their fulfillment through Right understanding and Resolution, Right understanding and Resolution as the activities of the Self, Self being central to Human Existence; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution

UNIT II **Right Understanding (Knowing)- Knower, Known & the Process** **3**

The domain of right understanding starting from understanding the human being (the knower, the experiencer and the doer) and extending up to understanding nature/existence –

its interconnectedness and co-existence; and finally understanding the role of human beings in existence (human conduct).

UNIT III Understanding Human Being 3

Understanding the human being comprehensively as the first step and the core theme of this course; human being as co-existence of the self and the body; the activities and potentialities of the self; Basis for harmony/contradiction in the self.

UNIT IV Understanding Nature and Existence 3

A comprehensive understanding (knowledge) about the existence, Nature being included; the need and process of inner evolution (through self-exploration, selfawareness and self-evaluation), particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/ order leading to comprehensive knowledge about the existence).

UNIT V Understanding Human Conduct, All-encompassing Resolution & Holistic Way of Living 3

Understanding Human Conduct, different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with Allencompassing Resolution covering all four dimensions of human endeavor viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from Self to Nature and entire Existence

Outreach Activities 15

- Introduction to Service Learning (SL) - Concept and meaning of Service Learning - History and Evolution of Service Learning - Dynamics of Service Learning - Understanding the idea of learning through service.
- Understanding the process of Urbanization- Process of Urbanization - Characteristics and issues of Urban Poor - Urban Social Problems - Slums: Types, Living Conditions, Challenges.
- Cura personalis - Identifying groups in the community such as women-children-youth-elders and persons with disabilities-Equipping with the skills to address issues such as Education, health, sanitation, Environment & livelihood issues.
- Community Program Planning: Identifying an issue - Need analysis - brainstorming solutions to the issues - content creation - tool selection - venue arrangements - resource mobilization - budgeting - implementation of the planned activity - documentation and reflection guided by the principle of Magis.

Total Periods: 30

Course Outcomes:

At the end of the course, the students will be able to

1. Evaluate the significance of value inputs in formal education and start applying them in their life and profession

2. Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.
3. Analyze the value of harmonious relationship based on trust and respect in their life and profession
4. Examine the role of a human being in ensuring harmony in society and nature.
5. Apply the understanding of ethical conduct to formulate the strategy for ethical life and profession.
6. Recognize the socio-economic conditions of the urban poor and the importance of urbanization.
7. Analyse the socio-economic conditions in the slums and compare it to the larger state and national level realities.
8. Identify the community needs
9. Implement a simple community outreach activity and prepare documentation and present reflections based on the field experience.

Suggested Activities

- Classroom discussions
- Self-assessment
- Peer assessment
- Socially relevant project
- Group Activities

Text Books:

1. R R Gaur, R Asthana, G P Bagaria, 2019 (2nd Revised Edition), A Foundation Course in Human Values and Professional Ethics. ISBN 978-93-87034-47-1, Excel Books, New Delhi.
2. Premvir Kapoor, Professional Ethics and Human Values, Khanna Book Publishing, New Delhi, 2022.

References:

1. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and Harper Collins, USA
2. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
3. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986.
4. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.
5. A Nagraj, 1998, Jeevan Vidya EkParichay, Divya Path Sansthan, Amarkantak.
6. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
7. A N Tripathy, 2003, Human Values, New Age International Publishers.
8. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) Krishi Tantra Shodh, Amravati.
9. E G Seebauer& Robert L. Berry, 2000, Fundamentals of Ethics for Scientists &Engineers, Oxford University Press
10. M Govindrajran, S Natrajan& V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
11. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
12. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008. Science & Humanism – towards a unified worldview, P. L. Dhar & R. R. Gaur (1990), Commonwealth Publishers, New Delhi

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	3	-	-	-	-			
CO2	-	-	-	-	-	-	3	3	-	-	-	-			
CO3	-	-	-	-	-	-	3	3	3	3	-	-			
CO4	-	-	-	-	-	-	3	3	-	3	-	3			
CO5	-	-	-	-	-	-	3	3	-	-	-	3			
CO6	-	-	-	-	-	-	-	3	-	-	-	-			
Avg.	-	-	-	-	-	-	3	3	3	3	-	3			

			L	T	P	C
BS24502	**Logical Reasoning and Aptitude Training**	**BSC**	**2**	**0**	**0**	**1**

Course Objectives:

● To develop foundational knowledge and skills in averages, percentages.
● To develop foundational knowledge and skills in problems on ages, ratios and proportions, time and work.
● To enable students to apply quantitative reasoning techniques to solve practical problems involving boats & streams, pipes & cisterns, trains.
● To enhance logical reasoning skills from series, venn diagrams, tables and graphs. ● To enhance logical reasoning skills and critical thinking.

UNIT I QUANTITATIVE APTITUDE I 6

● Averages: Properties of Averages- Weighted Averages - Problems on Averages - Averages of Averages
● Percentage: Percentage Increase and Decrease - Finding Percentages - Percentage Change - Successive Percentage Changes - Percentage Comparisons
● Permutations and Combinations: Selection - Ordering - Arrangements

UNIT II QUANTITATIVE APTITUDE II 6

● Problems on Ages: Formulating Equations Based on Age Statements - Solving Single variable Age Problems - Solving Multi-variable Age Problems - Age Differences - Sum of Ages - Average Age - Age Ratios - Age Problems Involving Future and Past Scenarios
● Ratios & Proportions: Comparing Ratios - Proportions - Compound Ratios - Ratio and Proportion in Real-life Applications
● Time & Work: Work and Time Relationship - Work Efficiency - Combined Work - Work Rate - Fractional Work - Work and Wages - Real-life Applications

UNIT III QUANTITATIVE APTITUDE III 6

● Boats & Streams: Speed of Boat in Still Water - Speed of Stream or Current - Upstream and Downstream Concepts - Relative Speed - Calculating Efficiency
● Pipes & Cisterns: Inlet and Outlet Pipes - Individual Rates of Pipes - Combined Efficiency - Problems Involving Leakage or Partials - Alternative Filling Scenarios - Pipes with Different Capacities - Applications in Real-life Scenarios
● Problems on Trains: Relative Speed of Trains - Crossing and Overtaking Problems - Meetings and Passing - Time and Distance Problems - Platform and Bridge Problems - Average Speed of Trains.

UNIT IV LOGICAL REASONING I 6

● Series: Alphabet and Number Series - Odd Man Out Series – Puzzles and Patterns - Blood Relations - - Directional Sense Test.
● Venn Diagrams: Using Venn Diagrams for Logical Reasoning - Diagrammatic Representation of Data - Real-life Applications
● Data-Interpretation and Data-Sufficiency: Introduction to Data Interpretation - Types of Charts and Graphs - Calculations and Approximations - Percentage Calculations - Comparison and Analysis – Problem Solving Techniques

UNIT V LOGICAL REASONING II 6

● Non-verbal reasoning: Pattern Recognition - Analogy and Classification - Series Completion - Spatial Orientation and Visualization - Cube and Dice Problems - Mirror and Water Image Problems - Analytical Reasoning with Diagrams
● Syllogisms: Types of Syllogisms - Categorical Syllogisms - Venn Diagram Representation - Rules of Inference - Types of Validity - Formal vs Informal Fallacies - Conditional Syllogistic Reasoning
● Critical Thinking: Understanding Arguments - Argument Structure - Logical Fallacies - Evidence and Reasoning - Counter arguments and Rebuttal - Assumptions and Implications - Creative Thinking - Contextual Understanding - Practice and Application

Total Periods: 30

Course Outcomes:

On completion of the course, the students will be able to
● Apply different techniques to solve problems including averages and percentages.
● Solve quantitative problems including ages, ratios and proportions, time and work.
● Solve quantitative problems, including boats & streams, pipes & cisterns and trains.
● Apply logical reasoning and draw conclusions from series, venn diagrams, tables and graphs.
● Apply logical reasoning, analyse information and draw conclusions.

Suggested Activities
● Mock test
● Skill Rack Practices
● Case Study Analysis.

Text Books:
1. Dr R S Aggarwal, "Quantitative Aptitude for Competitive Examinations", S Chand and Company Ltd., 2025.
2. Dr R S Aggarwal, "A Modern Approach to Logical Reasoning", S Chand and Company Ltd., 2022.
3. S. Sridhar, "Design and Analysis of Alogorithms"2nd Edition, Oxford University Press 2024.
4. Nishit K Sinha, "Quantitative Aptitude for the CAT" , 6th Edition, Pearson Publication 2024.

5. Abhijit Guha, "Quantitative Aptitude for all Competitive Examination", 7th Edison, Mc Graw Hill Education 2020.
6. FACE, " Aptipedia: Aptitude Encyclopaedia" 2nd Edition, Wiley India Pvt. Ltd., 2017.

References:

1. Arun Sharma, "Quantitative Aptitude for the CAT" 10th edition, Mc Graw-Hill Publishing, 2022.
2. Praveen R V, "Quantitative Aptitude and Reasoning", 3rd edition, PHI Learning Pvt. Ltd., 2016.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	1	-	-	-	-	-	1	-	-	-
CO2	3	3	1	-	-	-	-	-	1	-	2	-	-	-
CO3	3	3	1	-	-	-	-	-	1	-	2	-	-	-
CO4	2	3	-	2	2	-	-	-	1	-	1	-	-	-
CO5	1	3	-	-	2	1	-	1	2	2	1	-	-	-
Avg.	2.4	2.8	1	2	1.6	1		1	1.25	2	1.4	-	-	-

			L	T	P	C
GE24501	**Project Management and Operations Management**	**PCC**	**2**	**0**	**2**	**3**

Course Objectives:

- To understand the fundamental concepts, roles, and lifecycle of project management
- To equip learners with planning, scheduling, and control techniques
- To introduce software project management methodologies and modern development frameworks
- To provide knowledge of operations management principles
- To familiarize students with quality management practices and sustainable operational strategies

UNIT I **Fundamentals of Project Management** **6**

Understanding Project Management – Project Management Role – Classification of Projects – Product Vs Project Management – Project Lifecycle – Project Risk Management – Case Studies: LP Manning Corporation and Project Firecracker

UNIT II Project Planning, Scheduling and control 6

Project planning process and Work Breakdown Structure (WBS) – Project scheduling techniques: Gantt chart, PERT, CPM – Resource allocation – Project budgeting and cost estimation – Project Management Information Systems (PMIS) and software tools (MS Project, Primavera)

UNIT III Software Project Management and process models 6

Software Process Models : Waterfall Model, Prototyping Model, RAD Model, Incremental Model, Spiral Model, Agile Fundamentals - Scrum Framework

UNIT IV Operations Management and inventory control 6

Production systems, Classification of Production systems, Operations system, Operations Management - Definition, Objectives, Strategic role of operations, Strategic Planning, Inventory control or management - Inventory, Objectives of inventory control, benefits, techniques (EOQ, JIT, ABC analysis)

UNIT V Quality management and Sustainable Operations 6

Quality Management: Preventive Vs Breakdown maintenance for Quality – Techniques for measuring quality - Supply chain management – Lean operations and Six Sigma overview - Quality management concepts – TQM, ISO standards, Kaizen, 5S

Periods: 30 PERIODS

Course Outcomes:

On completion of the course, the students will be able to

CO1: To comprehend the fundamental concepts of project management, including project lifecycle and risk management
CO2: Apply project planning and scheduling techniques such as WBS, Gantt charts, PERT, and CPM
CO3: Analyze and compare various software process models including Waterfall, Spiral, Agile, and Scrum frameworks.
CO4: Apply operations management principles and inventory control techniques such as EOQ, JIT, and ABC analysis in practical scenarios.
CO5: Evaluate quality management practices using tools such as TQM, Six Sigma, Kaizen, and ISO standards
CO6: Design and develop integrated solutions by combining project management, operations strategies, and quality frameworks

Suggested Activities

- Interactive lectures and discussions
- Case studies from engineering and industrial projects

- Hands-on workshops on PERT/CPM using software tools
- Group projects on planning and evaluating an engineering project
- Industry expert talks on project execution and operations excellence

Text Books:

1. Kerzner, H. (2018). Project Management: A Systems Approach to Planning, Scheduling and Controlling. Wiley.
2. Chandra, Prasanna. (2017). Projects: Planning, Analysis, Selection, Financing, Implementation and Review. McGraw Hill Education.
3. Anil Kumar, S. & Suresh, N. (2018). Operations Management. New Age International Publishers.
4. Robert Hughes and Mike Cotterell (2009). Software Project Management. McGraw-Hill Higher Education.

References:

1. Dale H. Besterfiled, Carol B.Michna, Glen H. Bester field, MaryB.Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.
2. Gray, C. F., & Larson, E. W. (2020). Project Management: The Managerial Process. McGraw Hill Education.
3. Jack R. Meredith & Samuel J. Mantel. (2019). Project Management: A Managerial Approach. Wiley India.
4. Bhavesh. M Patel, Sandhya Rai, J.S Chandan, Dr. A. Nag, Project Management, Vikas Publishing House, New Delhi, 2020.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	3	2			
CO2	3	3	2	2	-	-	-	-	-	-	3	2			
CO3	3	3	2	2	-	-	-	-	-	-	3	2			
CO4	3	3	2	2	-	-	-	-	-	-	3	2			
CO5	3	3	2	2	-	-	-	-	-	-	3	2			
CO6	3	3	3	2	-	-	-	-	-	-	3	2			
Avg.	3	3	2	2	-	-	-	-	-	-	3	2			

EE24611	POWER SYSTEM OPERATION AND CONTROL	PCC	L	T	P	C
			3	0	2	4

Course Objectives:

- Introduce the concepts and operational requirements of interconnected power systems.
- Present the principles of real power–frequency control in power systems.
- Introduce reactive power–voltage control techniques and compensation methods.
- Perform generation scheduling and economic operation of power system.
- Expose students to computer-aided monitoring and control of power systems using SCADA and EMS**.**

UNIT I INTRODUCTION 9

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

UNIT II REAL POWER FREQUENCY CONTROL 9

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

UNIT III REACTIVE POWER – VOLTAGE CONTROL 9

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

UNIT IV ECONOMIC OPERATION OF POWER SYSTEM 9

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

UNIT V COMPUTER AIDED CONTROL OF POWER SYSTEM 9

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

Periods:45

LIST OF EXPERIMENTS:

1. Analysis of Load – Frequency Dynamics of Single- Area Systems with and without controller
2. Analysis of Load – Frequency Dynamics of Two-Area Power Systems with and without controller.
3. Impact of Closed-Loop Pole Locations on the Dynamic Behavior of an Automatic Voltage Regulator
4. Solution to Economic Dispatch problem in Power Systems.
5. State estimation: Weighted least square estimation.

Periods:30

Total Periods:75

Course Outcomes:

On completion of the course, the students will be able to

CO1: Explain the day – to – day operation of the power system.
CO2: Model and analyse the control actions that are implemented to meet the minute-to-minute variation of system real power demand.
CO3: Model and analyse the compensators for reactive power control and various devices used for voltage control.
CO4: Prepare day ahead and real time economic generation scheduling.
CO5: Describe the necessity of computer control of power systems.
CO6: Ability to analyze the operational strategies to be implemented on power system to meet the minute-to-minute variation of system demand.

Suggested Activities:

- IEGC Activity: Study relevant provisions of the Indian Electricity Grid Code (IEGC) related to frequency regulation, voltage control, load dispatch, scheduling, reserve management, and grid security. Present a short report on how these regulations support secure and reliable power system operation.
- Case Study: Analyse a real-world power system event (e.g., major grid disturbance, blackout, frequency excursion, voltage collapse, or islanding event) and evaluate the operational measures, control actions, and lessons learned in terms of load frequency control, reactive power management, economic dispatch, and SCADA/EMS.

Text Books:

1. Olle. I. Elgerd, 'Electric Energy Systems theory – An introduction', McGraw Hill Education Pvt. Ltd., New Delhi, 2nd edition, 2017.
2. Allen. J. Wood and Bruce F. Wollen berg, 'Power Generation, Operation and Control', John Wiley & Sons, Inc., 3rd edition, 2013.
3. Abhijit Chakrabarti and Sunita Halder, 'Power System Analysis Operation and Control', PHI learning Pvt. Ltd., New Delhi, Fourth Edition, 2018.

References:

1. Kothari D.P. and Nagrath I.J., 'Power System Engineering', Tata McGraw– Hill Education, Second Edition, Reprint 2018.
2. Hadi Saadat, 'Power System Analysis', McGraw Hill Education Pvt. Ltd., New Delhi, 23rd reprint, 2015.
3. Kundur P., 'Power System Stability and Control, McGraw Hill Education Pvt. Ltd., New Delhi, 12th reprint, 2015.
4. B.M. Weedy, B.J. Cory et al, 'Electric Power systems', Wiley, Fifth Edition, 2012.
5. https://nptel.ac.in/courses/108104052

Laboratory Requirements:

S. No	Name of the Equipment/Software	Required
1.	Personal Computers (Intel Core i5 or i7, 500 GB, 8 GB RAM)	30
2.	Laser Printer	1
3.	Software: MATLAB/ EMTP / ETAP / CYME / MiPOWER / any Power system simulation software	8

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**2**	**1**	-	-	-	-	1	-	-	-	2	3	3	3
CO2	**3**	**2**	1	1	-	1	3	-	2	-	2	3	3	3
CO3	**3**	**2**	1	1	-	1	3	-	2	-	2	3	3	3
CO4	**3**	**2**	1	1	-	1	3	-	2	-	2	3	1	3
CO5	**2**	**1**	-	-	-	-	1	-	2	-	2	3	3	3
CO6	**3**	**2**	1	1	-	1	3	-	2	-	2	3	3	3
Avg.	**3**	**3**	1	1	-	1	2.33	-	2	-	2	3	2.67	3

EE24612 PROTECTION AND SWITCHGEAR PCC L T P C

3 0 2 4

Course Objectives:

- To introduce the fundamentals of power system protection, fault analysis, and grounding practices.
- To present the operating principles and characteristics of protective relays used in power systems.

- To familiarize students with protection schemes for major power system equipment.
- To expose students to static and numerical relays used in modern protection systems.
- To provide knowledge of circuit interruption phenomena and the operating principles of different types of circuit breakers.

UNIT I PROTECTION SCHEMES 9

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

UNIT II BASICS OF RELAYS 9

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

UNIT III OVERVIEW OF EQUIPMENT PROTECTION 9

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

UNIT IV STATIC RELAYS AND NUMERICAL PROTECTION 9

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

UNIT V CIRCUIT BREAKERS 9

Physics of arcing phenomenon and arc interruption – DC and AC circuit breaking – re-striking voltage and recovery voltage - rate of rise of recovery voltage - current chopping - interruption of capacitive current - resistance switching - Types of circuit breakers – air blast, oil, SF6 and vacuum circuit breakers – comparison of different circuit breakers

Periods:45

LIST OF EXPERIMENTS:

1. Performance analysis of Electromagnetic over current relay.
2. Performance analysis of impedance relay.
3. Testing of Current Transformer & Potential Transformer
4. Performance analysis of Digital over current relay.
5. Relay Coordination in Radial Feeder Protection Scheme

Periods:30

Total Periods:75

Laboratory Requirements

Sl.No.	Description of Equipment	Required numbers (for batch of 30 students)
1	Digital & Electromechanical (Both) Type Over current relay with test set up	1
2	Digital Impedance relay with test set up	1
3	CT & PT Testing kit	1
4	Simulator model of String insulator	1
5	Digital Relay Coordination test set up	1

Course Outcomes:

CO1: Explain the need for power system protection, identify different types of faults, and describe protection zones and grounding methods.
CO2: Analyse the operating characteristics of electromagnetic protective relays and select appropriate relays for various protection requirements.
CO3: Explain the protection schemes employed for transformers, generators, motors, busbars, and transmission lines using instrument transformers.
CO4: Analyze the operation of static and numerical relays for overcurrent, differential, and distance protection.
CO5: Explain arc interruption phenomena and evaluate the operating principles and applications of different types of circuit breakers.
CO6: Analyze and evaluate power system protection schemes by selecting appropriate relays and circuit breakers for reliable system protection.

Suggested Activities:

- Safety Standards: Study and prepare a report on Personal Protective Equipment (PPE), Lockout/Tagout (LOTO) procedures, electrical safety practices, and the classification and selection of suitable fire extinguishers for electrical fires.
- Artificial Intelligence-Based Protection: Conduct a case study or technical review on the application of Artificial Intelligence and Machine Learning techniques in fault detection, relay coordination, adaptive protection, and predictive maintenance of power systems.
- Surge Protection: Prepare a technical report or comparative study on surge protection methods, including surge protection devices (SPDs), lightning arresters, transient overvoltage protection, and their applications in power system equipment protection.

Text Books:

1. Sunil S.Rao, ‘Switchgear and Protection’, Khanna Publishers, New Delhi, Four Edition, 2010.
2. Badri Ram ,B.H. Vishwakarma, ‘Power System Protection and Switchgear’, New Age International Pvt Ltd Publishers, Second Edition 2011.

3. B.Rabindranath and N.Chander, 'Power System Protection and Switchgear', New Age International (P) Ltd., Second Edition, 2018.
4. Arun Ingole, 'Switch Gear and Protection' Pearson Education, 2018.

References:

1. Y.G.Paithankar and S.R.Bhide, 'Fundamentals of power system protection', Second Edition,Prentice Hall of India Pvt. Ltd., New Delhi, 2013.
2. C.L.Wadhwa, 'Electrical Power Systems', 6th Edition, New Age International (P) Ltd., 2018
3. VK Metha," Principles of Power Systems", S. Chand, Reprint, 2013
4. Bhavesh Bhalja, R.P. Maheshwari, Nilesh G. Chotani,'Protection and Switchgear' Oxford University Press, 2nd Edition 2018.
5. Safety in Electrical Low Voltage Installations Vol 1 – 8 , CAMTECH RDSO
6. Electrical Safety of Low Voltage Systems by Massimo Mitolo, 1st Edition, 2009 The McGraw-Hill Companies, Inc.
7. https://nptel.ac.in/courses/108107167

Laboratory Requirements:

S. No	**Name of the Equipment/Software**	**Required**
1.	Personal Computers (Intel Core i5 or i7, 500 GB, 8 GB RAM)	30
2.	Laser Printer	1
3.	Software: MATLAB/ EMTP / ETAP / CYME / MiPOWER / any Power system simulation software	8

MAPPING OF COs WITH POs AND PSOs

COs	**POs**											**PSOs**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**2**	**2**		**2**	**3**	**2**	**2**
CO2	**3**	**3**	**2**	**3**	**3**	**1**		**2**	**2**		**3**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**2**	**1**		**2**	**2**		**3**	**3**	**2**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**1**		**2**	**2**		**3**	**3**	**3**	**3**
CO5	**3**	**2**	**2**	**2**	**2**	**1**		**2**	**2**		**2**	**3**	**2**	**2**
CO6	**3**	**3**	**2**	**3**	**3**	**1**		**2**	**2**		**3**	**3**	**3**	**3**
Avg.	**3**	**2.83**	**2.33**	**2.67**	**2.5**	**1.17**	**1**	**2**	**2**		**2.67**	**3**	**2.5**	**2.67**

EE24614	ENERGY SYSTEMS	PCC	L	T	P	C
			2	0	2	3

The course aims to:

- Provide an understanding of the current global and Indian energy scenario, which emphasis on renewable energy potential and utilization.
- Explain the principles and technologies involved in solar, wind, biomass, ocean, and geothermal energy conversion systems.
- Analyse the design considerations, site selection and performance evaluation of renewable energy systems.
- Impart knowledge on integration, applications and environmental aspects of renewable energy sources.
- Develop the ability to analyse, simulate and propose solutions for sustainable energy generation and management through laboratory experience.

UNIT I ENERGY SCENARIO 6

Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status - Potential of various renewable energy sources - Global energy status - Per capita energy consumption - Future energy plans - Hydrogen Engines and their Role in Future Transportation Energy Scenario.

UNIT II SOLAR ENERGY 6

Solar radiation – Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photovoltaic conversion – Solar PV systems – Solar PV applications – Solar PV sizing – Inverter sizing – Block diagram of solar PV systems – Types of Solar PV systems: Stand-alone and Grid integrated systems - Model of solar PV and solar thermal systems.

UNIT III WIND ENERGY 6

Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Horizontal axis wind turbine – Components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Wind PV hybrid systems - Applications.

UNIT IV BIO-ENERGY 6

Bio resources – Biomass direct combustion – Thermochemical conversion - Biochemical Conversion - Mechanical conversion - Biomass gasifier - Types of biomass gasifiers – Cogeneration –- Carbonisation – Pyrolysis - Biogas plants – Digesters – Applications.

UNIT V OCEAN AND GEOTHERMAL ENERGY 6

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

Periods:30

LIST OF EXPERIMENTS

1. Experiment on "V-I characteristics and efficiency of 1kWp solar PV system"
2. Experiment on "Shadowing effect and diode-based solution in 1kWp solar PV system"
3. Experiment on performance assessment of Grid connected 1kWp Solar PV system
4. Experiment on performance assessment of Standalone 1kWp Solar Power System
5. Experiment on performance assessment of Micro wind energy generator
6. Experiment on performance assessment of Hybrid (Solar-Wind) power system

Periods:30

Total Periods:60

Sl.No.	Description of Equipment	Required numbers (for batch of 30 students)
1	Personal Computers (Intel Core i5 or i7, 500 GB, 8 GB RAM)	15
2	Laser Printer	1
3	Software: Matlab	8
4	1 KW SOLAR PV MODULE TRAINING SYSTEM	1
5	WIND SOLAR HYBRID POWER SYSTEM WITH MICRO WIND ENERGY GENERATOR	1
6	SOLAR PV EMULATOR	1

SUGGESTED ACTIVITIES:

1. Simulation study on solar PV energy system 1KW for OFF Grid Inverter
2. Simulation study on solar PV energy system 1KW for ON Grid Inverter
3. Simulation study on solar PV energy system 1KW for ON Grid Inverter
4. Simulation study on Wind Energy System Generator
5. Simulation study on hybrid PV Solar and Wind Energy System Generator

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1: Describe the current energy scenario, renewable energy potential, and future energy plans in India and globally.

CO2: Explain the working principles, design, and applications of solar thermal and solar PV systems.

CO3: Analyse wind energy conversion systems and evaluate site selection, turbine performance and hybrid applications.

CO4: Evaluate biomass conversion processes and their applications in energy generation.

CO5: Explain the operating principles and technologies of ocean and geothermal energy systems.

CO6: Integrate and analyze multiple renewable energy sources through experimental investigation and simulation to develop sustainable hybrid energy systems.

TEXT BOOKS:

1. B. H. Khan, Non-Conventional Energy Resources, McGraw Hill Education, 3rd Edition, 2020.
2. Godfrey Boyle, Renewable Energy: Power for a Sustainable Future, Oxford University Press, 4th Edition, 2019.
3. C. S. Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, PHI Learning Pvt. Ltd., 3rd Edition, 2021.
4. G. D. Rai, Non-Conventional Energy Sources, Khanna Publishers, 5th Edition, 2021.

REFERENCES:

1. John Twidell and Tony Weir, Renewable Energy Resources, Routledge, 4th Edition, 2021.
2. S. P. Sukhatme and J. K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill, 4th Edition, 2020.
3. G. N. Tiwari, Renewable Energy Resources: Basic Principles and Applications, Narosa Publishing House, 2019.
4. D. Yogi Goswami, Handbook of Energy Efficiency and Renewable Energy, CRC Press, 2nd Edition, 2017.
5. https://energyswaraj.org/energy-literacy-training/
6. https://nptel.ac.in/courses/103103206
7. https://nptel.ac.in/courses/127103236

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	2	1	2	2	3	3	2	3	3
CO2	3	3	2	2	2	2	1	2	2	3	3	2	3	3
CO3	3	3	2	2	2	2	1	2	2	3	3	2	3	3
CO4	2	3	2	2	2	2	1	2	2	3	3	2	3	3
CO5	3	3	2	2	2	2	1	2	2	3	3	2	3	3
CO6	3	3	2	2	2	2	1	2	2	3	3	2	3	3
Avg.	3	3	2	2	2	2	1	2	2	3	3	2	3	3

			L	T	P	C
GE24503	**FINANCIAL LITERACY**	HSMC	2	0	0	2

Course Objectives:

- Develop financial awareness among engineering students.
- Enable students to make informed decisions regarding personal finance, savings and investments.
- Equip learners with the skills to manage budgets, taxes, credit and debt efficiently.
- Provide knowledge on digital financial systems, fintech applications and entrepreneurship finance.
- Foster responsible financial behaviour and ethical decision-making.

UNIT I Introduction to Financial Literacy and Money Management 6

Meaning, need and importance of financial literacy - Basic financial concepts: income, expenses, assets, liabilities, cash flow - Financial goals and planning process - Budgeting for Skilled Money Management - Time value of money and inflation

UNIT II Banking and Digital Financial Systems 6

Process of Opening Bank Accounts - Types of bank accounts and their operation - Cheques, demand drafts, ATM, debit and credit cards - Digital banking: UPI, Internet banking, mobile banking, NEFT, RTGS, IMPS - Digital payment security and cyber safety - Role of RBI, NPCI and SEBI

UNIT III Saving and Investment Options 6

Difference between saving and investment - Risk and return concepts - Types of investment avenues: bank deposits, mutual funds, stocks, bonds, PPF, NPS, insurance, gold bonds, real estate - Government Schemes for Various Savings & Investment Options - Introduction to capital markets - Systematic Investment plan and portfolio diversification

UNIT IV Credit, Loans and Taxation 6

Concept of credit - Types of loans: education loan, vehicle loan, home loan, personal loan, Gold Loan - Understanding credit cards and managing debt - Credit score and its importance - Basics of taxation: income tax structure in India, PAN, TDS, filing IT returns - Tax Exemptions and Deductions

UNIT V Financial Planning, Entrepreneurship and Ethical Finance 6

Components of comprehensive financial planning - Retirement planning and insurance planning - Financial aspects of entrepreneurship and start-ups - Costing, pricing and break-even analysis for small businesses - Sustainable and ethical financial practices

Periods: 30 PERIODS

Course Outcomes:

On completion of the course, the students will be able to

CO1: Understand the fundamentals of personal and business finance.

CO2: Prepare personal budgets and financial plans.

CO3: Evaluate different saving and investment options.

CO4: Use digital tools and platforms for financial transactions and management.

CO5: Apply basic financial principles in entrepreneurial or career settings.

CO6: Effectively manage personal finances using financial literacy and planning skills.

Suggested Activities

- Hands-on sessions on budgeting and investment planning using Excel or Google Sheets/ Create a Daily Spending Diary/ Conduct a Money Management SWOT Analysis
- Mock Account Opening Activity/ Digital Payment Demonstration: Hands-on demo of UPI, NEFT, IMPS and online payment apps (without real transactions)
- Analysis of the Government Schemes/ Create a mock investment portfolio/ Review on FinTech innovations and investment apps
- Demonstrate mock IT return filing using a sample Form 16 and income data/ Compare education, housing and vehicle loans from 2–3 banks, highlighting interest rates, EMIs and eligibility.
- Create a personal financial plan including budgeting, insurance, investments and retirement goals/ Mini Start-Up Simulation: Groups design a simple business idea and calculate costing, pricing and break-even point using realistic figures.

Text Books:

1. Shalu Garg, "Personal Financial Planning", Sultan Chand & Sons, Educational Publishers New Delhi, First Edition: 2024.
2. Jack R. Kapoor, Les R. Dlabay, Robert J. Hughes, Melissa M. Hart, "Personal Finance", 14th edition, McGraw Hill LLC, 2023.
3. Financial Education Booklet, Securities and Exchange Board of India (SEBI), Mumbai, November 2020.
4. Banking Theory and Practice, Mahesh Kumar Sarva, Excel Books Private Limited, New Delhi.

References:

1. "Principles and Practices of Banking" – Indian Institute of Banking & Finance (IIBF)
2. Financial Education Handbook For New Entrants at Workplace, National Centre for Financial Education (NCFE), First Edition September 2024.
3. Tulsi Bharatbhai Raval, "Financial Planning", Study Guide Educational Publication, December 2021.
4. National Finance Olympiad, "Personal Finance Handbook", Pockvue Solutions Pvt. Ltd., Ed. 1, 2024 - 2025

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	3	-	-	-	1	-	2	-	3	3			
CO2	-	3	-	-	2	1	-	-	2	3	3			
CO3	-	3	-	-	3	1	2	-	2	3	3			
CO4	-	-	-	-	3	1	2	2	2	3	3			
CO5	-	-	-	-	2	1	2	2	2	3	3			
CO6	-	2	-	-	-	1	2	3	2	3	3			
Avg.	**-**	**2.75**	**-**	**-**	**2.5**	**1**	**2**	**2.25**	**2**	**3**	**3**			

VERTICAL I - POWER ENGINEERING

PEE2401 HIGH VOLTAGE ENGINEERING L T P C

3 0 0 3

COURSE OBJECTIVES:

- To introduce the causes and effects of over voltages in electrical power systems and methods of insulation coordination.
- To provide knowledge on dielectric materials and breakdown mechanisms in gases, liquids, vacuum, and solid insulation systems.
- To familiarize students with generation and measurement techniques for high voltages and high currents.
- To develop understanding of high voltage testing procedures and standards for electrical power apparatus.
- To enable students to understand industrial and electrostatic applications of high voltage engineering.

UNIT I OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS 9

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

UNIT II DIELECTRIC BREAKDOWN 9

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

UNIT III GENERATION AND MEASUREMENTS OF HIGH VOLTAGES AND HIGH CURRENTS 9

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

UNIT IV HIGH VOLTAGE TESTING & INSULATION COORDINATION 9

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

transformers - Insulation Coordination.

UNIT V APPLICATION IN INDUSTRY 9

Introduction – electrostatic applications- electrostatic precipitation, separation, painting / coating,

spraying, imaging, printing, Transport of materials – manufacturing of sand paper – Smoke particle detector – Electrostatic spinning, pumping, propulsion – Ozone generation – Biomedical applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon the successful completion of the course, students will be able to:

CO1: Explain over voltages, travelling waves, protection methods, and insulation coordination in power systems.

CO2: Describe dielectric materials and breakdown mechanisms in gaseous, liquid, vacuum, and solid insulation systems.

CO3: Explain the generation and measurement of high DC, AC, impulse voltages, and high currents.

CO4: Describe high voltage testing procedures, standards, and insulation coordination for electrical equipment.

CO5: Explain electrostatic and industrial applications of high voltage engineering.

CO6: Evaluate high voltage phenomena, testing methods, and insulation systems for reliable power system operation.

Suggested Activities:

1. Case Study: Investigate Benjamin Franklin's 1752 kite experiment and present the inference.
2. Poster Presentation: Prepare a poster to demonstrate the breakdown process in a dielectric.
3. Circuit design and Calculation: Design a Cockcroft-Walton voltage multiplier or Marx impulse generator circuit and perform the required calculations.
4. Industry Standards Review: Study IEC/IS standards for transformer and circuit breaker testing and prepare a summary report.
5. Seminar: Electrostatic and industrial applications of high voltage engineering

TEXT BOOKS:

1. M.S.Naidu and V. Kamaraju, 'High Voltage Engineering', Tata McGraw Hill, Fifth Edition, 2013.

2. E. Kuffel and W.S. Zaengl, J.Kuffel, 'High voltage Engineering fundamentals', Newnes Second Edition, Elsevier , New Delhi, 2005.

3. C.L. Wadhwa, 'High voltage Engineering', New Age International Publishers, Fourth Edition, 2020.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)

REFERENCES:

1. L.L.Alston, High Voltage Technology, Oxford University Press, First Indian Edition 2006.

2. C.L.Wadhwa, High voltage Engineering, New Age International Publishers, Fourth Edition, 2020

3. Mazen Abdel – Salam, Hussein Anis, Ahdab A-Morshedy, RoshdayRadwan, High Voltage Engineering – Theory &Practice,Second Edition, Taylor & Francis Gourp, 2019

4. Subir Ray." An Introduction to High Voltage Engineering "PHI Learning Private Limited, New Delhi, Second Edition-2011

MAPPING OF COs WITH POs AND PSOs

	CO-PO											CO-PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PSO2**	**PSO3**
CO1	3	2	–	1	–	–	–	–	–	–	–	3	1	–
CO2	3	2	–	1	–	–	–	–	–	–	–	3	1	–
CO3	3	2	1	2	2	–	–	–	–	–	–	3	2	–
CO4	3	2	1	2	1	–	–	–	–	–	–	3	2	–
CO5	2	1	–	1	–	–	–	–	–	–	–	2	1	–
CO6	3	3	1	2	1	–	–	1	–	–	–	3	2	1
Avg.	**2.83**	**2**	**1**	**1.5**	**1.33**	**–**	**–**	**1**	**–**	**–**	**–**	**2.83**	**1.5**	**1**

PEE2402 SMART GRID **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To introduce the basic concepts, structure, functions, and importance of Smart Grid systems.
- To provide knowledge on smart metering, AMI, and real-time monitoring in power systems.
- To familiarize students with Smart Grid technologies used in transmission and distribution systems.
- To develop understanding of communication, computing, and cyber security in Smart Grid applications.
- To enable students to analyze Smart Grid solutions for reliable and sustainable power system operation.

UNIT I INTRODUCTION (7+2 SKILL) 9

Evolution of Energy Systems, Concept, Definitions and Need, Difference between Conventional & Smart Grid, Drivers, structures, functions, opportunities, challenges and benefits of Smart Grid, Basics of Micro grid, National and International Initiatives in Smart Grid.

UNIT II SMART METERING (7+2 SKILL) 9

Introduction to Advanced Metering infrastructure (AMI) - drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Real time management and control, Phasor Measurement Unit (PMU).

UNIT III SMART GRID TECHNOLOGIES (Transmission) (7+2 SKILL) 9

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: Energy Management System, Wide area Monitoring, Protection and control.

UNIT IV SMART GRID TECHNOLOGIES (Distribution) (7+2 SKILL) 9

DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Electric Vehicles.

UNIT V SMART GRID ENABLING TECHNOLOGIES (7+2 SKILL) 9

Local Area Network (LAN), Home Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Computing technologies for Smart Grid applications (Web Service to CLOUD Computing), Role of big data and IoT, Cyber Security for Smart Grid.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)

1. Assignment-Familiarization of National and International Initiatives in Smart Grid
2. Simulation of smart meter using MATLAB/ ETAP/ SCILAB/ LABVIEW/ Proteus/ Equivalent open source software.
3. Visit to a substation for analysing the Automation Technologies like Monitoring, Protection and control.
4. Awareness about High- Efficiency Distribution Transformers, Phase Shifting Transformers in a substation.
5. Introduction to recent technologies in electric vehicles and understanding the operation of EV,HEV and PHEV.
6. Simulation of IoT based digital communication system for smart grid applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1: Explain Smart Grid concepts, functions, benefits, challenges, and microgrid basics.
CO2: Describe AMI, smart metering, PMU, and real-time monitoring in Smart Grid systems.
CO3: Analyze Smart Grid technologies used in transmission systems and automation.
CO4: Examine Smart Grid technologies used in distribution systems and electric vehicles.
CO5: Explain the role of communication, IoT, cloud computing, big data, and cyber security in Smart Grids.
CO6: Evaluate Smart Grid solutions for efficient, reliable, and sustainable power systems.

TEXT BOOKS:

1. Smart Grids Advanced Technologies and Solutions, Second Edition, Edited by Stuart Borlase,CRC, 2018.

2. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, John Wiley,2012
3. James Momoh ,Smart Grid Fundamentals of Design and Analysis, IEEE press 2012.

REFERENCES:

1. Ahmed F. Zobaa, Trevor J. Bihl, Big data analytics in future power systems, 1st Edition, CRC press 2018.
2. C. Gungor et al., "Smart Grid Technologies: Communication Technologies and Standards," in IEEE Transactions on Industrial Informatics, vol. 7, no. 4, pp. 529-539, Nov. 2011.doi: 10.1109/TII.2011.2166794.
3. X. Fang, S. Misra, G. Xue and D. Yang, "Smart Grid — The New and Improved Power Grid: A Survey," in IEEE Communications Surveys & Tutorials, vol. 14, no. 4, pp. 944- 980, Fourth Quarter 2012. doi: 10.1109/SURV.2011.101911.00087.
4. Stuart Borlase “Smart Grid : Infrastructure, Technology and Solutions”, CRC Press 2012.

MAPPING OF COs WITH POs AND PSOs

	CO-PO											CO-PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PSO2**	**PSO3**
CO1	3	2	1	–	–	2	–	–	–	–	1	2	–	2
CO2	3	2	–	1	2	–	–	–	–	–	1	2	1	2
CO3	3	3	2	2	3	1	–	–	–	–	1	3	2	2
CO4	3	3	2	2	3	2	–	–	–	–	1	3	2	2
CO5	2	2	1	–	3	1	1	–	1	–	2	2	2	3
CO6	3	3	3	2	2	3	1	1	1	1	2	3	2	3
Avg.	**2.83**	**2.5**	**1.8**	**1.75**	**2.6**	**1.8**	**1**	**1**	**1**	**1**	**1.33**	**2.5**	**1.8**	**2.33**

PEE2403 ELECTRICAL ENERGY GENERATION, UTILISATION AND CONSERVATION

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide knowledge on conventional and renewable energy generation systems.
- To introduce electric traction, electrical drives, and energy-efficient motor applications.
- To familiarize students with electrical energy utilization in lighting, heating, welding, and domestic applications.
- To develop understanding of energy conservation, energy auditing, and financial analysis methods.
- To enable students to analyze energy systems and suggest suitable conservation measures.

UNIT I ENERGY GENERATION (7+2 SKILL) 9

Overview of conventional and renewable sources; thermal, hydro, nuclear power; solar radiation and collectors (flat plate, concentrating); wind energy conversion systems; introduction to biomass and tidal energy - TANGEDCO Billing – HT and LT supply - steam trap - Cogeneration - Waste heat recovery devices

UNIT II ELECTRIC TRACTION (7+2 SKILL) 9

Fundamentals of electric drives; choice and application of motors; traction generator set; traction motors; power transformers; railway electrification; train movement and energy consumption; traction motor control; electric braking; track equipment - Transformers - Efficiency - Power Factor - Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors

UNIT III ILLUMINATION, HEATING & WELDING (7+2 SKILL) 9

Illumination engineering: definitions, Lux, Lumens, Types of lighting, Efficacy light sources (incandescent, fluorescent, sodium/mercury vapor, LEDs); design of indoor, factory, street, flood lighting systems; LED Lighting and scope of Encon in Illumination.electric heating: resistance, induction, dielectric, arc furnaces; electric welding: types, power supply for arc welding

UNIT IV ENERGY CONSERVATION & AUDITING (7+2 SKILL) 9

Energy Conservation Act 2001; review of industrial energy consumption; energy conservation in electrical industries; power factor improvement; energy auditing procedures; – Energy Accounting and Balancing - Energy ROI – Depreciation - Financial Analysis Techniques – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing – ESCO concept – CUSUM Technique – ESCO Concept – ESCO Contracts.

UNIT V DOMESTIC UTILIZATION OF ELECTRICAL ENERGY (7+2 SKILL) 9

House wiring; working principle of Refrigeration and air conditioning systems - Cooling Towers; induction appliances; UPS (online/offline); batteries; power quality in domestic loads; earthing systems for domestic, industrial and substation applications

TOTAL : 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc):

1. Compare conventional and renewable energy sources based on efficiency, cost, and environmental impact.
2. Calculate motor efficiency, power factor, and energy consumption for traction motors.
3. Design a simple lighting layout for a classroom and estimate energy consumption.
4. Conduct a basic energy audit of a classroom/ your home and suggest energy-saving measures.
5. Prepare a simple domestic wiring layout with load estimation and earthing arrangement.

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1: Explain conventional and renewable energy generation, cogeneration, waste heat recovery, and billing practices.

CO2: Analyze electric traction systems, motors, transformers, power factor, harmonics, and energy-efficient motor operation.
CO3: Design illumination systems and explain electric heating and welding processes.
CO4: Apply energy conservation methods, energy auditing, and financial analysis techniques.
CO5: Explain domestic electrical systems including wiring, refrigeration, air conditioning, UPS, batteries, and earthing.
CO6: Evaluate energy utilization and recommend suitable energy conservation strategies.

TEXT BOOKS:

1. C.L.Wadhwa, "Generation, Distribution and Utilisation of Electrical Energy", New Age international Pvt.Ltd., 3rd Edition, 2015 January.
2. J.B.Gupta, "Utilisation Electric power and Electric Traction", S.K.Kataria and sons, 2000 2012th Edition, 2013, January.
3. G.D.Rai,"Non-Conventional Energy sources",Khanna publications Ltd.,New Delhi 1998
4. D.P.Kothari, K.C.Singal, Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", PHI Learning Private Limited, 3rd Edition 2022.
5. Industrial Energy Conservation, Volume I-II, S C Bhatia, Sarvesh Devraj, Energy conservation and Managment by Akshay A pujara1st edition, June 2018.

REFERENCES:

1. R.K.Rajput, Utilisation of Electric Power, Laxmi publications 2nd Edition 2016.
2. H.Partab, Art and Science of Utilisation of Electrical Energy", Edition, Dhanpat Rai and Co., New Delhi-2004.
3. N.V. Suryanarayana, "Utilisation of Electric Power", Wiley Eastern Limited, New Age International Limited, 1994 & Second Edition 2017 Feb.
4. Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, Guide to Energy Management, Fifth Edition, The Fairmont Press, Inc., 2006
5. Energy Manager Training Manual (4 Volumes) available at https://beeindia.gov.in/content/energy-auditors, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2017.

MAPPING OF COs WITH POs AND PSOs

	CO-PO											CO-PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO 11**	**PS 01**	**PS O2**	**PS O3**
CO1	3	2	1	–	1	2	–	–	–	–	1	2	–	2
CO2	3	3	2	1	2	1	–	–	–	–	1	3	1	2
CO3	3	2	3	2	2	1	–	–	1	–	1	2	1	1
CO4	3	3	2	2	2	3	1	–	1	2	2	2	2	2
CO5	2	2	1	–	2	1	–	–	–	–	1	2	–	1
CO6	3	3	3	2	2	3	1	1	1	2	2	3	2	3
Avg.	**2.83**	**2.5**	**2**	**1.75**	**1.83**	**1.83**	**1**	**1**	**1**	**2**	**1.33**	**2.33**	**1.5**	**1.83**

PEE2404 POWER QUALITY L T P C

3 0 0 3

COURSE OBJECTIVES:

- To introduce the basic concepts, standards, and importance of power quality.
- To provide knowledge on voltage disturbances, transients, interruptions, and harmonics.
- To familiarize students with the analysis, monitoring, and mitigation of power quality problems.
- To develop understanding of power quality assessment tools and disturbance analysis methods.
- To enable students to apply suitable compensation techniques for improving power quality and reliability.

UNIT I INTRODUCTION TO POWER QUALITY (7+2 SKILL) 9

Terms and definitions – Overloading, under voltage, over voltage - Concepts of transients - Short duration variations such as interruption - Long duration variation such as sustained interruption - Voltage sag - Voltage swell - Voltage imbalance – Voltage fluctuation - Power frequency variations - International standards of power quality – Computer Business Equipment Manufacturers Associations (CBEMA) curve.

UNIT II VOLTAGE SAGS AND INTERRUPTIONS (7+2 SKILL) 9

Sources of sags and interruptions - Estimating voltage sag performance - Thevenin's equivalent source - Analysis and calculation of various faulted condition - Voltage sag due to induction motor starting - Estimation of the sag severity - Mitigation of voltage sags, active series compensators - Static transfer switches and fast transfer switches.

UNIT III OVERVOLTAGES & HARMONICS (7+2 SKILL) 9

Sources of over voltages - Capacitor switching – Lightning - Ferro resonance - Mitigation of voltage swells - Surge arresters - Low pass filters - Power conditioners - Lightning protection – Shielding - Line arresters - Protection of transformers and cables - Harmonics Vs transients. Effect of harmonics – Harmonic distortion - Voltage and current distortion - Harmonic indices - Devices for controlling harmonic distortion - Passive and active filters.

UNIT IV POWER QUALITY MONITORING (7+2 SKILL) 9

Monitoring considerations - Monitoring and diagnostic techniques for various power quality problems - Modeling of power quality (harmonics and voltage sag) problems by mathematical simulation tools - Power line disturbance analyzer – Quality measurement equipment - Harmonic / spectrum analyzer - Flicker meters - Disturbance analyzer.

UNIT V POWER QUALITY MITIGATION (7+2 SKILL) 9

Conventional load Compensation methods: Harmonic reduction & Voltage Sag reduction – Analysis of Unbalance – Load compensation using DSTATCOM: Ideal 3-phase Shunt Compensation structure,

Reference current generation, realization and control of DSTATCOM – Introduction to series compensation using DVR.

TOTAL : 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)

1. Harmonic analysis of single phase power converters (Semi converters and Full Converters) with R and RL load via simulation
2. Harmonic analysis of three phase power converters (Semi converters and Full Converters) with R and RL load via simulation
3. Harmonic analysis of single phase inverters with R and RL load via simulation
4. Harmonic analysis of three phase inverters with R and RL load via simulation
5. Mitigation of Harmonics using Tuned Filter

List of Open Source Software/ Learning website:

1. http://nptel.iitm.ac.in/courses.php
2. https://old.amu.ac.in/emp/studym/2442.pdf
3. https://electricalacademia.com/electric-power
4. https://www.intechopen.com/books/6214
5. https://www.cde.com/resources/technical-papers/Mitigation-of-Harmonics.pdf
6. https://www.academia.edu/43237017/Use_Series_Compensation_in_Distribution_Networks_33_KV

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1: Explain power quality issues, voltage variations, transients, interruptions, and standards.

CO2: Analyze voltage sags, interruptions, their causes, severity, and mitigation methods.

CO3: Examine overvoltages, lightning disturbances, harmonic distortions, and their mitigation.

CO4: Apply monitoring techniques and diagnostic tools for power quality analysis.

CO5: Analyze compensation techniques such as DSTATCOM and DVR for power quality improvement.

CO6: Evaluate power quality problems and recommend suitable mitigation solutions.

TEXTBOOKS:

1. Arindam Ghosh and Gerad Ledwich “Power Quality Enhancement Using Custom Power Devices”, Kluwer Academic Publishers, First Edition,2002

2. G.T.Heydt, “Electric Power Quality”, Stars in a Circle Publications, Second Edition, 2011.

3. George J. Wakileh, “Power System Harmonics – Fundamentals, Analysis and Filter Design”, Springer – Verlag Berlin Heidelberg, New York, 2019.

REFERENCES:

1. R.C.Duggan “Electric Power Systems Quality”, Tata MC Graw Hill Publishers, Third Edition, 2012.

2. Arrillga “Power System Harmonics”, John Wiely and Sons, 2003 2nd Edition.

3. Derek A.Paice “Power Electronic Converter Harmonics” IEEE Press, 1995, Wiley – IEE Press 1999, 18th Edition.

List of Standards (Not for examination):

Unit I

1. IEEE Std 1159: Recommended Practice for Monitoring Electric Power Quality
2. IEC 61000 Series: Electromagnetic Compatibility (EMC) Standards
3. IEEE Std 519: Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

Unit II

1. SEMI F47: Voltage Sag Immunity Standard for Semiconductor Equipment
2. IEEE Std 1668: Voltage Sag and Interruption Ride-Through for End-Use Electrical Equipment

Unit III

1. IEEE Std 519: Harmonic Control in Electrical Power Systems
2. IEC 61000-3-2 and IEC 61000-3-4: Limits for Harmonic Current Emissions
3. IEC 62305: Protection against Lightning

Unit IV

1. IEC 61000-4-30: Power Quality Measurement Methods
2. IEC 61000-4-7: Harmonic Measurement Techniques
3. IEC 61000-4-15: Flickermeter Functional and Design Specifications

Unit V

1. IEEE Std 1547: Interconnection and Interoperability of Distributed Energy Resources
2. IEC 61000-3-6: Assessment of Emission Limits for Distorting Loads.

MAPPING OF COs WITH POs AND PSOs

	CO-PO											CO-PSO		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PS01**	**PSO2**	**PSO3**
CO1	3	2	1	–	1	1	–	–	–	–	1	2	–	1
CO2	3	3	2	2	2	1	–	–	–	–	1	3	2	1
CO3	3	3	2	2	2	2	–	–	–	–	1	3	2	1
CO4	3	2	1	3	3	1	–	–	1	–	1	3	3	1
CO5	3	3	3	2	3	2	–	1	1	–	1	3	2	2
CO6	3	3	3	2	2	3	1	1	1	1	2	3	2	2
Avg.	**3**	**2.67**	**2**	**2.2**	**2.17**	**1.67**	**1**	**1**	**1**	**1**	**1.17**	**2.83**	**2.2**	**1.33**

PEE2405 HVDC AND FACTS L T P C

3 0 0 3

COURSE OBJECTIVES:

- To introduce reactive power control, compensation techniques, and the importance of FACTS and HVDC transmission.
- To provide knowledge on shunt and series compensation using SVC and TCSC.

- To familiarize students with VSC-based FACTS controllers such as STATCOM, SSSC, and UPFC.
- To develop understanding of line commutated and VSC-based HVDC transmission systems.
- To enable students to analyze FACTS and HVDC technologies for improving power system performance.

UNIT I INTRODUCTION (7+2 SKILL) 9

Reactive power control in electrical power transmission lines–load & system compensation, Uncompensated transmission line–shunt and series compensation. Need for HVDC Transmission, Comparison between AC & DC Transmission, Types of HVDC transmission System.

UNIT II STATIC VAR COMPENSATOR (SVC) AND THYRISTOR CONTROLLED SERIES COMPENSATOR (TCSC) (7+2 SKILL) 9

VI characteristics of FC+TSR, TSC+TSR, Voltage control by SVC–Advantages of slope in dynamic characteristics–Influence of SVC on system voltage–Design of SVC voltage regulator, Thyristor Controlled Series Compensator (TCSC), Concept of TCSC, Operation of the TCSC– Different modes of operation, Applications.

UNIT III VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS

(7+2 SKILL) 9

Static Synchronous Compensator (STATCOM)–Principle of operation–V-I Characteristics. Applications: Steady state power transfer-enhancement of transient stability-prevention of voltage instability. SSSC-operation of SSSC VI characteristics, Enhancement in Power transfer capability –, UPFC – Operation Principle Applications.

UNIT IV LINE COMMUTATED HVDC TRASMISSION (7+2 SKILL) 9

Operation of Gratz bridge - Effect of delay in Firing Angle – Effect of commutation overlap - Equivalent circuit,. Basic concept of HVDC transmission. Modes of operations and control of power flow, CC and CIA mode of operation.

UNIT V VSC BASED HVDC TRANSMISSION (7+2 SKILL) 9

Basic 2 level IGBT inverter operation - 4 Quadrant operation- phase angle control- dq Control- Control of power flow in VSC based HVDC Transmission, Topologies of MTDC system.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)

1. Simulation of FC+TSR connected to IEEE 5 bus system
2. Realization of reactive power, support by SVC in open loop and closed loop control in simulation.
3. Regulation of line flows employing TCSC and TSSC in closed loop control in simulation
4. Simulation of two terminal HVDC Link, closed loop control in CC and CIA mode in simulation

5. Realization of four quadrant operation of VSC in open loop mode in simulation

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1: Explain reactive power compensation, transmission line compensation, and the need for HVDC transmission.

CO2: Analyze the operation and control of SVC and TCSC for voltage and power flow control.

CO3: Examine the principles and applications of STATCOM, SSSC, and UPFC for system stability improvement.

CO4: Analyze line commutated HVDC systems including Graetz bridge operation and power flow control.

CO5: Explain VSC-based HVDC systems, control strategies, and multi-terminal DC topologies.

CO6: Evaluate FACTS and HVDC technologies for improving stability, efficiency, and reliable power system operation

TEXT BOOKS:

1. R.Mohan Mathur, Rajiv K.Varma,"Thyristor–Based Facts Controllers for Electrical Transmission Systems", IEEE press andJohnWiley&Sons,Inc,2002.

2. Narain G.Hingorani,"Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems", Standard Publishers Distributors,Delhi-110006,2011.

REFERENCES:

1. K.R.Padiyar,"FACTS Controllersin Power Transmission and Distribution", New Age International (P) Limited, Publishers, New Delhi, 2008.

2. A.T.John,"FlexibleA.C.TransmissionSystems",InstitutionofElectricalandElectronic Engineers(IEEE), 1999.

3. V. K.Sood, HVDC and FACTS controllers–Applications of Static Converters in Power System, APRIL 2004, Kluwer Academic Publishers,2004.

MAPPING OF COs WITH POs AND PSOs

	CO-PO											**CO-PSO**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PS01**	**PSO 2**	**PSO 3**
CO1	3	2	1	–	1	1	–	–	–	–	1	3	1	1
CO2	3	3	2	2	2	1	–	–	–	–	1	3	2	1
CO3	3	3	3	2	3	2	–	–	1	–	1	3	2	2

CO4	3	3	2	2	2	1	–	–	–	–	1	3	2	1
CO5	3	2	2	1	3	1	–	–	–	–	1	3	2	2
CO6	3	3	3	2	2	3	1	1	1	1	2	3	2	2
Avg.	**3**	**2.67**	**2.17**	**1.8**	**2.17**	**1.5**	**1**	**1**	**1**	**1**	**1.17**	**3**	**1.83**	**1.5**

PEE2406 GRID INTEGRATING TECHNIQUES AND CHALLENGES L T P C

3 0 0 3

COURSE OBJECTIVES:

- To introduce power generation systems in India, including conventional and renewable sources.
- To provide knowledge on power grids, load models, transformers, and microgrid systems.
- To familiarize students with converters, inverter operation, PWM techniques, and distributed generation.
- To develop understanding of grid integration challenges in renewable energy systems.
- To enable students to analyze grid interconnection techniques for reliable and efficient power system operation.

UNIT I PRESENT POWER SCENARIO IN INDIA (7+2 SKILL) 9

Introduction - Thermal Power Plant , Components of Thermal Power Plant , Major Thermal Power Plants in India- Gas-Based Power Generation - Nuclear Power Plants -Hydropower Generation - Pumped Storage Plants - Solar Power - Wind Energy – Power plants India

UNIT II POWER GRIDS (7+2 SKILL) 9

Introduction -Electric Power ,Background , The Construction of a Power Grid System , Basic Concepts of Power Grids -Load Models - Transformers in Electric Power Grids - Modelling a Microgrid System

UNIT III MODELING OF CONVERTERS IN POWER GRID DISTRIBUTED GENERATION SYSTEMS (7+2 SKILL) 9

Introduction - Single-Phase DC/AC Inverters with Two Switches, Three-Phase DC/AC Inverters, Pulse Width Modulation Methods, The Triangular, The Identity Method, Analysis of DC/AC Three-Phase Inverters. Micro grid of Renewable Energy Systems- DC/DC Converters in Green Energy -Pulse Width Modulation -Sizing of an Inverter for Microgrid Operation, Sizing of a Rectifier for Microgrid Operation, The Sizing of DC/DC Converters for Micro grid

UNIT IV WIND ENERGY SYSTEM GRID INTEGRATION (7+2 SKILL) 9

Introduction- Significance of Electrical Power Quality in Wind Power System- Integration Issues in Grid-Connected Wind Energy- Effect of Power Quality Issues, Importance of Custom Power Devices-Power Quality Point of View.

UNIT V GRID INTER CONNECTION (7+2 SKILL) 9

Grid Code requirements-Grid integration of WECS-Grid Integration of PV systems

TOTAL : 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc):

1. Develop a model for the control of DC micro grid for non linear loads
2. Simulation study of three phase inverters with fixed and sine PWM techniques, Simulation and Design of buck/boost converters.
3. Simulate a Grid Connected Wind Energy System with STATCOM and investigate the improvement in power quality.

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1: Explain power generation systems in India and the role of conventional and renewable energy sources.

CO2: Describe power grids, load models, transformers, and microgrid systems.

CO3: Analyze converters, inverter sizing, rectifier sizing, and PWM techniques used in distributed generation.

CO4: Examine power quality issues and grid integration challenges in wind energy systems.

CO5: Explain grid code requirements and grid integration of WECS and PV systems.

CO6: Evaluate grid integration techniques for reliable and sustainable renewable energy systems.

TEXT BOOKS:

1. Brian D'Andrade "The Power Grid", Academic Press, 1st Edition, 2017.
2. Yang Han, "Modeling and Control of Power Electronic Converters for Microgrid Applications", Springer, 1st Edition 2022.
3. Siegfried Heier, "Grid Integration of Wind Energy: Onshore and Offshore Conversion Systems", John Wiley & Sons, Ltd, 2014, 3rd Edition.

REFERENCES:

1. Integration of Renewable Energy Sources with Smart Grid, M. Kathiresh, A. Mahaboob Subahani, and G.R. Kanaga chidambaresan, Scrivener & Wiley, 2021, 1st Edition.

2. Control and Operation of Grid-Connected Wind Energy Systems, Ali M. Eltamaly, Almoataz Y. Abdelaziz, Ahmed G. Abo-Khalil, Springer 2021, 1st Edition.

3. Design of smart power grid renewable energy systems, Third Edition, Ali Keyhani, Wiley 2019.

4. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, Wiley 2017, 1st Edition.

5. Fundamentals of Power Electronics with MATLAB, Randall Shaffer, Laxmi publications, 2013, 2nd Edition.

6. Power Conversion and Control of Wind Energy Systems, Bin Wu, 2011, Wiley-IEEE, 1st Edition.

7. Wind Power Integration - Connection and System Operational Aspects, Brendan Fox, 2014, IET, 2nd Edition.

8. Renewable Energy Devices and Systems with Simulations in MATLAB and ANSYS, Frede Blaabjerg, Dan M. Ionel, CRC press, 2017, 1st Edition.

List of Open Source Software/ Learning website:

1. https://www.academia.edu/14628492/Current_Power_Scenario_In_India

2. https://energyeducation.ca/encyclopedia/Electrical_grid

3. https://www.academia.edu/32120081/Power_Converters_Modeling_in_Matlab_Simulink_for_Microgrid_Simulations_Power_Converters_Modeling_in_Matlab_Simulink_for_Microgrid_Simulations

4. https://dnv.com/services/wind-farm-control-and-grid-integration

5. https://www.wind-energy-the-facts.org/images/chapter2.pdf

MAPPING OF COs WITH POs AND PSOs

	CO-PO											**CO-PSO**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PS01**	**PSO 2**	**PSO 3**
CO1	3	2	1	–	1	2	–	–	–	–	1	2	–	2
CO2	3	2	1	1	2	1	–	–	–	–	1	2	1	2
CO3	3	3	2	2	3	1	–	–	–	–	1	3	2	2
CO4	3	3	2	2	2	3	–	–	1	–	1	3	2	2
CO5	3	3	2	2	2	3	1	–	1	–	1	3	2	3
CO6	3	3	3	2	2	3	1	1	1	1	2	3	2	3

Avg.	**3**	**2.67**	**1.83**	**1.8**	**2**	**2.17**	**1**	**1**	**1**	**1**	**1.17**	**2.67**	**1.8**	**2.33**

PEE2407 SUSTAINABLE HV INSULATION SYSTEM L T P C

3 0 0 3

COURSE OBJECTIVES:

- To introduce sustainability concepts, carbon footprint, and environmental requirements in HV insulation systems.
- To provide knowledge on environmental impacts of conventional insulation materials and green alternatives.
- To familiarize students with green gaseous, liquid, and solid dielectric materials and their properties.
- To develop understanding of eco-friendly insulation materials for high voltage applications.
- To enable students to analyze standards, testing, management, and disposal of sustainable insulation systems.

UNIT I SUSTAINABLE AND ENVIRONMENT FRIENDLY ENERGY AND PRODUCTS (7+2 SKILL) 9

Energy Pyramid, Carbon footprint, global warming potential, environment requirement for any product and system.

UNIT II GREEN GASEOUS INSULATORS (7+2 SKILL) 9

SF6 gas and its hazardous environmental effects alternate gases gaseous mixtures and other sources and it's properties.

UNIT III GREEN LIQUID INSULATORS (7+2 SKILL) 9

Hazardous effects of existing liquid dielectric materials (such as organic oil), alternate sources of environment friendly liquid dielectrics such as ester oil, vegetable oils, dielectric and it's properties.

UNIT IV GREEN SOLID INSULATORS (7+2 SKILL) 9

Hazardous effects of existing solid dielectric materials, alternate sources of environment friendly solid dielectric and its properties.

UNIT V EVOLVING STANDARDS FOR GREEN INSULATION SYSTEMS (7+2 SKILL) 9

Requirements, evolving standards of management, testing, usage and disposal of alternate insulation systems, Major applications, and standards.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc):

1. Calculate the carbon footprint of a simple electrical product or system.
2. Compare SF_6 gas with alternative green gaseous insulators based on properties and environmental impact.
3. Prepare a comparison chart of mineral oil, ester oil, and vegetable oils based on dielectric and environmental properties.
4. Identify eco-friendly solid insulating materials and compare them with conventional solid dielectrics.
5. Study one standard related to green insulation systems and summarize its testing and disposal requirements.

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1: Explain carbon footprint, global warming potential, and environmental requirements of insulation systems.

CO2: Analyze SF_6 gas hazards and evaluate alternative green gaseous insulation systems.

CO3: Examine conventional liquid dielectrics and compare eco-friendly liquid insulation materials.

CO4: Evaluate conventional solid dielectrics and explain sustainable solid insulation alternatives.

CO5: Describe standards, testing, management, and disposal methods of green insulation systems.

CO6: Assess sustainable HV insulation systems and recommend suitable green insulation solutions.

REFERENCES:

1. Dielectric Materials for Electrical Engineering, Juan Martinez-Vega (Editor), ISBN: 978-1118-55741-9, March 2013, Wiley-ISTE
2. Carbon Footprint Analysis: Concepts, Methods, Implementation, and Case Studies (Systems Innovation Book Series) – 18 June 2012
3. The Carbon Footprint Handbook, Edited By Subramanian Senthilkannan Muthu, ISBN 9781482262223, Published September 23, 2015 by CRC Press
4. Design of Green Liquid Dielectrics for Transformers: An Experimental ApproachBiodegradable Insulating Materials for Transformers Forthcoming. Authors: T.

Mariprasath, Victor Kirubakaran, Perumal Saraswathi, Cheepati Kumar Reddy, Prakasha Kunkanadu Rajappa, ISBN: 9788770041522 e-ISBN: 9788770041225

5. Gas Discharge and Gas Insulation: 6, ISBN-10: 3662514699, ISBN-13: 978-3662514696

6. Industrial Applications of Green Solvents – Volume I, Eds. Inamuddin, Mohd Imran Ahamed and Abdullah M. Asiri, Materials Research Foundations Vol. 50, Print ISBN 978-1-64490022-2, ePDF ISBN 978-1-64490-023-9, DOI: 10.21741/9781644900239

List of Open Source Software/ Learning website:

1. https://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID,FSP_LANG_ID:1275,25
2. https://www.iec.ch/ords/f?p=103:41:628762356646470::::FSP_ORG_ID,FSP_LANG_ID:3237,25
3. https://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID,FSP_LANG_ID:1299,25
4. https://www.iec.ch/sdgs/sdg13
5. https://highperformanceinsulation.eu/wpcontent/uploads/2016/08/sustainability_a_guide.pdf
6. https://www.ictfootprint.eu/en/iec-tr-627252013-factsheet

MAPPING OF COs WITH POs AND PSOs

	CO-PO											**CO-PSO**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PS01**	**PSO 2**	**PSO 3**
CO1	2	2	1	–	–	3	1	–	–	–	1	1	–	2
CO2	3	3	2	2	2	3	1	–	–	–	1	2	1	3
CO3	3	3	2	2	2	3	1	–	–	–	1	2	1	3
CO4	3	3	2	2	2	3	1	–	–	–	1	2	1	3
CO5	2	2	1	1	2	3	1	–	1	1	1	1	1	2
CO6	3	3	3	2	2	3	1	1	1	1	2	2	2	3
Avg.	**2.67**	**2.67**	**1.83**	**1.8**	**2**	**3**	**1**	**1**	**1**	**1**	**1.17**	**1.67**	**1.2**	**2.67**

PEE2408 SUSTAINABLE ELECTRIFICATION FOR REMOTE COMMUNITIES **L T P C 3 0 0 3**

COURSE OBJECTIVES:

- To introduce nano grids and micro grids for sustainable electrification in remote communities.
- To provide knowledge on the design and sizing of DG units, renewable sources, converters, and storage systems.
- To familiarize students with control strategies, protection schemes, and communication systems for nano and micro grids.
- To develop understanding of hybrid grid systems, energy management, and resilience improvement techniques.
- To enable students to analyze sustainable electrification solutions for remote communities.

UNIT I FUNDAMENTALS OF NANO AND MICRO GRIDS 9

Need for nano and micro grids in remote areas- Architectures: Comparison of nano & micro grid architectures -Distributed Generation (DG) technologies for renewable energy sources -Techno-economic feasibility analysis.

UNIT II DESIGN CONSIDERATIONS FOR NANO GRIDS 9

Renewable energy source selection for nano grids-design , sizing of DG units, converters, storage for nano grid- Control strategies and Protection schemes for nano grids.

UNIT III DESIGN CONSIDERATIONS FOR MICRO GRIDS 9

Resource assessment - Design principles and considerations for micro grids in remote areas-Integration of renewable energy sources into micro grids - Power converters- Energy storage selection and integration for microgrids.

UNIT IV CONTROL AND PROTECTION FOR MICRO GRIDS 9

Control strategies :centralized, decentralized, droop control, communication protocols- Power management : load shedding, demand response, islanding with seamless transition- Microgrid protection schemes :fault detection, isolation, reconfiguration-Communication infrastructure :SCADA systems, data acquisition for real-time management.

UNIT V ADVANCED TOPICS IN REMOTE AREA ELECTRIFICATION 9

Hybrid nano and micro grid configurations - Integration of energy management systems - Microgrid resilience - Socio-economic and environmental impact assessment of nano and micro grids in remote communities.

TOTAL: 45PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc):

1. Compare nano grid and micro grid architectures for remote area electrification.
2. Design a basic nano grid with suitable renewable source, DG unit, and storage system.
3. Prepare a simple micro grid layout showing renewable integration, converters, and storage.

4. Study a microgrid protection scheme and explain fault detection and isolation methods.

5. Analyze a case study of hybrid nano/micro grid implementation in a remote community.

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1: Explain the need, architecture, and feasibility of nano grids and micro grids for remote electrification.

CO2: Design nano grid systems using suitable renewable sources, DG units, converters, storage, and protection schemes.

CO3: Analyze micro grid design principles, renewable integration, converters, and energy storage systems.

CO4: Examine control strategies, protection schemes, communication protocols, and power management in microgrids.

CO5: Evaluate hybrid nano and micro grid systems, resilience methods, and socio-economic impacts.

CO6: Assess sustainable electrification solutions for reliable and inclusive energy access in remote communities.

TEXT BOOKS:

1. Antonio Carlos Zambroni de Souza and Miguel Castilla, Microgrids: Design and Implementation, Springer, 2019.

2. Rajeev Kumar Chauhan, Kalpana Chauhan, Sri Niwas Singh , Microgrids for Rural Areas: Research and case studies (Energy Engineering), IET, 2020.

3. Nikos Hatziargyriou, Microgrids: Architectures and Control, John Wiley and Sons Ltd, 2014.

REFERENCES:

1. Simon Rolland, Rural Electrification with Renewable Energy Technologies, Quality Standars and Business Models, 2011.

MAPPING OF COs WITH POs AND PSOs

	CO-PO											**CO-PSO**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PS0 1**	**PSO 2**	**PSO 3**
CO1	3	2	1	1	1	3	–	–	–	–	1	2	1	3
CO2	3	3	3	2	3	2	–	–	1	–	1	3	2	3

CO3	3	3	2	2	3	2	–	–	–	–	1	3	2	3
CO4	3	3	2	2	3	2	–	1	1	–	1	3	2	2
CO5	3	3	2	2	2	3	1	1	1	1	2	2	1	3
CO6	3	3	3	2	2	3	1	1	1	1	2	3	2	3
Avg.	**3**	**2.83**	**2.17**	**1.83**	**2.33**	**2.5**	**1**	**1**	**1**	**1**	**1.33**	**2.67**	**1.67**	**2.83**

VERTICAL II - ELECTRIC VEHICLE TECHNOLOGY

PEE2411 ELECTRIC VEHICLE ARCHITECTURE AND DYNAMICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the evolution and fundamentals of Electric Vehicles (EVs), Hybrid Electric Vehicles (HEVs), and Plug-in Hybrid Electric Vehicles (PHEVs).
- To analyze the architecture and configuration of EVs and HEVs, including series, parallel, and hybrid topologies.
- To study vehicle dynamics and traction principles relevant to EV performance.
- To evaluate and design EV/HEV powertrain components and their sizing methodologies.
- To understand control strategies and operational modes of hybrid and plug-in hybrid vehicles.
- To develop the ability to model, simulate, and analyze EV systems for real world applications.

UNIT I EV HISTORY AND ITS EVOLUTION 9

Electric Vehicle History - IC Engines, BMEP and BSFC, Vehicle Fuel Economy, Emission Control Systems, Treatment of Diesel Exhaust Emissions, Evolution of Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs).

UNIT II HEV ARCHITECTURE 9

Architecture of HEVs - Series, Parallel and Series Parallel Architecture, Micro and Mild architectures. HEVs in Hilly terrains - Mountain Bike - Motorcycle - Electric Cars and Heavy Duty EVs. - Details and Specifications

UNIT III VEHICLE DYNAMICS 9

Vehicle dynamics - Roadway fundamentals, Laws of motion - Drive Cycles, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire – Road mechanics, - Tractive Force, Tractive Power, Tractive Energy - Tractive System Design.

UNIT IV POWER COMPONENTS AND BRAKES 9

Power train Component sizing- Motors, Gears, Clutches, Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Powertrain sizing, Example. EV Wiring Harness - Hybrid vehicle control strategy: Vehicle supervisory control, Mode selection strategy, Modal Control strategies.

UNIT V PLUG-IN HYBRID ELECTRIC VEHICLE 9

Introduction - History - Comparison with electric and hybrid electric Vehicle-Construction and working of PHEV - Block diagram and Components - Charging Mechanisms - Advantages of PHEVs.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc)

1. Simulation of Electric Vehicle power components
2. Simulation of drive cycles.
3. Simulation of Power train components
4. Simulation of Motors, Gears, Clutches
5. Estimation of Torque/Power/Energy requirements for operation of EVs / HEVs

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1: Explain the history, evolution, and performance comparison of EVs, HEVs, and conventional IC engine vehicles.

CO2: Describe and compare various EV/HEV architectures and configurations.

CO3: Apply principles of vehicle dynamics, tractive effort and drive cycles to analyze EV performance.

CO4: Analyze and design EV/HEV powertrain components and sizing methodologies.

CO5: Evaluate control strategies and operational performance of hybrid and plug-in hybrid electric vehicles.

CO6: Develop simulation models and integrated solutions for EV systems considering real-world constraints.

TEXT BOOKS:

1. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, "CRC Press, Taylor & Francis Group, Third Edition 2021.

2. Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.

3. Chris Mi & M. Abul Masrur, *Hybrid Electric Vehicles: Principles and Applications*, 3rd Edition, Wiley, 2025.

4. James Larminie & John Lowry, *Electric Vehicle Technology Explained*, 2nd Edition, Wiley, Reprint 2020.

5. Sheldon S. Williamson, *Energy Management Strategies for Electric and Hybrid Vehicles*, Springer, 2019.

REFERENCES:

1. Christopher H. T. Lee (Ed.), *Emerging Technologies for Electric and Hybrid Vehicles*, Springer, 1st Edition, 2024.

2. *Smart Electric and Hybrid Vehicles: Design, Modeling and Assessment*, Wiley/CRC Press, 1st Edition, 2024.

3. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, *Electric Vehicles: Modern Technologies and Trends*, Springer, 1st Edition, 2021.

4. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, First edition 2017.

5. Heavy-duty Electric Vehicles from Concept to Reality, Shashank Arora, Alireza Tashakori Abkenar, Shantha Gamini Jayasinghe, Kari Tammi, Elsevier Science, 2021

6. Electric Vehicles Modern Technologies and Trends, Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen Springer, 2020

7. 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.

MAPPING OF COs WITH POs AND PSOs

	CO-PO											**CO-PSO**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PS01**	**PSO 2**	**PSO 3**

CO1	3	2	2	2	2	2	2	2	2	3	3	2	3	3
CO2	3	2	2	2	2	2	2	2	2	3	3	2	3	3
CO3	3	3	3	3	2	2	2	2	2	3	3	2	3	3
CO4	2	2	3	3	2	2	2	2	2	3	3	2	3	3
CO5	3	2	2	2	2	2	2	2	2	3	3	2	3	3
CO6	3	3	3	3	2	2	2	2	2	3	3	2	3	3
Avg.	**3**	**2.3**	**2.5**	**2.5**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**3**	**3**

PEE2412 ELECTRIC AND HYBRID VEHICLES L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand the design considerations and performance requirements of electric vehicles.
- To analyze different energy storage systems such as batteries, fuel cells and ultracapacitors.
- To study the working principles and characteristics of electric motors and drives used in EVs/HEVs.
- To evaluate the role of power electronic converters and controllers in EV applications.
- To understand the architecture, configurations, and control strategies of hybrid electric vehicles.
- To develop the ability to analyze and design EV/HEV subsystems for practical applications.

UNIT I DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES (7+2 SKILL) 9

Need for Electric vehicle - Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. - Design requirement for electric vehicles - Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refuelling Systems.

UNIT II ENERGY SOURCES (7+2 SKILL) 9

Battery Parameters - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion- Sodium based - Metal Air. Battery Modelling - Equivalent circuits, Battery charging - Quick Charging devices. Fuel Cell - Fuel cell Characteristics - Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System.

UNIT III MOTORS AND DRIVES (7+2 SKILL) 9

Types of Motors - DC motors - AC motors, PMSM motors, BLDC motors, Switched reluctance motors working principle, construction and characteristics.

UNIT IV POWER CONVERTERS AND CONTROLLERS (7+2 SKILL) 9

Solid state Switching elements and characteristics – BJT, MOSFET, IGBT, SCR and TRIAC - Power Converters – rectifiers, inverters and converters - Motor Drives - DC, AC motor, PMSM motors, BLDC motors, Switched reluctance motors – Four quadrant operations – operating modes

UNIT V HYBRID AND ELECTRIC VEHICLES (7+2 SKILL) 9

Main components and working principles of hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc):

1. Develop MATLAB code for Vehicle Resistance Modeling (Rolling resistance / Aerodynamic drag)
2. Battery Modeling (Battery SOC Estimation)
3. Converter Modeling - Simulation of DC-DC Converter
4. Hybrid Vehicle Simulation - Energy Management Strategy (Develop a rule-based MATLAB model)
5. Complete EV System Simulation in MATLAB/Simulink

COURSE OUTCOMES:

At the end of this course, the student will be able to

CO1: Explain the design requirements and performance characteristics of electric and hybrid vehicles.

CO2: Compare and evaluate different energy sources such as batteries, fuel cells, and ultracapacitors.

CO3: Analyze the operation and selection of electric motors and drives for EV applications.

CO4: Apply the concepts of power electronic converters and motor control strategies in EV systems.

CO5: Analyze the architecture, configurations, and control strategies of hybrid electric vehicles.

CO6: Design and develop integrated EV/HEV systems considering performance, efficiency, and real-world constraints.

TEXT BOOKS:

1. Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals, ”CRC Press, Taylor & Francis Group, Third Edition 2021.

2. Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.

3. Chris Mi & M. Abul Masrur, *Hybrid Electric Vehicles: Principles and Applications*, 3rd Edition, Wiley, 2025.

4. James Larminie & John Lowry, *Electric Vehicle Technology Explained*, 2nd Edition, Wiley, Reprint 2020.

REFERENCES:

1. Smart Electric and Hybrid Vehicles: Design, Modeling and Assessment, Wiley/CRC Press, 1st Edition, 2024.

2. Christopher H. T. Lee (Ed.), *Emerging Technologies for Electric and Hybrid Vehicles*, 1st Edition, Springer, 2024.

3. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, *Electric Vehicles: Modern Technologies and Trends*, Springer, 1st Edition, 2021.

4. Shashank Arora, Alireza Tashakori Abkenar, Shantha Gamini Jayasinghe, Kari Tammi, *Heavy-Duty Electric Vehicles: From Concept to Reality*, 1st Edition, Elsevier, 2021.

5. Sheldon S. Williamson, *Energy Management Strategies for Electric and Hybrid Vehicles*,

6. 1st Edition, Springer, 2013 (Reprint 2019).

7. James Larminie and John Lowry, “Electric Vehicle Technology Explained “ John Wiley & Sons,2003

8. Lino Guzzella, “ Vehicle Propulsion System” Springer Publications,2005.

9. Ron HodKinson, “Light Weight Electric/ Hybrid Vehicle Design”, Butterworth Heinemann Publication, 2005.

List of Open-Source Software/ Learning website:

1. https://www.sciencedirect.com/topics/engineering/hybrid-energy-system.

2. https://www.academia.edu/32120081/Power_Converters_Modeling_in_Matlab_Simulink_for_Microgrid_Simulations_Power_Converters_

3. Modeling_in_Matlab_Simulink_for_Microgrid_Simulations.

4. https://onlinecourses.nptel.ac.in/noc25_ee33/preview, https://elearn.nptel.ac.in/shop/nptel/electric-vehicles-and-renewable-energy/?v=c86ee0d9d7ed

MAPPING OF COs WITH POs AND PSOs

	CO-PO											**CO-PSO**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PS0 1**	**PSO 2**	**PSO 3**
CO1	3	2	3	2	2	1	2	1	2	3	2	2	3	3

CO2	3	2	2	2	3	1	2	1	1	2	2	2	3	3
CO3	3	3	3	2	2	1	1	1	2	3	2	3	3	3
CO4	3	3	3	3	3	1	1	1	2	3	2	3	3	3
CO5	3	3	3	3	3	1	1	1	2	3	2	3	3	3
CO6	3	3	3	3	3	2	2	1	3	3	3	3	3	3
Avg.	**3.0**	**2.7**	**2.8**	**2.5**	**2.7**	**1.2**	**1.5**	**1.0**	**2.0**	**2.8**	**2.2**	**2.7**	**3.0**	**3.0**

PEE2413 DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLES

L T P C

3 0 0 3

COURSE OBJECTIVES:

- To review the drive cycles and requirements of EVs
- To know the working of motors used in Electric Vehicle
- To analyze and model the buck/boost converter operation and to design the same
- To learn the simulation basics of control systems
- To derive transfer functions for DC-DC converters

UNIT I ELECTRIC VEHICLE DYNAMICS 9

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

UNIT II MOTORS FOR ELECTRIC VEHICLES 9

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

UNIT III BASICS OF CONTROL SYSTEMS 9

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

UNIT IV MODELING OF DC-DC CONVERTERS 9

Overview of PWM Converter Modelling -Power Stage Modelling - PWM Block Modelling - Voltage Feedback Circuit and Small-Signal Model of PWM Converter - Averaging Power Stage Dynamics

- Average Models for buck/boost Converter - Small-Signal Model of Converter Power Stage - Frequency Response of Converter

UNIT V POWER STAGE TRANSFER FUNCTIONS OF DC – DC CONVERTERS 9

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.

TOTAL: 45 PERIODS

SUGGESTED ACTIVITIES:

1. Simple simulation exercises of basic control systems

2. Bode plots and calculation of Gain margin and Phase margin for power stage transfer function via simulation.

3. Design of buck converter

4. Design of boost converter

5. Simulation of buck, boost and buck boost converter-open loop (With power circuit and Transfer function).

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1: To use appropriate electric machine for electric vehicle application

CO2: To compute transfer function with factors such as constant, integral, differential, first order factor and second order factor (both numerators & denominators)

CO3: To compute transfer function from state models

CO4: To design buck, boost and buck-boost converter.

CO5: To compute a power stage transfer functions for DC-DC converters

CO6: To simulate DC-DC converters and to obtain gain margin and phase margin.

TEXT BOOKS:

1. Fundamentals of Power Electronics, Robert W. Erickson, Dragan Maksimović, 3rd Edition, 2020, Springer.

2.Islam M.R., Shah M.R., Ali M.H., *Emerging Power Converters for Renewable Energy and Electric Vehicles: Modeling, Design, and Control*, CRC Press, First edition, 2021.

3. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Third Edition, CRC Press, Taylor & Francis Group, Third Edition 2021.

4. Modern Control Engineering, Katsuhiko Ogata, 6th Edition, Pearson, 2023.

5. Control Systems Engineering, Norman S. Nise, 8th Edition, Wiley, 2020.

REFERENCES:

1. Power Electronic Converters : Modeling, Design and Control, Teuvo Suntio, Tuomas Messo, Joonas Puukko, Second Edition 2021.
2. Fundamentals of Power Electronics with MATLAB, Randall Shaffer, 2nd Edition, 2013, Lakshmi publications
3. Feedback Control problems using MATLAB and the Control system tool box, Dean Frederick and Joe Cho, 2000, 1st Edition, Cengage learning.
4. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005,1st Edition.
5. Electrical Machine Fundamentals with Numerical Simulation using MATLAB / SIMULINK, Iqbal A, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Wiley, 1st Edition, 2021.
6. Emerging Power Converters for Renewable Energy and Electric Vehicles Modeling, Design, and Control, Md. Rabiul Islam,Md. Rakibuzzaman Shah, Mohd. Hasan Ali, CRC Press,2021, 1st Edition.
7. Modeling and Control of Power Electronics Converters, Blaabjerg F. (Ed.), 1st Edition, Academic Press (Elsevier), 2022.

MAPPING OF COs WITH POs AND PSOs

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	2	2	1	2	2	2	3	2	2	3
CO2	3	2	2	2	2	2	1	2	2	2	3	2	2	3
CO3	3	2	2	3	2	2	1	2	2	2	3	2	2	3
CO4	3	2	2	2	2	2	1	2	2	2	3	2	2	3
CO5	3	2	2	3	2	2	1	2	2	2	3	2	2	3
CO6	3	2	2	3	2	2	1	2	2	2	3	2	2	3
Avg	3	2	2	2.33	2	2	1	2	2	2	3	2	2	3

PEE2414 BATTERY MANAGEMENT SYSTEM AND CHARGING TECHNOLOGIES

L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand advanced battery technologies, their chemistry, performance characteristics, and degradation mechanisms.
- To develop knowledge on battery pack design, configuration, and modeling techniques for EV applications.

- To analyze battery state estimation methods and the architecture and functions of Battery Management Systems (BMS).
- To study EV charging technologies, standards and associated power electronic converters.
- To explore advanced charging methods including wireless charging, renewable integration, and grid interaction.
- To enable students to design, analyze, and evaluate BMS and EV charging systems for real-world applications.

UNIT I ADVANCED BATTERIES (7+2 SKILL) 9

Li-ion batteries: types, formats, chemistry, safe operating area, efficiency and aging; battery characteristics – State of Charge (SOC), Depth of Discharge (DOD), State of Health (SOH); cell balancing techniques – passive and active balancing; advanced batteries – NCM and NCA batteries; specifications of cylindrical cells (e.g., NCR18650B).

UNIT II BATTERY PACK AND MODELLING (7+2 SKILL) 9

Battery pack design: configuration, sizing, and calculations; battery pack architecture and flow; peak power – definition, testing methods, relationship with temperature and internal resistance; battery modelling methods – equivalent circuit models (Rint, Thevenin, PNGV), electrochemical models, neural network models; introduction to state-space models and simulation frameworks. EV Wiring Harness.

UNIT III BATTERY STATE ESTIMATION AND BMS (7+2 SKILL) 9

SOC estimation: definition, importance, single cell vs pack estimation; estimation methods – open circuit voltage, load voltage, AC impedance, Ah counting; advanced estimation techniques – neural networks, neuro-fuzzy systems, Kalman filter; Battery Management System (BMS): need, functions, architecture, and classification; BMS development using model-based design.

UNIT IV EV CHARGING TECHNOLOGIES AND POWER ELECTRONICS

(7+2 SKILL) 9

EV charging technologies – onboard and offboard chargers; AC and DC charging systems; conductive charging; layouts of EV charging systems; power electronic converters for charging – AC-DC converters with power factor correction, bidirectional DC-DC converters, non-isolated converter topologies; charging standards and regulations.

UNIT V ADVANCED CHARGING METHODS AND GRID INTEGRATION (7+2 SKILL) 9

Wireless power transfer – inductive, resonant, capacitive methods; static and dynamic charging; standards for wireless charging (SAE J2954, IEC 61980); EV charging using renewable energy sources – solar PV integrated charging systems; vehicle-to-grid (V2G) and grid-to-vehicle (G2V); energy storage integration; power factor correction in EV charging systems.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/ Mini Project/ Assignment/ Content Preparation / Quiz/ Surprise Test / etc)

1. Develop a MATLAB/Simulink model of Battery pack, SOC estimation and Charging system.

2.State Estimation & BMS - SOC Estimation using Ah Counting.

3. Kalman Filter SOC Estimation.

4.BMS Fault Detection using Embedded logic design.

5. Wireless Charging Efficiency Model

6.V2G Power Flow Simulation

7.Solar EV Charging Model

8. Design and simulate a battery pack with BMS and charging system for an EV application.

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1: Explain the characteristics, chemistry, and performance parameters of advanced battery technologies used in EVs.

CO2: Design and analyze battery packs, including configuration, sizing, and performance evaluation.

CO3: Apply battery modeling techniques and develop equivalent circuit/state-space models.

CO4: Evaluate SOC, SOH estimation methods and analyze the architecture and operation of BMS.

CO5: Analyze EV charging systems, standards, and power electronic converters used in charging infrastructure.

CO6: Assess advanced charging technologies such as wireless charging, V2G, and renewable-integrated EV systems.

TEXT BOOKS:

1. Jiuchun Jiang and Caiping Zhang, Fundamentals and Applications of Lithium-Ion Batteries in Electric Drive Vehicles, 1st Edition, Wiley, 2015.
2. Davide Andrea, Battery Management Systems for Large Lithium-Ion Battery Packs, Artech House, 2nd Edition, 2021.
3. James D. Halderman, Electric and Hybrid Electric Vehicles, Pearson, 1st Edition, 2022.
4. John T. Warner, The Handbook of Lithium-Ion Battery Pack Design, Elsevier, 2nd Edition, 2024.

REFERENCES:

1. Miao Wang Ran Zhang Xuemin (Sherman) Shen, Mobile Electric Vehicles Online Charging and Discharging, Springer, 1st Edition, 2016,.
2. Alicia Triviño-Cabrera, José M. González-González, José A. Aguado, Wireless Power Transferor Electric Vehicles: Foundations and Design Approach, Springer Publisher, 1st Edition. 2020.

3. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, Electric Vehicles : Modern Technologies and Trends. Springer Publisher 1st Edition, 2021.
4. 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,, 1st Edition, 2021.
5. James D Halderman, Electric and Hybrid Electric Vehicles, Pearson, 2nd Edition, Reprint 2022.
6. Ali Emadi, Handbook of Automotive Power Electronics & Motor Drives, Taylor & Francis, CRC Press, 2nd Edition, 2017.
7. Rajiv Singh, Sanjeevikumar Padmanaban, Sanjeet Dwivedi, Marta Molinas, Frede Blaabjerg, Cable-Based and Wireless Charging Systems for Electric Vehicles, IET, 1st Edition, 2021.

MAPPING OF COs WITH POs AND PSOs

	CO-PO											**CO-PSO**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PS01**	**PSO 2**	**PSO 3**
CO1	3	2	3	2	2	2	2	1	2	2	3	2	2	3
CO2	3	2	3	2	3	2	2	1	1	2	3	2	2	3
CO3	3	3	3	2	2	2	1	1	2	2	3	2	2	3
CO4	3	3	3	3	3	2	1	2	2	2	3	2	2	3
CO5	3	3	3	3	3	2	1	2	2	2	3	2	2	3
CO6	3	3	3	3	3	3	2	2	3	2	3	2	2	3
Avg.	**3.0**	**2.7**	**3.0**	**2.5**	**2.7**	**2.2**	**1.5**	**1.5**	**2.0**	**2.0**	**3.0**	**2.0**	**2.0**	**3.0**

PEE2415 DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand EV charging infrastructure, technologies, and global standards for electric mobility.
- To analyze power electronic converters and topologies used in EV charging systems.
- To explore renewable energy integrated EV charging systems and their control strategies.

- To study wireless power transfer (WPT) techniques and their applications in EV charging.
- To design and evaluate power factor correction (PFC) circuits for efficient charging systems.
- To develop the ability to model, simulate, and design EV charging systems for real-world applications

UNIT I CHARGING STATIONS AND STANDARDS (7+2 SKILL) 9

Introduction-Charging technologies - On board/Off board chargers - 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.

UNIT II POWER ELECTRONICS FOR EV CHARGING (7+2 SKILL) 9

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

UNIT III EV CHARGING USING RENEWABLE AND STORAGE SYSTEMS

(7+2 SKILL) 9

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

UNIT IV WIRELESS POWER TRANSFER (7+2 SKILL) 9

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

UNIT V POWER FACTOR CORRECTION IN CHARGING SYSTEM

(7+2 SKILL) 9

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.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/ Mini Project/ Assignment/ Content Preparation / Quiz/ Surprise Test / etc)

1. Simulation and analysis for bi-directional charging V2G and G2V.

2. Design and demonstrate solar PV based EV charging station.

3. Simulate and infer wireless power charging station for EV charging.

4. Simulation of boost converter based power factor correction.

TOTAL:45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1: Explain EV charging technologies, infrastructure, and international standards.

CO2: Analyze and design power electronic converters used in AC/DC and DC/DC EV charging systems.

CO3: Evaluate renewable energy integrated EV charging systems and their operational strategies.

CO4: Explain and analyze wireless power transfer techniques and operating principles for EV charging.

CO5: Assess standards, safety, and interoperability issues in wired and wireless EV charging systems.

CO6: Design and simulate power factor correction (PFC) circuits and evaluate their performance.

TEXT BOOKS:

1. Electric and Hybrid Electric Vehicles, James D. Halderman, Pearson, 1st Edition, 2022.
2. Handbook of Lithium-Ion Battery Pack Design, John T. Warner, 2nd Edition, Elsevier, 2024.
3. Advanced Battery Management System for Electric Vehicles, Shichun Yang, Xinhua Liu, Shen Li, Cheng Zhang, Springer, 1st Edition, 2023.
4. Electric Vehicle Technology, James Larminie, John Lowry, Wiley, 2nd Edition, Reprint 2020.
5. Electric Vehicle Charging Infrastructures and its Challenges, Ashutosh K. Giri, Madhusudan Singh, Springer, 1st Edition, 2025.

REFERENCES:

1. Mobile Electric Vehicles Online Charging and Discharging, Miao Wang Ran Zhang Xuemin (Sherman) Shen, Springer 2016, 1st Edition.
2. Wireless Power Transferor Electric Vehicles: Foundations and Design Approach, Alicia Triviño-Cabrera, José M. González-González, José A. Aguado, Springer Publisher 1st Edition. 2020.
3. Electric Vehicles, Modern Technologies and Trends, Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, Springer Publisher 1st Edition, 2021.
4. Cable Based and Wireless Charging Systems for Electric Vehicles, Technology and control, management and grid integration, Rajiv Singh, Sanjeevikumar Padmanaban, Sanjeet Dwivedi, Marta Molinas and Frede Blaabjerg, IET, 1st Edition, 2021..

5. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005.

6. Battery Management in Electric Vehicles: Current Status and Future Trends, Prodip K. Das, MDPI, 1st Edition, 2024.

7. Planning and Operation of Electric Vehicles in Smart Grids, Mehdi Rahmani-Andebili, Springer, 1st Edition, 2023.

MAPPING OF COs WITH POs AND PSOs

	CO-PO											**CO-PSO**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PS01**	**PSO 2**	**PSO 3**
CO1	3	2	2	2	2	3	2	2	2	3	3	2	2	3
CO2	3	2	3	2	2	3	2	2	2	3	3	2	2	3
CO3	3	3	3	3	2	3	2	2	2	3	3	2	2	3
CO4	2	2	3	3	2	2	2	2	2	3	3	2	2	3
CO5	3	3	3	3	2	3	2	2	2	3	3	2	2	3
CO6	3	3	3	3	2	3	2	2	2	3	3	2	2	3
Avg.	**3**	**2.5**	**2.8**	**2.6**	**2**	**3**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**3**

PEE2416 GRID INTEGRATION OF ELECTRIC VEHICLES L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand the fundamentals, architecture, and operational concepts of Vehicle-to-Grid (V2G) systems.
- To analyze the technical, economic, and environmental benefits of V2G in modern power systems

- To examine the challenges associated with V2G, including battery degradation, communication, market design, and regulatory issues
- To study the impact of electric vehicles and V2G on smart grids and renewable energy integration
- To understand communication standards, protocols, and architectures (e.g., IEC 61850, M2M) for EV grid integration
- To develop the ability to model, simulate, and evaluate EV grid integration systems, including power quality and energy management aspects.

UNIT I DEFINITION AND STATUS OF V2G (7+2 SKILL) 9

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

UNIT II BENEFITS OF V2G (7+2 SKILL) 9

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

UNIT III CHALLENGES TO V2G (7+2 SKILL) 9

Battery Degradation, Charger Efficiency, Aggregation and Communication, V2G in a Digital Society. Evaluating V2G Costs and Revenues , EV Costs and Benefits, V2G and Regulatory Frameworks , Market Design Challenges. Other V2G Regulatory and Legal Challenges.

UNIT IV IMPACT OF EV AND V2G ON THE SMART GRID AND RENEWABLE ENERGY SYSTEMS (7+2 SKILL) 9

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

UNIT V GRID INTEGRATION AND MANAGEMENT OF EVs (7+2 SKILL) 9

Introduction - Machine to Machine (M2M) in distributed energy management systems - M2M communication for EVs - M2M communication architecture (3GPP) - Electric vehicle data logging - Scalability of electric vehicles -M2M communication with scheduling - Introduction to IoT-based communication protocols for EV and grid integration such as MQTT, CoAP, IEC 61850 and DNP3

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)

1. Simulation of connecting the three phase inverter to the grid.

2. Simulate and analyse the power quality issues of V2G systems

3. Design and simulate battery management system for smart grid with distributed generation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1: Explain the fundamentals, architecture, and operational concepts of Vehicle-to-Grid (V2G) systems.

CO2: Analyze the technical, economic, and environmental benefits of V2G in modern power systems.

CO3: Examine the challenges associated with V2G, including battery degradation, communication, market design, and regulatory issues.

CO4: Analyze the impact of electric vehicles and V2G on smart grids and renewable energy systems.

CO5: Explain communication standards, protocols, and architectures (such as IEC 61850 and M2M) for EV grid integration and management.

CO6: Model, simulate, and evaluate EV grid integration systems, including grid-connected three-phase inverter operation, power quality, and energy management aspects

TEXT BOOKS:

1. Junwei Lu and Jahangir Hossain, Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid, IET, 1st Edition, 2015.

2. Rodrigo Garcia-Valle, João A. Peças Lopes, Electric Vehicle Integration into Modern Power Networks, Power Electronics and Power Systems, 2016

3. Janaka Ekanayake (Author), Kithsiri Liyanage (Author), Jianzhong Wu, Smart Grid: Technology and applications, 2015.

REFERENCES:

1. Ali Emadi, Advanced Electric Drive Vehicles, CRC Press, 1st Edition, 2017.

2. Sumedha Rajakaruna, Farhad Shahnia and Arindam Ghosh, Plug In Electric Vehicles in Smart Grids, Charging Strategies, Springer, 1st Edition, 2015.

3. Nand Kishor; Jesus Fraile-Ardanuy, ICT for Electric Vehicle Integration with the Smart Grid, IET, 1st Edition, 2020.

4. Lance Noel · Gerardo Zarazua de Rubens Johannes Kester · Benjamin K. Sovacool, Vehicle-to Grid A Sociotechnical Transition Beyond Electric Mobility, 1st Edition, 2019.

MAPPING OF COs WITH POs AND PSOs

	CO-PO											CO-PSO		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PS0 1**	**PSO 2**	**PSO 3**
CO1	3	3	3	3	3	3	2	2	2	3	3	2	2	3
CO2	3	3	3	3	3	3	2	2	2	3	3	2	2	3
CO3	3	3	3	3	3	3	2	2	2	3	3	2	2	3
CO4	2	3	3	3	3	2	2	2	2	3	3	2	2	3
CO5	3	3	3	3	3	3	2	2	2	3	3	2	2	3
CO6	3	3	3	3	3	3	2	2	2	3	3	2	2	3
Avg.	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**3**

PEE2417 INTELLIGENT CONTROL OF ELECTRIC VEHICLES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To model BLDC motors and analyze their operating characteristics under various drive modes and conditions.
- To understand and apply speed control techniques including PID, vector control, and intelligent methods such as Fuzzy Logic, ANN and GA.
- To design fuzzy logic systems using fuzzification, rule base, inference and defuzzification methods.
- To understand FPGA architecture and develop VHDL programs for digital and motor control applications.
- To study inverter-fed BLDC drives and rotor position sensing using Hall effect sensors.
- To implement real-time BLDC motor control techniques using microcontroller/DSP.

UNIT I MATHEMATICAL MODEL AND CHARACTERISTICS ANALYSIS (7+2 SKILL) 9

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

UNIT II SPEED CONTROL FOR ELECTRIC DRIVES (7+2 SKILL) 9

Introduction - PID Control Principle - Anti windup Controller - Intelligent Controller: Fuzzy Logic Control - Artificial Neural Networks (ANN) based control - Genetic Algorithms (GA) based optimization in drives - Overview of hybrid intelligent techniques - Vector Control - Control applied to BLDC motor.

UNIT III FUZZY LOGIC (7+2 SKILL) 9

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

UNIT IV FPGA AND VHDL BASICS (7+2 SKILL) 9

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

UNIT V REAL TIME IMPLEMENTATION (7+2 SKILL) 9

Inverter design, identifying rotor position via hall effect sensors, open loop and fuzzy logic control of 48 V BLDC motor using microcontroller/ DSP.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / etc)

1. Design and simulate speed controller for induction motors in EV for both dynamic and steady state performance

2. Simulate a fuzzy logic controller based energy storage system for EV.

3. Fuzzy logic control of BLDC motor using microcontroller/DSP in real time

COURSE OUTCOMES:

Upon the successful completion of the course, students will be able to:

CO1: Model and analyze the mathematical representation and operating characteristics of BLDC motors.

CO2: Apply conventional and advanced control techniques, including PID, anti-windup, and vector control, to BLDC motor drives.

CO3: Analyze the principles and design of fuzzy logic controllers, including fuzzification, inference, and defuzzification methods.

CO4: Develop VHDL programs and explain FPGA architecture for implementing motor control applications.

CO5: Design inverter-fed BLDC motor drive systems incorporating rotor position sensing techniques.

CO6: Implement and evaluate real-time fuzzy logic control of BLDC motors using FPGA.

TEXTBOOKS:

1. Duane C. Hanselman, Brushless Permanent-magnet Motor Design, McGraw Hill, 1994.

2. Modern Control Engineering, Katsuhiko Ogata, 6th Edition, Pearson, 2023.

3. Timothy J. Ross, Fuzzy Logic with Engineering Applications, 3rd edition, 2011.

4. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Third Edition" CRC Press, Taylor & Francis Group, 2021, 1st Edition.

5. Electric and Plug-in Hybrid Vehicle Networks Optimization and Control, Emanuele Crisostomi • Robert Shorten, Sonja Stüdli • Fabian Wirth, CRC Press, 1st Edition. 2018.

REFERENCES:

1. Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, John G. Hayes, G. Abas Goodarzi, Wiley 1st Edition 2018.

2. VHDL Primer, A (3rd Edition), Jayaram Bhasker, Prentice Hall, 1st Edition 2015.

3. Chang-liang, Permanent Magnet Brushless DC Motor Drives and Controls, Xia Wiley 2012, 1st Edition.

4. 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.

5. Wei Liu, Hybrid Electric Vehicle System Modeling and Control, Wiley 2017, 2nd Edition

MAPPING OF COs WITH POs AND PSOs

	CO-PO											**CO-PSO**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PS0 1**	**PSO 2**	**PSO 3**
CO1	3	3	2	2	3	3	2	3	2	3	3	2	2	3
CO2	3	3	2	2	3	3	2	3	2	3	3	2	2	3
CO3	3	3	3	3	3	3	2	1	2	3	3	2	2	3
CO4	2	3	3	3	3	2	2	1	2	3	3	2	2	3
CO5	3	3	3	3	3	3	2	2	2	3	3	2	2	3
CO6	3	3	3	3	3	3	2	2	2	3	3	2	2	3
Avg.	**3**	**3**	**2.6**	**2.6**	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**3**

PEE2418 TESTING AND THERMAL MANAGEMENT OF ELECTRIC VEHICLES

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand EV standardization bodies, international standards, and testing protocols for electric vehicle systems.

- To analyze testing methods and performance evaluation techniques for electric motors and controllers used in EVs.
- To examine functional safety principles, hazard analysis, and electromagnetic compatibility (EMC) requirements in EV systems.
- To analyze EMI/EMC issues, sources, coupling mechanisms, and mitigation techniques in EV subsystems.
- To study thermal behavior and heat generation in EV components, including batteries, power electronics, and electric motors.
- To evaluate and design thermal management systems for EVs to enhance safety, performance, and efficiency.

UNIT I EV STANDARDIZATION AND TESTING PROTOCOLS (7+2 SKILL) 9

Introduction to electric vehicle standardization; current status of EV standards; standardization bodies and activities; international standards (IEC, ISO); standardization of EV components; testing protocols and certification procedures for EV systems.

UNIT II TESTING OF ELECTRIC MOTORS AND CONTROLLERS (7+2 SKILL) 9

Testing of electric motors and controllers for EV/HEV applications; test procedures using M-G set; eddy current dynamometer testing; AC dynamometer testing; test strategies and performance evaluation; analysis of test results for motor and controller systems.

UNIT III FUNCTIONAL SAFETY AND EMC IN EVs (7+2 SKILL) 9

Functional safety lifecycle; hazard and risk assessment; fault tree analysis; reliability and redundancy; software development process models; configuration management; functional safety standards for EVs; electromagnetic compatibility (EMC) and its significance in EV systems.

UNIT IV EMI/EMC ISSUES IN EV SYSTEMS (7+2 SKILL) 9

EMC challenges in EV subsystems: motor drives, DC-DC converters, wireless charging systems, vehicle controllers, and battery management systems; vehicle-level EMC requirements; EMI mechanisms; conducted emissions; EMI sources and coupling paths; modelling of EMI in EV systems.

UNIT V THERMAL MANAGEMENT IN ELECTRIC VEHICLES (7+2 SKILL) 9

Thermal issues in EVs; heat generation in batteries, power electronics, and electric motors; battery thermal management systems (BTMS); cooling techniques – air cooling, liquid cooling, phase change materials; thermal modelling and performance analysis; thermal safety and efficiency improvement in EV systems.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / etc):

1. Prepare a summary of major EV standards (IEC, ISO) and certification procedures for EV components.
2. Analyze motor performance using test results from dynamometer testing and efficiency calculations.
3. Perform a simple hazard analysis for an EV subsystem using fault tree concepts.
4. Identify EMI sources in EV subsystems and suggest suitable EMC mitigation methods.
5. Compare different EV cooling techniques for batteries and motors based on performance and safety.

COURSE OUTCOMES (COs):

After completion of the course, students will be able to:

CO1: Explain EV standardization frameworks, international standards (IEC/ISO), and testing protocols.

CO2: Analyze testing procedures and performance characteristics of electric motors and controllers using dynamometer-based methods.

CO3: Apply functional safety concepts, including hazard analysis and risk assessment, and evaluate EMC requirements in EV systems.

CO4: Analyze EMI/EMC issues in EV subsystems and propose appropriate mitigation techniques.

CO5: Analyze thermal behavior and heat generation in EV components such as batteries, motors, and power electronics.

CO6: Design and evaluate thermal management systems (e.g., air cooling, liquid cooling, PCM-based systems) for improved EV performance and safety.

TEXTBOOKS:

1. Beate Müller & Gereon Meyer, Electric Vehicle Systems Architecture and Standardization Needs, Springer, 1st Edition, 2015.
2. ELECTRIC AND HYBRID VEHICLES : DESIGN FUNDAMENTALS, 3RD EDITION, CRC Press, 2021
3. Henry W. Ott Electromagnetic Compatibility Engineering , 24 August, Wiley, 2009.
4. Davide Andrea (Author)Battery Management Systems for Large Lithium Battery Packs, Artech House Publisher, 2010.

REFERENCES:

1. Ali Emadi, Handbook of Automotive Power Electronics and Motor Drives, Taylor & Francis, 1st Edition, 2005.
2. Li Zhai, Electromagnetic Compatibility of Electric Vehicles, Springer, 1st Edition, 2021.

3. Kai Borgeest, EMC and Functional Safety of Automotive Electronics, IET, 1st Edition, 2018.

4. Druce Archam beault, colin branch, Omar M.Ramachi, EMI/EMC Computational Modeling Handbook, Springer, 2nd Edition, 2012.

5. Mark Steffka, Automotive EMC, Springer, 1st Edition, 2013.

MAPPING OF COs WITH POs AND PSOs

	CO-PO											CO-PSO		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PS01**	**PSO 2**	**PSO 3**
CO1	3	3	3	3	2	3	2	2	2	3	3	2	2	3
CO2	3	3	3	3	2	3	2	2	2	3	3	2	2	3
CO3	3	3	3	3	2	3	2	2	2	3	3	2	2	3
CO4	2	3	3	3	2	2	2	2	2	3	3	2	2	3
CO5	3	3	3	3	2	3	2	2	2	3	3	2	2	3
CO6	3	3	3	3	2	3	2	2	2	3	3	2	2	3
Avg.	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**3**

VERTICAL - III: ELECTRICAL DRIVES & CONTROL

PEE2421 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS

L T P C

2 0 2 3

COURSE OBJECTIVES

- To comprehend renewable energy sources and their environmental impact.
- To examine electrical machines used in wind energy systems.
- To design solar PV systems and associated components.
- To interpret the operation of power converters in wind applications.
- To analyze hybrid energy systems and MPPT methods.
- To develop modelling and simulation skills for renewable energy systems.

UNIT I INTRODUCTION TO RENEWABLE ENERGY SYSTEMS 6

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

UNIT II ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS (WECS) 6

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

UNIT III POWER CONVERTERS AND ANALYSIS OF SOLAR PV SYSTEMS 6

Power Converters: Boost and buck-boost converters - selection of inverter, battery sizing, array sizing. Block diagram of the solar PV systems - Types of Solar PV systems: Stand-alone PV systems, Grid integrated solar PV Systems - Grid Connection Issues.

UNIT IV POWER CONVERTERS FOR WIND SYSTEMS 6

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

UNIT V HYBRID RENEWABLE ENERGY SYSTEMS 6

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

30 PERIODS

LAB COMPONENT:

1. Simulation on modelling of Solar PV System- V I Characteristics.
2. Simulation on Modelling of fuel cell- V I Characteristics.
3. Simulation of self- excited Induction Generator.
4. Simulation of DFIG/ PMSG based Wind turbine.
5. Simulation on Grid integration of RES.

TOTAL: 30+30 = 60 PERIODS

COURSE OUTCOMES:

Upon completion of the of the course students will be able to

CO1: Explain the classification, characteristics, and environmental impacts of conventional and renewable energy systems.

CO2: Analyze the operation and performance of electrical machines used in wind energy conversion systems.

CO3: Design and evaluate solar PV systems including converters, inverter selection, and sizing aspects.

CO4: Assess the operation of power electronic converters used in wind energy systems.

CO5: Evaluate hybrid renewable energy systems and apply MPPT techniques for efficient energy utilization.

CO6: Simulate the renewable energy systems and their grid integration using appropriate software tools.

TEXT BOOKS:

1. B. H. Khan, *Non-Conventional Energy Resources*, McGraw Hill Education, 3rd Edition, 2017.
2. S. N. Bhadra, D. Kastha and S. Banerjee, *Wind Electrical Systems*, Oxford University Press, 2nd Edition, 2014.
3. Chetan Singh Solanki, *Solar Photovoltaics: Fundamentals, Technologies and Applications*, PHI Learning, 3rd Edition, 2015.
4. Muhammad H. Rashid, *Power Electronics: Circuits, Devices and Applications*, Pearson Education, 4th Edition, 2014.

REFERENCE BOOKS:

1. G. D. Rai, *Non-Conventional Energy Sources*, Khanna Publishers, 5th Edition, 2011.
2. Erich Hau, *Wind Turbines: Fundamentals, Technologies, Application, Economics*, Springer, 3rd Edition, 2013.
3. Gilbert M. Masters, *Renewable and Efficient Electric Power Systems*, Wiley India, 2nd Edition, 2013.
4. D. P. Kothari, K. C. Singal and Rakesh Ranjan, *Renewable Energy Sources and Emerging Technologies*, PHI Learning, 2nd Edition, 2011.
5. Ned Mohan, Tore M. Undeland and William P. Robbins, *Power Electronics: Converters, Applications and Design*, Wiley, 3rd Edition, 2003.
6. Fang Lin Luo and Hong Ye, *Advanced DC–DC Converters*, CRC Press, 2nd Edition, 2016.

MAPPING OF COs WITH POs AND PSOs

CO	PO											PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3

CO1	3	2	–	–	–	3	–	2	1	–	2	1	1	2
CO2	3	2	–	-	-	–	–	2	1	–	2	3	2	2
CO3	3	2	2	2	2	–	–	2	1	–	2	3	2	2
CO4	3	2	2	2	2	–	–	2	1	–	2	3	2	2
CO5	3	2	2	2	2	–	–	2	1	–	2	3	2	2
CO6	3	2	2	2	3	–	–	3	1	–	2	3	2	2
CO	**3.00**	**2.00**	**2.00**	**2.00**	**2.25**	**3.00**	–	**2.17**	**1.00**	–	**2.00**	**2.67**	**1.83**	**2.00**

PEE2422 MULTILEVEL POWER CONVERTERS L T P C

3 0 0 3

COURSE OBJECTIVES

- To understand the fundamentals, classification, and applications of multilevel converters.
- To study the operation and modulation techniques of cascaded H-bridge multilevel inverters.
- To analyze the configuration and performance of diode clamped multilevel converters.
- To examine the operation and voltage balancing of flying capacitor multilevel converters.
- To explore advanced multilevel converter topologies and their applications.
- To develop practical skills in analyzing and multilevel converters using appropriate software tools.

UNIT I INTRODUCTION AND FUNDAMENTALS (7+2 SKILL) 9

Need for multilevel converters – Advantages and limitations – Classification: Neutral Point Clamped (NPC), Flying Capacitor (FC), Cascaded H-Bridge (CHB) – Symmetric and asymmetric configurations – Basic operation – Applications in renewable energy systems, electric vehicles, HVDC and FACTS.

UNIT II CASCADED H-BRIDGE MULTILEVEL INVERTER (7+2 SKILL) 9

Structure and operation – Equal and unequal DC sources – Voltage level generation – Phase-shifted and level-shifted PWM techniques – Harmonic analysis – Total Harmonic Distortion (THD) – Comparison of modulation strategies.

UNIT III DIODE CLAMPED MULTILEVEL CONVERTER

(7+2 SKILL) 9

Circuit configuration – Switching states – Working principle – Neutral point voltage balancing – Advantages and limitations – Performance comparison with CHB.

UNIT IV FLYING CAPACITOR MULTILEVEL CONVERTER (7+2 SKILL) 9

Topology and operation – Capacitor voltage balancing – Switching strategies – Advantages and limitations – Comparison with NPC and CHB.

UNIT V ADVANCED MULTILEVEL CONVERTERS AND APPLICATIONS

(7+2 SKILL) 9

Reduced switch count multilevel inverters – Switched capacitor and hybrid topologies – Introduction to Modular Multilevel Converter (MMC) – Fault analysis and reliability – Applications in solar PV, electric vehicles, motor drives and grid systems.

45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)

1. NPC vs FC vs CHB Parameter Comparison Using Microsoft Excel.
2. CHB Inverter Output Waveform THD Calculation Using MATLAB.
3. Neutral Point Voltage Variation Plot for NPC Using MATLAB.
4. Flying Capacitor Voltage Balancing Trend Analysis Using MATLAB.
5. Solar PV Multilevel Inverter Output Data Visualization Using Microsoft Excel.

COURSE OUTCOMES:

Upon completion of the of the course students will be able to

CO1: Explain the fundamentals, types, and applications of multilevel converters.

CO2: Analyze the operation, modulation techniques, and harmonic performance of cascaded H-bridge multilevel inverters.

CO3: Evaluate the operation and performance of diode clamped multilevel converters.

CO4: Assess the operation and capacitor voltage balancing of flying capacitor multilevel converters.

CO5: Analyze advanced multilevel converter topologies and their applications in modern power systems.

CO6: Simulate and analyze multilevel inverter behavior using appropriate software tools.

TEXT BOOKS:

1. Muhammad H. Rashid, *Power Electronics: Circuits, Devices and Applications*, Pearson Education, 4th Edition, 2014.
2. Ned Mohan, Tore M. Undeland and William P. Robbins, *Power Electronics: Converters, Applications and Design*, Wiley, 3rd Edition, 2003.
3. Bimal K. Bose, *Modern Power Electronics and AC Drives*, Pearson Education, 1st Edition, 2002.

REFERENCE BOOKS

1. Jose Rodriguez, Jih-Sheng Lai and Fang Zheng Peng, *Multilevel Inverters: A Survey of Topologies, Controls, and Applications*, IEEE Transactions on Industrial Electronics, 2002.
2. Bin Wu, *High-Power Converters and AC Drives*, Wiley-IEEE Press, 2nd Edition, 2006.

3. Fang Lin Luo and Hong Ye, *Advanced DC–DC Converters*, CRC Press, 2nd Edition, 2016.
4. Krishnan R., *Electric Motor Drives: Modeling, Analysis and Control*, Pearson Education, 1st Edition, 2001.
5. Marian P. Kazmierkowski, Ramu Krishnan and Frede Blaabjerg, *Control in Power Electronics: Selected Problems*, Academic Press, 2002.

MAPPING OF COs WITH POs AND PSOs

CO	PO											PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	–	–	–	–	–	1	1	–	1	2	–	1
CO2	3	3	–	2	2	–	–	1	1	–	–	3	2	1
CO3	3	3	–	2	2	–	–	1	1	–	–	3	2	1
CO4	3	3	–	2	2	–	–	1	1	–	–	3	2	1
CO5	3	3	3	2	2	2	–	1	1	-	1	3	3	3
CO6	2	2	–	3	3	–	–	2	1	–	2	3	3	2
CO	**2.83**	**2.67**	**3.00**	**2.20**	**2.20**	**2.00**	–	**1.17**	**1.00**	–	**1.33**	**2.83**	**2.40**	**1.50**

PEE2423 POWER ELECTRONIC DRIVES L T P C

2 0 2 4

COURSE OBJECTIVES

- To understand the characteristics and dynamics of electric drives and motor selection.
- To study the operation and control of converter and chopper fed DC motor drives.
- To analyze induction motor drives and their control techniques.
- To examine synchronous motor drives and their control strategies.
- To design controllers for electric drives with feedback mechanisms.

- To develop simulation skills for analysis of electric drive systems.

UNIT I DRIVE CHARACTERISTICS 6

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

UNIT II CONVERTER / CHOPPER FED DC MOTOR DRIVE 6

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

UNIT III INDUCTION MOTOR DRIVES 6

Stator voltage control – v/f control – Slip power recovery scheme - Field weakening mode – voltage / current fed inverter – closed loop control.

UNIT IV SYNCHRONOUS MOTOR DRIVES 6

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

UNIT V DESIGN OF CONTROLLERS FOR DRIVES 6

Transfer function for DC motor / load and converter – Closed loop control with current and speed feedback – Armature voltage control and field weakening mode – Design of controllers - Current controller and speed controller - Converter selection and characteristics.

30 PERIODS

LAB COMPONENT

1. Simulation of converter and chopper fed DC drive.
2. Simulation of closed loop operation of stator voltage control of induction motor drive.
3. Simulation of closed loop operation of v/f control of induction motor drive.
4. Simulation of synchronous motor drive**.**

TOTAL: 30+30 = 60 PERIODS

COURSE OUTCOMES:

Upon completion of the of the course students will be able to

CO1: Explain drive characteristics, motor dynamics, and selection criteria.

CO2: Analyze the performance and control of converter/chopper fed DC motor drives.

CO3: Evaluate the operation and control techniques of induction motor drives.

CO4: Assess the performance and control of synchronous motor drives.

CO5: Design and analyze controllers for electric drives with feedback systems.

CO6: Simulate and analyze electric drive systems using appropriate software tools.

TEXT BOOKS:

1. Gopal K. Dubey, *Fundamentals of Electrical Drives*, Narosa Publishing House, 2nd Edition, 2010.

2. Bimal K. Bose, *Modern Power Electronics and AC Drives*, Pearson Education, 1st Edition, 2002.

3. S. K. Pillai, *A First Course on Electrical Drives*, Wiley Eastern Limited, 3rd Edition, 2012.

REFERENCE BOOKS:

1. J. M. D. Murphy and F. G. Turnbull, *Thyristor Control of AC Motors*, Pergamon Press, Oxford, 1st Edition, 1988.

2. Gopal K. Dubey, *Power Semiconductor Controlled Drives*, Prentice Hall Inc., New Jersey, 1st Edition, 1989.

3. R. Krishnan, *Electric Motor Drives: Modeling, Analysis and Control*, Prentice Hall of India, 1st Edition, 2001.

4. A. Inba Rexy and J. S. Nancy Mary, *Electrical Drives*, Vijay Nicole Publications, 1st Edition, 2025.

MAPPING OF COs WITH POs AND PSOs

CO	PO											PSO		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	2	3	–	–	1	2	2	–	2	3	3	2
CO2	3	2	2	3	–	–	1	2	2	–	2	3	3	3
CO3	3	2	2	3	–	–	1	2	2	–	2	3	3	3
CO4	3	2	2	3	–	–	1	2	2	–	2	3	3	3
CO5	3	2	2	3	-	-	1	2	2	-	2	3	3	3
CO6	3	2	2	3	3	–	1	2	2	–	2	3	3	3
CO	**3**	**2**	**2**	**2**	**3**	-	1	2	2	–	**2**	**3**	**3**	**2.83**

PEE2424 SWITCHED MODE POWER CONVERSION L T P C

3 0 0 3

COURSE OBJECTIVES

- To understand the fundamentals and operation of switched-mode power supplies.
- To study non-isolated DC–DC converters and their operating principles.
- To analyze isolated converter topologies and their applications.
- To learn control techniques and design aspects of SMPS.
- To understand the operation and applications of UPS systems.
- To apply analytical and simulation tools for evaluating SMPS and UPS systems.

UNIT I INTRODUCTION TO SMPS (7+2 SKILL) 9

Linear power supply vs switched mode power supply – Advantages and limitations – Basic block diagram of SMPS – Switching devices (MOSFET, IGBT) – Switching characteristics – PWM control – Applications.

UNIT II NON-ISOLATED DC–DC CONVERTERS (7+2 SKILL) 9

Buck converter – Boost converter – Buck-Boost converter – Operating principles – Continuous and discontinuous conduction modes – Output voltage control – Efficiency considerations – Applications.

UNIT III ISOLATED CONVERTERS (7+2 SKILL) 9

Need for isolation – Flyback converter – Forward converter – Push-pull converter – Half-bridge and full-bridge converters – Transformer design basics – Comparison of isolated topologies.

UNIT IV CONTROL AND DESIGN OF SMPS (7+2 SKILL) 9

PWM control techniques – Voltage mode and current mode control – Feedback and regulation – Design considerations – EMI and filtering – Thermal management – Protection circuits.

UNIT V UPS SYSTEMS AND APPLICATIONS (7+2 SKILL) 9

Introduction to UPS – Types: Offline, Online, Line-interactive – Block diagram and working – Static switch and inverter – Battery types and charging methods – Power quality issues – Applications in IT, industries and hospitals.

45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)

1. SMPS vs Linear Power Supply Efficiency Comparison Using Microsoft Excel.
2. Buck–Boost Converter Output Voltage Analysis Using MATLAB.

3. Flyback vs Forward Converter Performance Comparison Using Microsoft Excel.
4. PWM Duty Cycle vs Output Voltage Plot Using MATLAB.
5. UPS Backup Time Calculation and Load Analysis Using Microsoft Excel.

COURSE OUTCOMES:

Upon completion of the of the course students will be able to

CO1: Explain the fundamentals, components, and operation of SMPS.

CO2: Analyze the operation and performance of non-isolated DC–DC converters.

CO3: Evaluate isolated converter topologies and their design considerations.

CO4: Assess control techniques and design aspects of SMPS.

CO5: Explain the operation, types, and applications of UPS systems.

CO6: Ability to analyze, compare, and simulate SMPS and UPS systems using software tools.

TEXT BOOKS:

1. Muhammad H. Rashid, *Power Electronics: Circuits, Devices and Applications*, Pearson Education, 4th Edition, 2014.
2. Abraham I. Pressman, Keith Billings and Taylor Morey, *Switching Power Supply Design*, McGraw Hill, 3rd Edition, 2009.
3. Ned Mohan, Tore M. Undeland and William P. Robbins, *Power Electronics: Converters, Applications and Design*, Wiley, 3rd Edition, 2003.
4. V. Ramanarayanan, Course Material on Switched Mode Power Conversion, Department of Electrical Engineering Indian Institute of Science Bangalore. https://ee.iisc.ac.in/wp-content/uploads/2023/01/SMPC_VRamnarayanan.pdf

REFERENCE BOOKS:

1. Christophe P. Basso, *Switch-Mode Power Supplies: SPICE Simulations and Practical Designs*, McGraw Hill, 2nd Edition, 2014.
2. Sanjaya Maniktala, *Switching Power Supplies A–Z*, Elsevier, 2nd Edition, 2012.
3. Marian K. Kazimierczuk, *Pulse-Width Modulated DC–DC Power Converters*, Wiley, 2nd Edition, 2015.
4. P. T. Krein, *Elements of Power Electronics*, Oxford University Press, 2nd Edition, 2015.

MAPPING OF COs WITH POs AND PSOs

CO	PO											PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	3	2	–	–	–	–	–	1	1	–	1	2	–	1
CO2	3	3	2	2	2	–	–	1	1	–	1	3	2	1
CO3	3	3	2	2	2	–	–	1	1	–	1	3	2	1
CO4	3	3	2	2	2	–	–	1	1	–	1	3	2	1
CO5	3	3	2	2	2	-	–	1	1	-	1	3	3	2
CO6	2	2	2	3	3	1	–	2	1	–	2	3	3	2
CO	**2.83**	**2.67**	**2.00**	**2.20**	**2.20**	**1.00**	–	**1.17**	**1.00**	–	**1.17**	**2.83**	**2.40**	**1.33**

PEE2425 CONTROL OF POWER ELECTRONIC CIRCUITS L T P C

2 0 2 4

COURSE OBJECTIVES:

- To understand the fundamentals of control in power electronic circuits and converter modeling.
- To study control techniques for DC–DC converters.
- To analyze control strategies for AC–DC and DC–AC converters.
- To learn digital control methods for power electronic systems.
- To explore advanced control techniques for power converters.
- To develop simulation and implementation skills for controlled power electronic systems.

UNIT I INTRODUCTION TO CONTROL OF POWER ELECTRONIC CIRCUITS 6

Overview of power electronic converters – Need for control – Open-loop and closed-loop control – Review of control system fundamentals – Transfer function modeling of converters – Small signal analysis – Block diagram representation.

UNIT II CONTROL OF DC-DC CONVERTERS 6

Control objectives – Voltage mode control – Current mode control – Pulse Width Modulation (PWM) techniques – Stability analysis – Compensation techniques – Design of controllers.

UNIT III CONTROL OF AC-DC AND DC-AC CONVERTERS 6

Control of rectifiers – Phase angle control – PWM rectifiers – Control of inverters – Sinusoidal PWM (SPWM) – Space Vector PWM (SVPWM) – Harmonic reduction techniques – Power factor improvement.

UNIT IV DIGITAL CONTROL OF POWER ELECTRONIC SYSTEMS 6

Introduction to digital control – Discrete-time modeling – Sampling and quantization – Microcontroller/DSP-based control – Implementation issues – Digital PWM techniques.

UNIT V ADVANCED CONTROL TECHNIQUES 6

PID controller design and tuning – Hysteresis control – Sliding mode control (basic concept) – Introduction to intelligent control (fuzzy logic, neural networks) – Applications in renewable energy and electric vehicles.

30 PERIODS

LAB COMPONENT

- Closed-Loop Control of DC-DC Converter using PI Controller.
- Current Mode Control of DC-DC Converter.
- SPWM-Based Voltage Source Inverter Simulation.
- Closed-Loop Speed Control of DC Motor using Converter.
- Hysteresis Control of Voltage Source Inverter Simulation.

TOTAL: 30+30 = 60 PERIODS

COURSE OUTCOMES:
Upon completion of the of the course students will be able to
CO1: Explain control fundamentals, modelling, and small signal analysis of power electronic converters.
CO2: Analyze and design control techniques for DC–DC converters.
CO3: Evaluate control strategies for AC–DC and DC–AC converters, including PWM techniques.
CO4: Apply digital control techniques for power electronic systems.
CO5: Analyze advanced control methods such as PID, hysteresis, and intelligent control techniques.

CO6: Simulate and implement control of power electronic circuits using appropriate software tools.

TEXT BOOKS:

1. Ned Mohan, Tore M. Undeland and William P. Robbins, *Power Electronics: Converters, Applications and Design*, Wiley, 3rd Edition, 2003.
2. Muhammad H. Rashid, *Power Electronics: Circuits, Devices and Applications*, Pearson Education, 4th Edition, 2014.
3. V. Ramanarayanan, Course Material on Switched Mode Power Conversion, Department of Electrical Engineering Indian Institute of Science Bangalore. https://ee.iisc.ac.in/wp-content/uploads/2023/01/SMPC_VRamnarayanan.pdf

4. L. Umanand, Power Electronics – Essentials & Applications, Wiley-India, 2009. https://tole.intelektual.org/wp-content/uploads/2020/09/pe-umanand.pdf

REFERENCE BOOKS:

1. Erickson R. W. and Maksimovic D., *Fundamentals of Power Electronics*, Springer, 2nd Edition, 2001.
2. Marian K. Kazimierczuk, *Pulse-Width Modulated DC–DC Power Converters*, Wiley, 2nd Edition, 2015.
3. Christophe P. Basso, *Switch-Mode Power Supplies: SPICE Simulations and Practical Designs*, McGraw Hill, 2nd Edition, 2014.
4. P. T. Krein, *Elements of Power Electronics*, Oxford University Press, 2nd Edition, 2015.
5. Katsuhiko Ogata, *Modern Control Engineering*, Prentice Hall, 5th Edition, 2010.

MAPPING OF COs WITH POs AND PSOs

CO	PO											PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	3	2	–	–	–	–	–	1	1	–	1	2	–	1
CO2	3	3	2	2	2	–	–	1	1	–	1	3	3	1
CO3	3	3	2	2	2	–	–	1	1	–	1	3	3	1
CO4	3	3	2	2	2	–	–	1	1	–	1	3	3	2
CO5	3	3	2	2	2	-	–	1	1	-	1	3	3	3
CO6	3	3	2	3	3	1	–	2	1	–	2	3	3	2
CO	**3.00**	**2.83**	**2.00**	**2.20**	**2.20**	**1.00**	–	**1.17**	**1.00**	–	**1.17**	**2.83**	**3.00**	**1.67**

PEE2426 EMBEDDED CONTROL FOR ELECTRIC DRIVES L T P C

3 0 0 3

COURSE OBJECTIVES

- To understand the fundamentals of electric drives and their operation.
- To study embedded systems used in motor control applications.
- To analyze control techniques for induction drives.
- To analyze control techniques for BLDC drives.

- To analyze control techniques for SRM drives.
- To apply simulation and analytical tools for studying electric drive characteristics, PWM control, and motor performance.

UNIT I INTRODUCTION TO ELECTRIC DRIVES (7+2 SKILL) 9

Electric drives – Classification and applications – Four-quadrant operation – Components of electric drives– Solid-state controlled drives – Introduction to digital control of electric drives.

UNIT II EMBEDDED SYSTEMS FOR MOTOR CONTROL (7+2 SKILL) 9

Embedded processors for motor control – Microcontrollers, DSPs – PWM generation – Timers, ADC, interrupts – Sensors for electric drives (current, speed, position) – Signal conditioning – Gate driver circuits – Communication protocols (UART, SPI, I2C, CAN) – IoT-based monitoring of drives.

UNIT III CONTROL OF INDUCTION MOTOR DRIVES (7+2 SKILL) 9

Induction motor basics for drives – Speed control methods – PWM techniques – VSI-fed induction motor – V/f control – Introduction to Field Oriented Control (FOC) – Embedded implementation of induction motor control.

UNIT IV CONTROL OF BLDC MOTOR DRIVES (7+2 SKILL) 9

BLDC motor fundamentals – Electronic commutation – Hall sensor-based control – Sensorless control (overview) – PWM techniques – Speed control – Embedded controller-based BLDC motor drive.

UNIT V CONTROL OF SRM DRIVES (7+2 SKILL) 9

SRM fundamentals – Torque production – Converter topologies – Speed control methods – PWM control – Embedded implementation of SRM drives.

45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)

1. Four-Quadrant Operation Analysis of Electric Drives Using Microsoft Excel.
2. PWM Signal Generation and Duty Cycle Analysis Using MATLAB.
3. Induction Motor Speed Control Characteristics Plot Using MATLAB.
4. BLDC Motor Speed vs PWM Duty Cycle Analysis Using MATLAB.
5. SRM Torque vs Current Characteristics Plot Using Microsoft Excel.

COURSE OUTCOMES:

Upon completion of the of the course students will be able to

CO1: Explain the fundamentals and classification of electric drives.
CO2: Select appropriate embedded systems and interfaces for motor control applications.
CO3: Analyze and implement control techniques for induction motor drives.
CO4: Design and implement control strategies for BLDC motor drives.
CO5: Analyze and implement control of SRM drives.
CO6: Ability to analyze and evaluate electric drive systems and motor characteristics using software tools.

TEXT BOOKS:

1. R. Krishnan, *Electric Motor Drives – Modeling, Analysis and Control*, Prentice-Hall of India Pvt. Ltd., New Delhi, 2010, 1st Edition.

2. Steve Kilts, *Advanced FPGA Design: Architecture, Implementation, and Optimization*, Wiley, 2007, 1st Edition.

REFERENCES:

1. Vedam Subrahmanyam, *Electric Drives – Concepts and Applications*, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2002, 2nd Edition.

2. K. Venkataratnam, *Special Electrical Machines*, Universities Press, 2014, 1st Edition.

3. Steve Furber, *ARM System on Chip Architecture*, Addison Wesley, 2015, 2nd Edition.

4. Ron Sass and Andrew G. Schmidt, *Embedded System Design with Platform FPGAs: Principles and Practices*, Elsevier, 2010, 1st Edition.

5. Tim Wescott, *Applied Control Theory for Embedded Systems*, Elsevier, 2006, 1st Edition.

MAPPING OF COs WITH POs AND PSOs

CO	PO											PSO		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	–	–	–	–	–	1	1	–	1	2	–	1
CO2	3	3	2	2	3	–	–	1	1	–	1	3	3	2
CO3	3	3	2	2	2	–	–	1	1	–	1	3	3	2
CO4	3	3	2	2	3	–	–	1	1	–	1	3	3	3
CO5	3	3	2	2	2	–	–	1	1	-	–	3	3	2
CO6	3	3	2	3	3	–	–	2	1	–	2	3	3	2
CO	**3.00**	**2.83**	**2.00**	**2.20**	**2.60**	–	–	**1.17**	**1.00**	–	**1.20**	**2.83**	**3.00**	**2.00**

PEE2427 ADVANCED CONTROL THEORY L T P C

2 0 2 4

COURSE OBJECTIVES

- To understand state space modeling, analysis, and controller/observer design.
- To study nonlinear system behavior and stability analysis techniques.
- To understand optimal control principles and LQR design.
- To learn adaptive and robust control strategies for dynamic systems.
- To introduce digital and intelligent control methods.
- To apply simulation techniques for modeling, analysis, and control design of linear and nonlinear systems.

UNIT I STATE SPACE ANALYSIS AND DESIGN 6

State space representation – Transfer function to state model – State transition matrix – Solution of state equations – Controllability and Observability – State feedback and pole placement – Observer design

UNIT II NONLINEAR CONTROL SYSTEMS 6

Nonlinear system characteristics – Phase plane analysis – Describing function method – Stability of nonlinear systems – Lyapunov stability – Limit cycles

UNIT III OPTIMAL CONTROL THEORY 6

Formulation of optimal control problem – Calculus of variations – Pontryagin's Minimum Principle – Linear Quadratic Regulator (LQR) – Riccati equation

UNIT IV ADAPTIVE AND ROBUST CONTROL 6

Adaptive control – Model Reference Adaptive Control (MRAC) – Self-tuning regulators – Introduction to robust control – Sensitivity functions – H-infinity control basics.

UNIT V DIGITAL AND INTELLIGENT CONTROL 6

Discrete-time systems – Z-transform – Stability analysis – Digital controller design – Introduction to intelligent control – Fuzzy logic control – Neural network control

30 PERIODS

LAB COMPONENT:

1. Simulation of State Space Modelling and Controllability Analysis.
2. Simulation of State Feedback Controller using Pole Placement.
3. Simulation of Phase Plane Analysis for Nonlinear Systems.
4. Simulation of Linear Quadratic Regulator (LQR) Design.

5. Simulation of the Model Reference Adaptive Control (MRAC) System.

TOTAL: 30+30 = 60 PERIODS

Suggested Activity or Skill Development Activities:

- Suggested Activity
- Digital Control Experiment
- Industry / Research Paper Review
- Simulation-Based Competition
- MATLAB/Simulink Proficiency
- Problem-Solving & Critical Thinking
- Coding Skills

Web references

- Phase Plane Analysis Tutorials and MATLAB examples (YouTube + resources).
- MIT OCW Notes on Phase-Plane Analysis: https://ocw.mit.edu/courses/16-30-estimation-and-control-of-aerospace-systems-spring-2004/0b318c74f4b1ae41dc4393e39b9cab17_ch3_nnl.pdf
- LQR Design in MATLAB: https://www.mathworks.com/help/control/ref/lti.lqr.html
- LQR for Autonomous Vehicles / Robotics: https://www.mathworks.com/videos/matlab-and-simulink-robotics-arena-lqr-control-of-an-autonomous-underwater-vehicle-1543831839770.html
- MathWorks MRAC Documentation: https://www.mathworks.com/help/slcontrol/ug/model-reference-adaptive-control.html
- MRAC Examples (Wing Rock / Satellite): https://www.mathworks.com/help/slcontrol/ug/model-reference-adaptive-control-of-aircraft-undergoing-wing-rock.html

COURSE OUTCOMES:

Upon completion of the of the course students will be able to

CO1: To model, analyze, and design state feedback controllers and observers.
CO2: To analyze nonlinear systems using phase plane and stability methods.
CO3: To formulate and solve optimal control problems using LQR techniques.
CO4: To design and analyze adaptive and basic robust control systems.

CO5: To analyze discrete systems and apply digital, fuzzy, and neural control techniques.

CO6: To analyze and design advanced control systems using modern control strategies through simulation tools.

TEXT BOOKS:

1. K. Ogata, *Modern Control Engineering*, 5th Edition, Prentice Hall, 2010.

2. M. Gopal, *Modern Control System Theory*, 3rd Edition, New Age International, 2014.

REFERENCE BOOKS:

1. K. Zhou and J.C. Doyle, *Robust and Optimal Control*, Prentice Hall, 1998.

2. H.K. Khalil, *Nonlinear Systems*, 3rd Edition, Prentice Hall, 2002.

3. K.J. Åström and B. Wittenmark, *Adaptive Control*, 2nd Edition, Addison-Wesley, 2008.

4. B.C. Kuo and F. Golnaraghi, *Automatic Control Systems*, 9th Edition, Wiley, 2014.

5. D.E. Kirk, *Optimal Control Theory: An Introduction*, Dover Publications, 2004.

MAPPING OF COs WITH POs AND PSOs

CO	PO											PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	2	–	–	1	1	–	1	3	3	2
CO2	3	3	2	2	1	–	–	1	1	–	1	3	2	1
CO3	3	3	2	2	2	–	–	1	1	1	1	3	3	2
CO4	3	3	2	2	2	1	–	1	1	1	1	3	3	3
CO5	3	3	2	3	3	1	–	1	1	-	1	3	3	3
CO6	3	3	2	3	3	–	–	2	1	–	1	3	3	3
CO	**3.00**	**3.00**	**2.17**	**2.33**	**2.17**	1	–	**1.17**	**1.00**	–	**1.00**	**3.00**	**2.83**	**2.33**

VERTICAL - IV: SMART CONNECTIVITY SYSTEMS

PEE2431 EMBEDDED SYSTEM DESIGN L T P C
2 0 2 3

COURSE OBJECTIVES

- To introduce the Building Blocks of an embedded System and Software Tools
- To emphasize the role of Input/output interfacing with Bus Communication protocol.
- To illustrate the ISR and scheduling for the multitasking process.
- To explain the basics of a Real-time operating system
- To analyze the applications based on embedded design approaches

UNIT I INTRODUCTION TO EMBEDDED SYSTEMS 6

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

UNIT II EMBEDDED NETWORKING 6

Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols RS232 standard – RS485 – CAN Bus- Serial Peripheral Interface (SPI) – InterIntegrated Circuits (I^2C).

UNIT III INTERRUPT SERVICE MECHANISM AND DEVICE DRIVE 6

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

UNIT IV RTOS-BASED EMBEDDED SYSTEM DESIGN 6

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

UNIT V EMBEDDED SYSTEM APPLICATION DEVELOPMENT 6

Embedded Product Development Life Cycle (Waterfall, V Cycle, Spiral, Rapid Prototype) - Case Study: Precision Agriculture- Autonomous car.

30 PERIODS

LAB COMPONENT

1. Laboratory exercise: Use any Embedded processor/IDE/open source platform to give hands-on training on basic concepts of embedded system design:

- Configure timer block for signal generation (with given frequency).
- Interrupts programming example using GPIO.
- I^2C communication with peripherals
- Master-slave communication between processors using SPI.
- Networking of processors using Wi-Fi.
- Basic RTOS concept and programming
- ADC Data Acquisition using DMA

2. Assignment: Introduction to VxWorks, чC/OS-II, RT Linux

3. Embedded systems-based Mini project.

TOTAL: 30+30 = 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course students will be able to

CO1: Apply the concepts of embedded system architecture, memory, and processor organization. *(K3)*

CO2: Analyze embedded communication protocols for networking applications. *(K3)*

CO3: Develop embedded programs using interrupt handling and device drivers. *(K3)*

CO4: Analyze RTOS concepts, scheduling, and interprocess communication. *(K4)*

CO5: Design embedded solutions for automation applications using appropriate development methodologies. *(K4)*

CO6: Develop embedded system applications using hardware interfaces, RTOS, and software tools. *(K4)*

TEXTBOOKS:

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

REFERENCES:

1. Shibu. K.V, "Introduction to Embedded Systems", TataMcgraw Hill, 2nd edition 2017.
2. Lya B.Das," Embedded Systems" ,Pearson Education, 1st edition 2012.
3. Parag H.Dave,Himanshu B.Dave," Embedded Systems-Concepts ,Design and Programming, Pearson Education,2015, 1st edition.
4. Elicia White, "Making Embedded systems", O'Reilly Series ,SPD,2011, 1st edition.
5. Jonathan W. Valvano, 'Embedded Microcomputer Systems Real-time Interfacing', Cengage Learning , 3rd edition 2010.
6. Tammy Noergaard, "Embedded Systems Architecture", Newnes, 2nd edition, 2013.

LIST OF OPEN SOURCE SOFTWARE/ LEARNING WEBSITES:

1. https://nptel.ac.in/courses/108102045
2. https://ece.uwaterloo.ca/~dwharder/icsrts/Lecture_materials/A_practical_introduction_to_re al-time_systems_for_undergraduate_engineering.pdf
3. https://www.circuitbasics.com/basics-of-the-i2c-communication-protocol/
4. https://www.tutorialspoint.com/embedded_systems/es_interrupts.htm
5. https://www.theengineeringprojects.com/2016/11/examples-of-embeddedsystems.html#:~:text=Embedded%20Product%3A%20Automatic%20Washing%20Machine, done%20by%20your%20machine%20itself.

MAPPING OF COs WITH POs AND PSOs

CO	PO											PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	1	2	-	-	-	-	-	2	3	2	3
CO2	3	3	2	2	2	-	-	-	-	-	2	3	3	3

CO3	3	3	2	2	3	-	-	-	-	-	2	3	3	3
CO4	3	3	3	3	3	-	-	-	-	-	2	3	3	3
CO5	3	3	3	2	3	1	-	-	-	-	3	3	3	3
CO6	3	3	3	3	3	1	-	-	1	-	3	3	3	3
Avg	**3.00**	**2.83**	**2.5**	**2.17**	**2.67**	**1**	-	-	1	-	**2.33**	**3.00**	**2.83**	**3.00**

PEE2432 EMBEDDED C- PROGRAMMING USING ARM CORTEX-M **L T P C**

3 0 0 3

COURSE OBJECTIVES:

- To expose the students to the fundamentals of embedded Programming
- To Introduce the GNU C Programming Tool Chain.
- To study the basic concepts of embedded C.
- To teach the basics of 8051 Programming
- To involve Discussions/ Practice/Exercise in revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

UNIT I BASIC C PROGRAMMING (7+2 SKILL) 9

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

UNIT II EMBEDDED C (7+2 SKILL) 9

Adding Structure to 'C' Code: Object-oriented programming with C, Header files for Project and Port, Examples. Meeting Real-time constraints: Creating hardware delays - Need for timeout mechanism - Creating loop timeouts - Creating hardware timeouts - Introduction to CMSIS / Hardware Abstraction Layer (HAL) concepts.

UNIT III ARM Programming in C (7+2 SKILL) 9

Data types and time delay in ARM Cortex-M, GPIO programming, Bitwise and logical operations, Data conversion programs, Accessing Flash memory, Data serialization using ARM.

UNIT IV ARM SERIAL PORT AND INTERRUPT PROGRAMMING IN C (7+2 SKILL) 9

Basics of serial communication, ARM UART interface programming, Interrupt handling in ARM Cortex-M, Timer configuration and programming..

UNIT V ARM INTERFACING (7+2 SKILL) 9

ARM Cortex-M: ADC interfacing, DAC interfacing, Sensor interfacing, LCD interfacing, Stepper motor interfacing.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar /Mini Project /Assignment / Content Preparation / Quiz/ Surprise Test / etc)

1. Laboratory exercise: Use ARM Cortex-M microcontroller/ Embedded processor/ IDE/ open source platform to give hands-on training on Embedded C- programming.
2. Introduction to IDE (like code blocks, vscode ,etc) and Programming Environment (Keil uVision / STM32CubeIDE / Proteus)
3. Configuring an I/O port using bitwise programming (GPIO programming in ARM Cortex-M)
4. Configuring timer for generating hardware delay (using ARM timers).
5. Flashing an LED using an interrupt (external interrupt / timer interrupt in ARM Cortex-M)
6. Serial communication using UART port of ARM Cortex-M
7. Interfacing an ADC with ARM Cortex-M
8. Interfacing an analog sensor with ARM Cortex-M
9. Interfacing 16x2 LCD and keypad interface with ARM Cortex-M
10. Configuring timer for generating PWM signal using ARM timers
11. Interfacing a stepper motor with ARM Cortex-M
12. Assignment: Introduction to Arduino IDE, Raspberry Pi
13. Embedded C-Programming -based Mini project.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the of the course students will be able to

CO1: Develop C programs using fundamental programming constructs, functions, and arrays. *(K3)*

CO2: Apply Embedded C concepts, hardware abstraction, and real-time programming techniques. *(K3)*

CO3: Develop ARM Cortex-M programs using GPIO, data manipulation, and memory access techniques. *(K3)*

CO4: Implement UART communication, timer configuration, and interrupt handling in ARM Cortex-M. *(K3)*

CO5: Interface ARM Cortex-M with ADC, DAC, sensors, LCD, and stepper motor peripherals. *(K3)*

CO6: Develop Embedded C applications using ARM Cortex-M, IDEs, and peripheral interfacing for real-time embedded systems. *(K4)*

TEXT BOOKS:

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

REFERENCES:

1. Noel Kalicharan, "Learn to Program with C", Apress Inc., 2015, 1st edition.
2. Steve Oualline, "Practical C programming", O'Reilly Media, 1997, 3rd edition.
3. Muhammad Ali Mazidi, Janice G. Mazidi and Rolin D. McKinlay, ‘The 8051 Microcontroller and Embedded Systems’ Prentice Hall, 2nd Edition 2007.
4. Myke Predko, “Programming and customizing the 8051 microcontrollers”, McGraww Hill 2000, 1st edition.

LIST OF OPEN SOURCE SOFTWARE/ LEARNING WEBSITES:

1. https://www.hackerrank.com/
2. https://www.cprogramming.com/
3. https://www.allaboutcircuits.com/technical-articles/introduction-to-the-c-programminglanguage-for-embedded-applications/
4. https://onlinecourses.nptel.ac.in/noc19_cs42/preview
5. https://microcontrollerslab.com/8051-microcontroller-tutorials-c/
6. https://www.circuitstoday.com/getting-started-with-keil-uvision

MAPPING OF COs WITH POs AND PSOs

CO	PO											PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	-	-	-	-	-	2	3	2	3
CO2	3	3	2	2	3	-	-	-	-	-	2	3	3	3
CO3	3	3	2	2	3	-	-	-	-	-	2	3	3	3
CO4	3	3	3	3	3	-	-	-	-	-	2	3	3	3
CO5	3	3	3	2	3	1	-	-	-	-	3	3	3	3
CO6	3	3	3	3	3	1	-	-	1	-	3	3	3	3
CO	**3.00**	**2.83**	**2.5**	**2.17**	**2.83**	**1**	-	-	1	-	**2.33**	**3.00**	**2.83**	**3.00**

PEE2433 EMBEDDED PROCESSORS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To introduce the architecture of the ARM processor.
- To train students in ARM programming.
- To discuss memory management, append location development with an ARM processor.
- To involve Discussions/ Practice/Exercise in revising & familiarizing the concepts
- To impart the knowledge on single board embedded processors.

UNIT I ARM ARCHITECTURE (7+2 SKILL) 9

Architecture – Memory Organization – addressing modes -Registers – Pipeline - Interrupts – Coprocessors – Interrupt Structure.

UNIT II ARM MICROCONTROLLER PROGRAMMING (7+2 SKILL) 9

ARM general Instruction set – Thumb instruction set –Introduction to DSP on ARM- basic programming.

UNIT III PERIPHERALS OF ARM (7+2 SKILL) 9

ARM: I/O Memory – EEPROM – I/O Ports – SRAM –Timer –UART - Serial Communication with PC – ADC/DAC Interfacing-stepper motor interfacing.

UNIT IV ARM COMMUNICATION (7+2 SKILL) 9

ARM With CAN (frame structure, initialization, transmission and reception), I^2C (addressing, initialization, master/slave data transfer, sensor/EEPROM interfacing) and SPI protocols (CPOL/CPHA, master/slave communication, full-duplex transfer).

UNIT V INTRODUCTION TO SINGLE BOARD EMBEDDED PROCESSOR

(7+2 SKILL) 9

Raspberry Pi Architecture - Booting Up RPi- Operating System and Linux Commands -Working with RPi using Python and Sensing Data using Python-programming - GPIO and interfacing peripherals With Raspberry Pi.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc)

1. Laboratory exercise:
    - Programming with IDE - ARM microcontroller

- Advanced Timer Features, PWM Generator.
- RTC interfacing with ARM using Serial communication programming, Stepper motor control.
- ARM-Based Wireless Environmental Parameter Monitoring System displayed through Mobile device.

2. Seminar:
   - ARM and GSM/GPS interfacing
   - Introduction to ARM Cortex Processor
3. Raspberry Pi based Mini project.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the of the course students will be able to

CO1: Explain the ARM architecture, memory organization, addressing modes, and interrupt structure. *(K2)*

CO2: Develop ARM assembly language programs using ARM and Thumb instruction sets. *(K3)*

CO3: Interface ARM processors with memory and peripheral devices for embedded applications. *(K3)*

CO4: Implement CAN, I²C, and SPI communication protocols using ARM microcontrollers. *(K3)*

CO5: Develop Raspberry Pi-based embedded applications using Python and GPIO interfacing. *(K3)*

CO6: Design embedded system applications using ARM processors, communication interfaces, and single-board embedded platforms. *(K4)*

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TEXT BOOKS:

1. Steve Furber, 'ARM system on chip architecture',Addisonn Wesley,2nd Edition,2015.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, John Rayfield's ARM System Developer's Guide Designing and Optimizing System Software', Elsevier 2004, 1st Edition.

REFERENCES:

1. William Hohl, 'ARMAssebly Language' Fundamentals and Techniques, CRC Press, 2nd Edition 2014.
2. Rajkamal, "Microcontrollers Architecture, Programming, Interfacing, & System Design, Pearson,2012, 2nd Edition.
3. ARM Architecture Reference Manual, LPC214x User Manual www.Nuvoton .com/websites on Advanced ARM Cortex Processors

4. ARM System Developer's Guide: Designing and Optimizing System Software 1st Edition (Designing and Optimizing System Software) Publisher: Morgan Kaufmann Publishers, 2011.

LIST OF OPEN SOURCE SOFTWARE/ LEARNING WEBSITES:

1. https://nptel.ac.in/courses/117106111
2. https://onlinecourses.nptel.ac.in/noc20_cs15/preview
3. https://www.csie.ntu.edu.tw/~cyy/courses/assembly/12fall/lectures/handouts/lec08_ARMarch.pdf
4. https://maxembedded.com/2013/07/introduction-to-single-board-computing/
5. https://www.youtube.com/watch?v=J4fhE4Pp55E&list=PLGs0VKk2DiYypuwUUM2wxzcI9BJHK4Bfh

MAPPING OF COs WITH POs AND PSOs

CO	PO											PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	2	-	-	-	-	-	2	3	2	3
CO2	3	3	2	2	3	-	-	-	-	-	2	3	3	3
CO3	3	3	2	2	3	-	-	-	-	-	2	3	3	3
CO4	3	3	3	3	3	-	-	-	-	-	2	3	3	3
CO5	3	3	3	2	3	1	-	-	-	-	3	3	3	3
CO6	3	3	3	3	3	1	-	-	1	-	3	3	3	3
CO	**3.00**	**2.83**	**2.5**	**2.17**	**2.83**	**1**	-	-	1	-	**2.33**	**3.00**	**2.83**	**3.00**

PEE2434 SMART SYSTEM AUTOMATION L T P C

2 0 2 3

COURSE OBJECTIVES:

- To introduce the smart system technologies and its role in real time applications
- To teach the architecture and requirements of Home Automation.
- To provide an insight into smart appliances and energy management concepts.
- To familiarize the design and needs of smart wearable devices
- To teach the basics of robotics and its role for automation.

UNIT I INTRODUCTION 6

Overview of a smart system - Hardware and software selection - Smart sensors and Actuators – Communication protocols (I2C , SPI, UART, Wi-Fi, Bluetooth, , Zigbee, MQTT, CoAP) used for smart systems.

UNIT II HOME AUTOMATION 6

Home Automation – System Architecture - Essential Components- Design Considerations: Control Unit, Sensing Requirements, Communication, Data Security.

UNIT III SMART APPLIANCES AND ENERGY MANAGEMENT 6

Significance of smart appliances for energy management -Smart Meters: Significance, Architecture & Energy Measurement Technique – Security Considerations.

UNIT IV SMART WEARABLE DEVICES 6

Body Area Networks - Sensors– communication protocol for Wearable devices (Bluetooth Low Energy, IEEE 802.15.6, NFC- Cloud & Mobile Integration- MQTT, HTTP - Application of Smart Wearable in Healthcare & Activity Monitoring.

UNIT V EMBEDDED SYSTEMS AND ROBOTICS 6

Fundamental concepts in Robotics- Robots and Controllers components - Embedded processor based: pick and place robot- Mobile Robot Design- UAV.

30 PERIODS

LAB COMPONENTS:

1. Laboratory exercise: Use Arduino/ R pi/ any other Embedded processors to give hands on training to understand concepts related to smart automation.

. Hands on experiments based on Ubidots & Thing speak / Open-source Analytics Platform

b. Design and implementation of a smart home system .

c. Bluetooth Based Home Automation Project using Android Phone

d. Design a wearable health monitoring device

e. Programming and interfacing of smart sensors and actuators using Arduino IDE/Python on Raspberry Pi

Assignment: Revolution of Smart Automation system across the world and its current scope available in India

Mini project: Design of a Smart Automation system (for any application of students choice)

TOTAL: 30+30 = 60 PERIODS

Suggested Activity or Skill Development Activities:

- Compare at least two protocols (MQTT vs HTTP, or Wi-Fi vs Bluetooth) for real-time data transmission between embedded board and cloud platform.
- Design a wearable health monitoring device using pulse sensor / temperature sensor / accelerometer with Bluetooth Low Energy (BLE) connectivity to mobile app for real-time activity and health tracking.
- Smart Sensor and Actuator Interfacing Interface various smart sensors (DHT22, PIR, Ultrasonic, Current Sensor) and actuators (Relay, Servo, Buzzer) with Arduino/Raspberry Pi using different communication protocols (I2C, SPI, UART).
- Mobile application development for controlling smart systems (using MIT App Inventor or Android Studio).

- Cloud integration and data visualization using ThingSpeak / Ubidots platforms.
- Embedded system design for low-power wearable and home automation applications.
- Basic robotics programming – forward/inverse kinematics, sensor-based control for mobile/pick-place robots.
- Design of secure IoT systems with focus on data security and energy efficiency.
- Technical documentation of projects including circuit diagrams, flowcharts, and performance analysis.

COURSE OUTCOMES:

Upon completion of the of the course students will be able to

CO1: Understand the concepts of smart system design and its present developments.

CO2: Illustrate different embedded open-source and cost-effective techniques for developing.

CO3: Acquire knowledge on different platforms and Infrastructure for Smart system design.

CO4: Infer about smart appliances and energy management concepts.

CO5: Improve Employability and entrepreneurship capacity due to knowledge upgradation on embedded system technologies.

CO6: Design and implement practical smart automation applications using embedded platforms and open-source cloud services for real-time data acquisition and control.

TEXT BOOKS:

1. Grimm, Christoph, Neumann, Peter, Mahlknech and Stefan, Embedded Systems for Smart Appliances and Energy Management, Springer 2013, 1st Edition.
2. KazemSohraby, Daniel Minoli and TaiebZnati, Wireless Sensor Networks Technology, Protocols, and Applications, John Wiley & Sons, 2007, 1st Edition.
3. NilanjanDey, Amartya Mukherjee, Embedded Systems and Robotics with Open-Source Tools, CRC press, 2016, 1st Edition.

REFERENCES:

1. Thomas Bräunl, Embedded Robotics, Springer, 2003.
2. Raj Kamal, Embedded Systems - Architecture, Programming and Design, McGraw- Hill, 2008
3. Karim Yaghmour, Embedded Android, O'Reilly, 2013.
4. Steven Goodwin, Smart Home Automation with Linux and Raspberry Pi, Apress , 2013
5. C.K. Toh, AdHoc mobile wireless networks, Prentice Hall, Inc, 2002.
6. Anna Ha´c, Wireless Sensor Network Designs, John Wiley & Sons Ltd, 2003.
7. J. J. Craig, “Introduction to Robotics Mechanics and Control”, Pearson Education.
8. Y. Koren, “Robotics for Engineers”, McGraw-Hill. 9. Robert Faludi, Wireless Sensor Networks, O’Reilly, 2011.

LIST OF OPEN SOURCE SOFTWARE/ LEARNING WEBSITE:

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

4. https://electrovolt.ir/wp-content/uploads/2018/03/ExploringRaspberryPiMolloyDerekElectroVolt.ir.pdf
5. http://www.robot.bmstu.ru/files/books/(Ebook%20-%20English)%20Mcgraw-Hil,%20Pic%20Ro
6. botics%20--%20A%20Beginner'S%20Guide%20To%20Robotic.pdf

MAPPING OF COs WITH POs AND PSOs

	CO-PO											CO-PSO		
CO No.	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PS01**	**PSO 2**	**PSO 3**
CO1	2	1	3	1	3	-	-	-	-	-	2	1	2	2
CO2	3	1	2	2	3	-	-	-	-	-	2	1	1	3
CO3	2	2	3	2	3	-	-	-	-	-	2	2	2	2
CO4	2	2	2	1	3	-	-	-	-	-	2	1	2	2
CO5	3	2	2	2	3	-	-	-	-	-	2	2	2	3
CO6	3	2	2	3	3	3	-	3	3	2	3	2	2	3
Avg	2.5	1.6	2.3	1.8	3	3	-	3	3	2	2.1	1.5	1.83	2.5

PEE2435 **BASICS OF VLSI DESIGN** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

- To introduce the fundamentals of MOSFET operation, characteristics, and modeling techniques. To develop the ability to design CMOS-based combinational logic circuits using appropriate design methodologies.
- To impart knowledge on sequential logic design and various clocking strategies in digital systems.
- To provide understanding of memory architectures and the role of interconnects in VLSI systems.
- To familiarize students with interconnect effects and implementation of logic using programmable devices such as ROM, PLA, and FPGA.
- To enable the design and optimization of arithmetic building blocks considering speed, area, and power trade-offs.

UNIT I MOS TRANSISTOR PRINCIPLES 9

MOS logic families (NMOS and CMOS), Ideal and Non Ideal IV Characteristics, CMOS devices. MOS(FET) Transistor DC transfer Characteristics ,small signal analysis of MOSFET.

UNIT II COMBINATIONAL LOGIC CIRCUITS 9

Propagation Delays, stick diagram, Layout diagrams, Examples of combinational logic design, Elmore's constant, Static Logic Gates, Dynamic Logic Gates, Pass Transistor Logic, Power Dissipation.

UNIT III SEQUENTIAL LOGIC CIRCUITS AND CLOCKING STRATEGIES 9

Static Latches and Registers, Dynamic Latches and Registers, Pipelines, Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design .

UNIT IV INTERCONNECT, MEMORY ARCHITECTURE 9

Interconnect Parameters – Capacitance, Resistance, and Inductance, Logic Implementation using Programmable Devices (ROM, PLA, FPGA), Memory Architecture and Building Blocks.

UNIT V DESIGN OF ARITHMETIC BUILDING BLOCKS 9

Arithmetic Building Blocks: Data Paths, Adders-Ripple Carry Adder, Carry-Bypass Adder, Carry Select Adder, Carry-Look Ahead Adder, Multipliers, Barrel Shifter, power and speed tradeoffs.

Suggested Activity or Skill Development Activities:

- Memory Organization Case Study
- Flip-Flop Design and Simulation
- Clock Distribution Analysis

COURSE OUTCOMES:

Upon completion of the of the course students will be able to

CO1: Understand the working principle and characteristics of MOSFET

CO2**:** Design Combinational Logic Circuits

CO3: Design Sequential Logic Circuits and Clocking systems

CO4: Understand Memory architecture and interconnects

CO5: Interpret interconnect effects (RC, inductance) and implement logic using programmable devices such as ROM, PLA, and FPGA.

CO6: Develop and optimize arithmetic building blocks (adders, multipliers, shifters) with respect to speed, area, and power trade-offs.

TEXTBOOKS

1. Jan D Rabaey, Anantha Chandrakasan, “Digital Integrated Circuits: A Design Perspective”, PHI, 2016.(Units II, III IV and V).
2. Neil H E Weste, Kamran Eshranghian, “Principles of CMOS VLSI Design: A System Perspective,” Addison Wesley, 2009.(Units - I).

REFERENCES:

1. D.A. Hodges and H.G. Jackson, Analysis and Design of Digital Integrated Circuits, International Student Edition, McGraw Hill 1983
2. P. Rashinkar, Paterson and L. Singh, "System-on-a-Chip Verification-Methodology and Techniques", Kluwer Academic Publishers,2001
3. Samiha Mourad and Yervant Zorian, “Principles of Testing Electronic Systems”, Wiley 2000
4. M. Bushnell and V. D. Agarwal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers,2000

TOTAL: 45 PERIODS

MAPPING OF COs WITH POs AND PSOs

CO	**PO1**											**PSO**		
	PO 1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**POS1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	-	-	-	-	-	1	3	1	-
CO2	3	2	3	1	2	-	-	-	-	-	1	3	2	1

CO3	3	2	3	2	2	-	-	-	1	-	1	3	2	1
CO4	3	2	2	1	2	-	-	-	-	-	1	3	2	1
CO5	3	3	2	2	3	-	-	-	-	-	1	3	3	2
CO6	3	3	3	2	2	-	-	-	1	-	2	3	2	3
AVG	3	2.3	2.6	1.6	2.2	-	-	-	-	-	1.16	3	2	1.6

PEE2436 DIGITAL SIGNAL PROCESSING TECHNIQUES L T P C

3 0 0 3

COURSE OBJECTIVES:

- To introduce the concept of analyzing discrete time signals & systems in the time and frequency domain through mathematical representation.
- To develop understanding of Z-transform, convolution, and discrete-time system analysis.
- To study the various time to frequency domain transformation techniques.
- To Understand the computation algorithmic steps for Fourier Transform.
- To study about filters and their design for digital implementation.
- To introduce the programmable digital signal processor & its application.

UNIT I INTRODUCTION (7+2 SKILL) 9

Classification of systems: Continuous, discrete, linear, causal, stable, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; spectral density; sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect. Digital signal representation.

UNIT II DISCRETE TIME SYSTEM ANALYSIS (7+2 SKILL) 9

Z-transform and its properties, inverse z-transforms; difference equation – Solution by z-transform, application to discrete systems - Stability analysis, frequency response – Convolution – Introduction to Fourier Transform– Discrete time Fourier transform.

UNIT III DISCRETE FOURIER TRANSFORM & COMPUTATION (7+2 SKILL) 9

DFT properties, magnitude and phase representation - Computation of DFT using FFT algorithm – DIT & DIF - FFT using radix 2 – Butterfly structure.

UNIT IV DESIGN OF DIGITAL FILTERS (7+2 SKILL) 9

FIR & IIR filter realization – Parallel & cascade forms. FIR design: Windowing Techniques – Need and choice of windows – Linear phase characteristics. IIR design: Analog filter design - Butterworth and Chebyshev approximations; digital design using impulse invariant and bilinear transformation - Warping, prewarping -Frequency transformation.

UNIT V DIGITAL SIGNAL PROCESSORS (7+2 SKILL) 9

Introduction – Architecture of one DSP processor for motor control – Features – Addressing Formats– Functional modes - Introduction to Commercial Processors.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc)

1. Laboratory exercise : Use any DSP processor/MATLAB/open source platform to give hands on training on basic concepts of Digital Signal Processing

. To determine impulse and step response of two vectors

. To perform convolution between two vectors .

. To compute DFT and IDFT of a given sequence.

. To perform linear convolution of two sequence using DFT

. Design and Implementation of FIR Filter

. Design and Implementation of IIR Filter

. To determine z-transform from the given transfer function and its ROC

0. Assignment : Implementation of FIR/IIR filter with FPGA.

0. DSP processors based Mini project.

TOTAL:45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, students should be able to:

CO1: Classify signals and systems and represent them mathematically in continuous and discrete domains.

CO2: Apply sampling theorem and analyze the effects of quantization, aliasing, and signal representation.

CO3: Analyze discrete-time systems using Z-transform, convolution, and difference equations.

CO4: Perform frequency domain analysis using DFT and FFT algorithms.

CO5: Design and implement FIR and IIR digital filters using appropriate techniques.

CO6: Explain the architecture and operation of DSP processors and apply them to real-world applications.

TEXT BOOKS:

1. J.G. Proakis and D.G. Manolakis, 'Digital Signal Processing Principles, Algorithms and Applications', Pearson Education, New Delhi, 4th Edition 2007.
2. Robert J.Schilling & Sandra L.Harris ,' Introduction to Digital Signal Processing using MATLAB', Cengage Learning, 2nd Edition 2013.

REFERENCES:

1. Emmanuel C Ifeachor and Barrie W Jervis ,"Digital Signal Processing – A Practical approach" Pearson Education, Second edition, 2002.
2. Alan V. Oppenheim, Ronald W. Schafer and John R. Buck, 'Discrete – Time Signal Processing', Pearson Education, New Delhi, 2nd Edition 2012.
3. SenM.kuo, Woonseng…s.gan, "Digital Signal Processors, Architecture, Implementations & Applications, Pearson, 1st Edition 2004.
4. S.K. Mitra, 'Digital Signal Processing – A Computer Based Approach', Tata McGraw Hill, New Delhi, 4th Edition 2013.
5. B. Venkataramani, M. Bhaskar, 'Digital Signal Processors, Architecture, Programming and Applications', Tata McGraw Hill, New Delhi, 2003, 1st Edition.

MAPPING OF COs WITH POs AND PSOs

CO	PO1											PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	POS1	PSO2	PSO3
CO1	3	2	-	-	1	-	-	-	-	-	-	2	1	-
CO2	3	3	-	1	2	-	-	-	-	-	-	2	2	-
CO3	3	3	2	2	2	-	-	-	-	-	-	3	2	1
CO4	3	3	2	2	3	-	-	-	-	-	-	3	3	2
CO5	3	3	3	2	3	-	-	-	1	-	-	3	3	2
CO6	2	2	2	1	3	-	-	-	1	1	1	2	3	3
AVG	2.83	2.67	2.25	1.60	2.33	-	-	-	1.00	1.00	1.00	2.50	2.33	2.00

PEE2437 EMBEDDED SYSTEM FOR AUTOMOTIVE APPLICATIONS

L T P C

3 0 0 3

COURSE OBJECTIVES:

- To expose the students to the fundamentals and building of Electronic Engine Control systems.
- To teach on sensor functional components for vehicles.
- To discuss programmable controllers for vehicles management systems.
- To teach logics of automation & communication techniques for vehicle communication.
- To introduce the infotainment system development.

UNIT I INTRODUCTION TO AUTOMOTIVE SYSTEMS (7+2 SKILL) 9

Overview of Automotive systems, fuel economy, air-fuel ratio, emission limits and vehicle performance; Vehicle Control Unit – Electronic control Unit– open-source ECU - Controllers used in EV

UNIT II SENSORS AND ACTUATORS FOR AUTOMOTIVES (7+2 SKILL) 9

Review of automotive sensors- sensors interface to the ECU, Smart sensor and actuators for automotive applications.

UNIT III VEHICLE MANAGEMENT SYSTEMS (7+2 SKILL) 9

Energy Management system -Adaptive cruise control -Lane Departure Warning (LDW) and Lane Keep Assist (LKA)- Automatic Emergency Braking-Blind Spot Detection (BSD) and Rear Cross Traffic Alert-Traffic Sign Recognition-Driver Monitoring Systems-Gesture Control and Voice Recognition - anti-locking braking system - Safety and Collision Avoidance.

UNIT IV ONBOARD DIAGONSTICS AND COMMUNICATION (7+2 SKILL) 9

OBD , Vehicle communication protocols- Bluetooth, CAN, LIN, FLEXRAY, ETHERNET and MOST.

UNIT V RECENT TRENDS (7+2 SKILL) 9

Role of IoT in Automotive systems - Navigation- Autonomous car- Drive by wire - LiDAR, camera, computing unit, navigation system- path planning, path following, Vector map building- obstacle avoidance- traffic lights recognition- open CAN interface - IoT in Electric vehicle.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc)

1. Laboratory exercise:Use MATLAB SIMULINK /equivalent simulation /open source tools
    - Simulation study of automotive sensors and actuators components.
    - Adaptive cruise control, Anti-Lock Braking System.
    - CAN Connectivity in an Automotive Application using vehicle network toolbox.
    - Interfacing a sensor used in a car with a microcontroller.
    - Establishing connection between Bluetooth module and microcontroller.
2. Assignment: AUTOSAR

3. Mini project : Battery Management system for EV batteries

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the of the course students will be able to
CO1: Explain automotive electronic systems, ECUs, and controllers used in conventional and electric vehicles. *(K2)*
CO2: Analyze the operation of automotive sensors, actuators, and their interfacing with electronic control units. *(K3)*
CO3: Analyze vehicle management and advanced driver assistance systems for safe and efficient vehicle operation. *(K4)*
CO4: Apply onboard diagnostics and automotive communication protocols for vehicle networking applications. *(K3)*
CO5: Analyze emerging automotive technologies, including autonomous vehicles and IoT-enabled transportation systems. *(K4)*
CO6: Develop automotive system solutions using simulation tools, embedded controllers, and vehicle communication technologies. *(K4)*

TEXT BOOKS:

1. William B. Ribbens ,"Understanding Automotive Electronics", Elseiver,8th Edition, 2017.
2. Jurgen, R., Automotive Electronics Hand Book, McGraw Hill, 2nd Edition, 1999.
3. L.Vlacic,M.Parent,F.Harahima,"Intelligent Vehicle Technologies",SAE International, 2001, 1st Edition, 2017.

REFERENCES:

1. Ali Emedi, Mehrdedehsani, John M Miller , "Vehicular Electric power system- land, Sea, Air and Space Vehicles" Marcel Decker, 2004, 1st Edition.
2. Jack Erjavec,JeffArias,"Alternate Fuel Technology-Electric ,Hybrid& Fuel Cell Vehicles",Cengage ,2012, 2nd Edition.
3. Electronic Engine Control technology – Ronald K Jurgen Chilton's guide to Fuel Injection – Ford 2nd Edition, 2004.
4. Automotive Electricals / Electronics System and Components, Tom Denton, 5th Edition, 2017.
5. Uwe Kiencke, Lars Nielsen, "Automotive Control Systems: For Engine, Driveline, and Vehicle", Springer; 1st Edition, 2005.
6. Automotive Electricals Electronics System and Components, Robert Bosch Gmbh, 5th Edition 2014.
7. Automotive Hand Book, Robert Bosch, Bently Publishers, 10th Edition, 2018.

LIST OF OPEN SOURCE SOFTWARE/ LEARNING WEBSITE:

1. https://www.autosar.org/fileadmin/ABOUT/AUTOSAR_EXP_Introduction.pdf
2. https://microcontrollerslab.com/can-communication-protocol/
3. https://ackodrive.com/car-guide/different-types-of-car-sensors/
4. https://www.tomtom.com/blog/automated-driving/what-is-adaptive-cruise-control/

5. https://prodigytechno.com/difference-between-lin-can-and-flexray-protocols/
6. https://www.synopsys.com/automotive/what-is-autonomous-car.html

MAPPING OF COs WITH POs AND PSOs

CO	PO1											PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	1	-	-	-	-	2	3	2	3
CO2	3	3	2	2	3	1	-	-	-	-	2	3	3	3
CO3	3	3	3	3	3	2	1	-	-	-	2	3	3	3
CO4	3	3	2	3	3	1	-	-	-	-	2	3	3	3
CO5	3	3	3	3	3	2	1	-	-	-	3	3	3	3
CO6	3	3	3	3	3	2	1	1	1	-	3	3	3	3
AVG	3.00	2.83	2.5	2.5	2.83	1.5	1.00	1.00	1.00	-	2.33	3.00	2.83	3.00

VERTICAL IV - DIVERSIFIED COURSES

PEE2441 DRONE TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To introduce the basics of drone concepts
- To learn and understand the fundamentals of design, fabrication and assembly of drones
- To develop understanding of programming methods and control mechanisms used in drone operation.
- To impart the knowledge on flying,flight modes and operational techniques of drone
- To know about the various commercial applications of drone
- To introduce the safety regulations, risks and guidelines of fly safely technology including autonomy and swarm systems.

UNIT I INTRODUCTION TO DRONE TECHNOLOGY 9

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

UNIT II DRONE DESIGN, FABRICATION AND PROGRAMMING 9

Classifications of the UAV - Overview of the main drone parts- Technical characteristics of the parts - Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

UNIT III DRONE FLYING AND OPERATION 9

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity -Removable storage devices- Linked mobile devices and applications

UNIT IV DRONE COMMERCIAL APPLICATIONS 9

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

UNIT V FUTURE DRONES AND SAFETY 9

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

TOTAL: 45 PERIODS

Suggested Activity or Skill Development Activity:

- Prepare a timeline chart showing the evolution of drone technology and major milestones.
- Group seminar on various types of drones (Fixed-wing, Multirotor, Hybrid, Nano drones).
- Drone terminology quiz and component identification exercise.
- Case study analysis on drones in agriculture, surveying, logistics, disaster management, and infrastructure inspection.
- Study and present drone regulations issued by the Directorate General of Civil Aviation (DGCA).
- Seminar on drone swarms, delivery drones, and urban air mobility.

COURSE OUTCOMES:

Upon successful completion of the course, students should be able to:

CO1: Explain the fundamental concepts, history, types, and terminology of drone technology.
CO2: Describe the components, design aspects, fabrication, and programming of drones.
CO3: Demonstrate the operation and control of drones in a controlled environment.
CO4: Analyze various commercial applications of drones across different sectors.
CO5: Identify safety risks, regulations, and guidelines for safe drone operation.
CO6: Evaluate emerging trends such as drone autonomy, miniaturization, and swarm technology.

TEXT BOOKS :

1. Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, 2021 John Wiley & Sons, Inc.

2. Terry Kilby and Belinda Kilby, “Make:Getting Started with Drones “,Maker Media, Inc, 2016

REFERENCES :

1. John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016
2. Zavrsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018

MAPPING OF COs WITH POs AND PSOs

CO	PO1											PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	POS1	PSO2	PSO3
CO1	2	1	-	-	1	-	-	-	-	-	-	1	2	2
CO2	3	2	3	1	3	-	-	-	1	-	-	3	3	2
CO3	3	3	3	2	3	-	-	-	2	1	-	3	3	2
CO4	2	3	2	2	2	1	1	-	-	-	-	2	2	3
CO5	2	2	1	1	1	2	2	3	-	-	-	2	1	3
CO6	2	2	2	1	2	1	2	-	1	1	1	2	2	3
AVG	2.33	2.17	2.20	1.40	2.00	1.33	1.67	3.00	1.33	1.00	1.00	2.17	2.17	2.50

PEE2442 BIOMEDICAL INSTRUMENTATION & WEARABLES L T P C

3 0 0 3

COURSE OBJECTIVES:

- To introduce physiological systems and biomedical instrumentation.
- To study measurement and analysis of bioelectric and non-electrical signals.
- To explain wearable devices, sensors, and communication systems.
- To explore applications of wearable technologies in healthcare.

UNIT I PHYSIOLOGY AND BIOMEDICAL INSTRUMENTATION 9

Cell structure and function; resting and action potential; cardiovascular and respiratory systems; bioelectric signals – ECG, EEG, EMG; biomedical transducers and electrodes; selection criteria; instrumentation for physiological signal measurement.

UNIT II BIOPOTENTIAL MEASUREMENT AND DIAGNOSTIC SYSTEMS 9

Biopotential amplifiers – instrumentation and isolation amplifiers; ECG, EEG, EMG measurement systems; blood pressure measurement (direct and indirect); blood flow and respiratory measurements; patient monitoring systems; noise and artifacts in biomedical signals.

UNIT III WEARABLE SYSTEMS AND SENSORS 9

Introduction to wearable systems; need and applications; limitations of conventional monitoring; components of wearable devices; sensors for wearables – motion sensors, respiration sensors, impedance plethysmography, wearable force sensors; wearability issues and sensor placement.

UNIT IV WIRELESS HEALTH SYSTEMS AND SMART TEXTILES 9

Body Area Networks (BAN) – architecture and healthcare applications; wireless communication techniques; system security and reliability;

smart textiles – passive and active textiles; fabrication techniques – conductive fibres, fabrics, inks; smart fabrics for ECG and respiration monitoring.

UNIT V ENERGY MANAGEMENT AND APPLICATIONS OF WEARABLES 9

Energy requirements in wearable devices; energy harvesting techniques – solar, vibration, thermal, hybrid systems; power management; applications – medical diagnostics, chronic patient monitoring, elderly care, gait analysis, sports medicine; introduction to remote healthcare systems.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc)

- Market Survey of Wearable Devices
- Tinkercad simulation of sensor-based healthcare systems.
- Blynk IoT platform for remote health monitoring.
- ThingSpeak cloud platform for healthcare data visualization.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, students should be able to:

CO1: Explain physiological systems and biomedical instrumentation used for signal measurement.

CO2: Analyze biopotential measurement techniques and diagnostic systems.

CO3: Describe wearable systems and select appropriate sensors for healthcare applications.

CO4: Apply wireless communication and smart textile technologies in wearable healthcare systems.

CO5: Evaluate energy management techniques and applications of wearable medical devices.

CO6: Integrate biomedical sensors, wearable devices, and wireless technologies for smart healthcare applications.

TEXT BOOKS:

1. Leslie Cromwell, Biomedical Instrumentation and Measurements, PHI.
2. R.S. Khandpur, Handbook of Biomedical Instrumentation, McGraw Hill.
3. Edward Sazonov and Michael R. Neuman, Wearable Sensors: Fundamentals, Implementation and Applications, Elsevier, 2014.

4. Mehmet R. Yuce and Jamil Y. Khan, Wireless Body Area Networks, Pan Stanford Publishing, 2012.

REFERENCES:

1. Annalisa Bonfiglio and Danilo De Rossi, Wearable Monitoring Systems, Springer, 2011.
2. Guang-Zhong Yang, Body Sensor Networks, Springer, 2006.
3. Sandeep K.S. Gupta et al., Body Area Networks: Safety, Security, and Sustainability, Cambridge University Press, 2013.

MAPPING OF COs WITH POs AND PSOs

CO	PO1											PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	POS1	PSO2	PSO3
CO1	3	2	2	1	2	1	-	-	-	-	2	2	3	2
CO2	3	3	2	3	3	1	-	-	-	-	2	2	3	3
CO3	3	3	2	3	3	1	-	-	-	-	2	2	3	3
CO4	3	3	3	2	3	2	1	-	-	-	2	2	3	3
CO5	3	3	3	2	3	2	1	-	-	-	3	2	3	3
CO6	3	3	3	3	3	2	1	1	1	-	3	3	3	3
AVG	3.00	2.83	2.5	2.33	2.83	1.5	1	1	1	-	2.33	2.16	3.00	2.83

PEE2443 ROBOTICS & AUTONOMOUS SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To introduce the fundamentals of robotics and autonomous systems.
- To study robot kinematics, drive systems, and sensors.
- To explain perception, localization, and navigation in autonomous robots.
- To explore robot programming, control, and real-world applications.

UNIT I INTRODUCTION TO ROBOTICS AND AUTONOMOUS SYSTEMS 9

Overview of robotics and automation; robot anatomy; classification and generations of robots; degrees of freedom; work envelope; specifications (payload, speed, accuracy); principles of automation; embedded systems in robotics; introduction to autonomous systems; applications in industry, healthcare, and service sectors.

UNIT II ROBOT KINEMATICS AND DRIVE SYSTEMS 9

Forward and inverse kinematics of manipulators; homogeneous transformation matrices; robot dynamics (basic concepts); drive systems – electrical, hydraulic, pneumatic drives; DC servo, AC servo and stepper motors; selection of actuators; variable speed control; transmission systems.

UNIT III SENSORS, PERCEPTION AND MACHINE VISION 9

Sensors in robotics – position, proximity, tactile, force, vision sensors; MEMS and smart sensors; perception in robotics; signal acquisition and processing; machine vision system – image acquisition, processing, feature extraction, object recognition; sensor integration for autonomous systems.

UNIT IV LOCALIZATION, PATH PLANNING AND NAVIGATION 9

Kinematic constraints of mobile robots; wheeled and legged robot models; localization techniques – GPS, beacon-based, landmark-based; mapping and SLAM; path planning algorithms; obstacle avoidance; navigation architectures; trajectory planning and control.

UNIT V ROBOT PROGRAMMING AND AUTONOMOUS APPLICATIONS 9

Robot programming methods – teach pendant, lead-through programming; robot programming languages; Robot Operating System (ROS); human-robot interaction; collaborative robots; swarm robotics; applications – industrial automation, healthcare robots, autonomous vehicles, drones, and service robots.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc)

- Sensor Selection Exercise
- Autonomous Navigation Case Study
- Arduino IDE for robot control programming.

COURSE OUTCOMES:

Upon successful completion of the course, students should be able to:

CO1: Explain the fundamentals of robotics, automation, and autonomous systems. *(K2)*

CO2: Analyze robot kinematics, drive systems, and actuator selection for robotic applications. *(K4)*

CO3: Apply robotic sensors, perception, and machine vision techniques for autonomous systems. *(K3)*

CO4: Analyze localization, path planning, and navigation algorithms for autonomous robots. *(K4)*

CO5: Develop robot programs using modern robotic software frameworks for industrial and autonomous applications. *(K3)*

CO6: Design intelligent robotic systems by integrating robot kinematics, sensing, navigation, and programming techniques. *(K4)*

TEXT BOOKS:

1. John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson, 2017.

2. Mark W. Spong, Seth Hutchinson, M. Vidyasagar, Robot Modeling and Control, Wiley, 2020.
3. Roland Siegwart and Illah R. Nourbakhsh, Introduction to Autonomous Mobile Robots, MIT Press, 2004.
4. Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill 2005.

REFERENCES:

1. Mikell P. Groover, Industrial Robotics: Technology, Programming and Applications, McGraw Hill, 2nd edition, 2012.
2. Fu K.S., Gonzalez R.C., Lee C.S.G., Robotics: Control, Sensing, Vision and Intelligence, McGraw Hill book co. 2007.
3. Yoram Koren, Robotics for Engineers, McGraw Hill Book, Co., 2002
4. Jazar, Theory of Applied Robotics, Springer, 2010.

CO	PO1											PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	POS1	PSO2	PSO3
CO1	3	2	2	1	2	1	-	-	-	-	2	3	2	3
CO2	3	3	3	2	3	-	-	-	-	-	2	3	3	3
CO3	3	3	3	3	3	1	-	-	-	-	2	3	3	3
CO4	3	3	3	3	3	1	-	-	-	-	2	3	3	3
CO5	3	3	3	2	3	1	1	1	1	-	3	3	3	3
CO6	3	3	3	3	3	2	1	1	1	-	3	3	3	3
AVG	3.00	2.83	2.83	2.33	2.83	1.2	1	1	1	-	2.33	3.00	2.83	3.00

PEE2444 AI/ML & CYBERSECURITY IN ELECTRICAL SYSTEMS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To introduce AI, Machine Learning, and their applications in electrical and power systems.
- To provide knowledge on ML techniques such as regression, classification, clustering, and data preprocessing.
- To familiarize students with AI and ML applications in load forecasting, fault detection, and smart grids.
- To develop understanding of cybersecurity concepts, threats, and protection methods in power systems.
- To enable students to analyze the role of AI in cybersecurity and secure electrical system operation.

UNIT I INTRODUCTION TO AI IN ELECTRICAL SYSTEMS 9

Basics of Artificial Intelligence and Machine Learning; types of learning – supervised and unsupervised; role of AI in electrical engineering; data in power systems; simple problem-solving using search techniques; applications – load forecasting, fault detection, smart grid overview.

UNIT II MACHINE LEARNING FOR ELECTRICAL APPLICATIONS 9

Basic concepts of ML; regression – linear regression for load prediction; classification – KNN and decision tree; performance evaluation; simple case studies – electrical load forecasting, fault classification in power systems.

UNIT III DATA ANALYSIS AND CLUSTERING 9

Introduction to data preprocessing; feature selection; clustering basics – K-means; interpretation of clusters; applications – consumer load profiling, fault grouping, energy consumption analysis; introduction to dimensionality reduction (concept only).

UNIT IV INTRODUCTION TO CYBERSECURITY IN ELECTRICAL SYSTEMS 9

Basics of cybersecurity; need for security in power systems; common threats – malware, data attacks, false data injection; cybersecurity in smart grids; vulnerabilities in SCADA systems; basic protection methods – authentication, encryption, firewalls.

UNIT V AI FOR CYBERSECURITY AND SMART GRID APPLICATIONS 9

Role of AI in cybersecurity; anomaly detection using ML; intrusion detection basics; secure smart grid architecture; case studies – attack detection in power systems, smart meter security, renewable energy system protection; future trends.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / etc)

- Develop a simple load forecasting model using historical electrical data (using basic regression).
- Analyze and classify fault types in power systems using a simple decision tree or KNN approach.
- Perform consumer load profiling using clustering techniques (K-means) on sample datasets.
- Conduct a case study on cybersecurity attacks in smart grids and present mitigation strategies.
- Design a basic block diagram of a secure SCADA system with cybersecurity features.

- Simulate a simple anomaly detection system for identifying abnormal power consumption patterns.

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1: Explain AI, Machine Learning, learning types, and their applications in electrical systems.

CO2: Apply ML techniques such as regression, classification, and performance evaluation for electrical applications.

CO3: Analyze data preprocessing, feature selection, and clustering for load profiling and fault analysis.

CO4: Describe cybersecurity concepts, threats, vulnerabilities, and protection methods in power systems and smart grids.

CO5: Identify AI applications in cybersecurity such as anomaly detection and intrusion detection.

CO6: Apply AI and cybersecurity solutions for reliable and secure electrical system operation.

TEXT BOOKS

1. Stuart J. Russell & Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson.
2. Tom Mitchell, Machine Learning, McGraw-Hill.

REFERENCES

1. Christopher Bishop, Pattern Recognition and Machine Learning, Springer.
2. G. Andersson, Modelling and Analysis of Electric Power Systems, ETH Zurich.
3. Eric D. Knapp & Joel Langill, Industrial Network Security, Syngress.

MAPPING OF COs WITH POs AND PSOs

CO	PO1											PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	POS1	PSO2	PSO3
CO1	3	2	1	–	2	1	–	–	–	–	1	2	1	2
CO2	3	3	2	2	3	1	–	–	–	–	1	2	3	2
CO3	3	3	2	2	3	1	–	–	1	–	1	2	3	2
CO4	3	2	1	1	2	2	1	–	1	–	1	2	2	2
CO5	3	3	2	2	3	2	1	1	1	–	2	2	3	3
CO6	3	3	3	2	3	3	1	1	1	1	2	3	3	3

AVG	3	2.67	1.83	1.8	2.67	1.67	1	1	1	1	1.33	2.17	2.5	2.33

PEE2445 ELECTRICAL MACHINES FOR SPECIAL APPLICATIONS

L T P C

3 0 0 3

COURSE OBJECTIVES

- To understand the working of special machines like stepper motor, switched reluctance motor, BLDC motor & PMSM
- To derive torque equation and study the characteristics of special machines
- To design the controller for special machines
- To explain the working principle of synchronous reluctance motor
- To simulate closed loop operation of BLDC motor

UNIT I STEPPER MOTORS 9

Constructional features –Principle of operation –Types – Torque predictions – Linear and Non-linear analysis – Characteristics – Drive circuits – Closed loop control –Applications.

UNIT II SWITCHED RELUCTANCE MOTOR 9

Constructional features –Principle of operation- Torque prediction–Characteristics-Power controllers – Control of SRM drive- Speed control-current control-design procedures- Sensor less operation of SRM – Current sensing-rotor position measurement and estimation methods- sensor less rotor position estimation-inductance based estimation –applications.

UNIT III PERMANENT MAGNET BRUSHLESS DC MOTORS 9

Fundamentals of Permanent Magnets- Types- Principle of operation- Magnetic circuit analysis EMF and Torque equations- Characteristics- Controller design-Transfer function –Machine, Load and Inverter-Current and Speed Controller.

UNIT IV PERMANENT MAGNET SYNCHROUNOUS MOTORS 9

Permanent Magnet ac Machines, Machine Configurations, PMSM - Principle of operation – EMF and Torque equations - Phasor diagram - Torque speed characteristics –evaluation of control characteristics-design of current and speed controllers- Constructional features, operating principle and characteristics of synchronous reluctance motor.

UNIT V STUDY OF OTHER SPECIAL ELECTRICAL MACHINES 9

Principle of operation and characteristics of Hysteresis motor – AC series motors – Linear motor – Axial flux machines – PCB stators – EESM – Slot less machines – Applications.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / etc)

MATLAB/ Python based scripts for EM modelling/ Electromagnetic software: https://www.simscale.com/

- Simulation of BLDC motor
- Simulation of SRM motor
- Simulation of stepper motor
- Simulation of PMSM motor
- Simulation of any other special machines

Course Outcomes

Upon successful completion of the course, the students will be able to:

CO1: Explain the construction, operating principles, characteristics, and control of stepper motors. *(K2)*

CO2: Analyze the performance and control of switched reluctance motor drives. *(K4)*

CO3: Analyze the operation and controller design of permanent magnet brushless DC motors. *(K4)*

CO4: Analyze the characteristics and control of permanent magnet synchronous motors and synchronous reluctance motors. *(K4)*

CO5: Explain the operating principles and applications of special electrical machines. *(K2)*

CO6: Select appropriate special electrical machines and control techniques for industrial and electric drive applications. *(K4)*

REFERENCES:

1. Jacek F. Gieras, Dr. Rong-Jie Wang, Professor Maarten J. Kamper - Axial Flux Permanent Magnet Brushless Machines-Springer Netherlands 2008.
2. Bilgin, Berker Emadi, Ali Jiang, James Weisheng - Switched reluctance motor drives: fundamentals to applications-CRC 2019.
3. Ramu Krishnan - Permanent Magnet Synchronous and Brushless DC Motor Drives -CRC Press, Marcel Applications -CRC Press 2009
4. T.J.E. Miller, ‘Brushless magnet and Reluctance motor drives’, Clarendon press, London, 1989
5. R. Krishnan - Switched Reluctance Motor Drives Modeling, Simulation, Analysis, Design, and Applications -CRC Press 2017.

6. T.Kenjo, ‘ Stepping motors and their microprocessor controls’, Oxford University press, New Delhi, 2000 Dekker 2009

MAPPING OF COs WITH POs AND PSOs

CO	PO1											PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	POS1	PSO2	PSO3
CO1	3	2	2	1	2	1	-	-	-	-	2	3	3	2
CO2	3	3	3	2	3	1	-	-	-	-	2	3	3	3
CO3	3	3	3	3	3	1	-	-	-	-	2	3	3	3
CO4	3	3	3	3	3	2	-	-	-	-	2	3	3	3
CO5	3	2	2	1	2	2	1	-	-	-	2	3	2	3
CO6	3	3	3	2	3	3	1	-	-	-	3	3	3	3
AVG	3,00	2.67	2.67	2.00	2.67	1.67	1	-	-	-	2.16	3.00	2.83	2.83

PEE2446 ENERGY MANAGEMENT AND AUDITING L T P C
3 0 0 3

COURSE OBJECTIVES

- To introduce energy management, energy conservation, and energy auditing principles.
- To provide knowledge on material and energy balance, energy planning, and financial analysis.
- To familiarize students with energy efficiency improvement in thermal utilities.
- To explore of energy conservation opportunities in auxiliary and electrical utilities.
- To enable students to analyze energy systems and recommend suitable energy-saving measures.

UNIT I GENERAL ASPECTS OF ENERGY MANAGEMENT AND ENERGY AUDIT (7+2 SKILL) 9

Energy scenario – importance of energy conservation – Energy Conservation Act 2001 and amendments – energy pricing and tariff basics – need and types of energy audit – energy management approach – energy audit instruments – maximizing system efficiency and optimizing energy use.

UNIT II MATERIAL, ENERGY BALANCE AND FINANCIAL ANALYSIS (7+2 SKILL) 9

Process flow diagram – material and energy balance concepts – energy policy and planning – role of energy manager – financial analysis techniques: simple payback period, return on investment, net present value, internal rate of return.

UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES

(7+2 SKILL) 9

Boilers: performance evaluation and losses – steam system: steam losses, steam trapping and condensate recovery – furnaces: energy conservation measures – waste heat recovery – cogeneration systems.

UNIT IV ENERGY EFFICIENCY IN COMPRESSED AIR SYSTEM

(7+2 SKILL) 9

Compressed air systems – refrigeration and air conditioning systems – cooling towers – diesel generating systems – performance assessment and energy saving opportunities.

UNIT V ENERGY EFFICIENCY IN ELECTRICAL UTILITIES

(7+2 SKILL) 9

Electrical load management – power factor improvement and APFC – transformer losses – energy efficient motors – variable speed drives – pumps, fans and blowers – energy efficient lighting systems and controls.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)

1. Study of Energy Conservation and Energy Audit Using Energy Audit Instruments.
2. Performance Analysis of Electric Motor and Energy Efficient Motor (EEM)
3. Performance Analysis of fan characteristic curves at different operating points
4. Case study of illumination system 5. Performance Analysis of Compressors

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1:Explain energy management, energy conservation, energy auditing, tariff basics, and the Energy Conservation Act.

CO2:Apply material and energy balance, energy planning, and financial analysis techniques.

CO3:Analyze thermal utilities such as boilers, steam systems, furnaces, cogeneration, and waste heat recovery.

CO4:Examine auxiliary utilities including compressed air systems, refrigeration, cooling towers, and diesel generators.

CO5:Evaluate electrical utilities such as motors, transformers, APFC, VFDs, pumps, fans, blowers, and lighting systems.

CO6:Assess industrial energy systems and recommend suitable energy conservation solutions.

TEXT BOOKS:

1. Mehmet Kanoglu, Yunus A Cengel, "Energy Efficiency and Management for Engineers", McGraw-Hill Education, First Edition, 2020.
2. "Energy Efficiency in Electrical Utilities", Third Edition, Bureau of Energy Efficiency (BEE), India, 2010

REFERENCES:

1. Moncef Krati, 'Energy Audit of Building Systems: An Engineering Approach', Third Edition, CRC Press, Dec.2020.
2. Sonal Desai, 'Handbook of Energy Audit', McGraw Hill Education (India) Private Limited, 2015.
3. Michael P.Deru, Jim Kelsey, 'Procedures for Commercial Building Energy Audits', American Society of Heating, Refrigerating and Air conditioning Engineers, 2011.
4. Thomas D.Eastop, 'Energy Efficiency: For Engineers and Technologists', Longman Scientific & Technical, 1990, 1st Edition.
5. Daniel Martinez, Ben W. Ebenhack, Travis Wagner, "Energy Efficiency Concepts and Calculations", First Edition, Elsevier Science, 2019
6. Al Thumann, William J.Younger, Terry Niehus, "Handbook of Energy Audits", 8th Edition,The Fairmont Press, Inc., 2010.

LIST OF OPEN SOURCE SOFTWARE/ LEARNING WEBSITE:

1. https://facilio.com/blog/commercial-energy-audit
2. https://www.sciencedirect.com/science/article/pii/S2212827114004491
3. https://mppolytechnic.ac.in/mpstaff/notes_upload_photo/CS595EnergyEfficiencyinElectricalUtilities-5391.pdf
4. http://knowledgeplatform.in/wp-content/uploads/2017/03/1.3-Energy-management-Audit.pdf

MAPPING OF COs WITH POs AND PSOs

	CO-PO											**CO-PSO**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PS01**	**PSO 2**	**PSO 3**
CO 1	3	2	1	–	1	2	1	–	–	–	1	2	1	2

CO 2	3	3	2	2	2	1	–	–	1	2	1	2	2	2
CO 3	3	3	2	2	2	2	–	–	–	–	1	3	2	2
CO 4	3	3	2	2	2	2	–	–	–	–	1	3	2	2
CO 5	3	3	3	2	3	2	–	1	1	1	1	3	2	2
CO 6	3	3	3	2	2	3	1	1	1	2	2	3	2	3
Avg.	**3**	**2.83**	**2.17**	**2**	**2**	**2**	**1**	**1**	**1**	**1.67**	**1.17**	**2.67**	**1.83**	**2.17**

PEE2447 ELECTRICAL ENGINEERING MATERIALS L T P C
3 0 0 3

COURSE OBJECTIVES

- To understand the working of special machines like stepper motor, switched reluctance motor, BLDC motor & PMSM
- To derive torque equation and study the characteristics of special machines
- To design the controller for special machines
- To study the working principle of synchronous reluctance motor
- To simulate closed loop operation of BLDC motor

UNIT I INTRODUCTION TO ELECTRICAL AND ELECTRONIC MATERIALS 9

Introduction to Electrical and Electronic Materials: Importance of materials, Classification of electrical and electronic materials, Scope of electrical and electronic materials, Requirement of Engineering materials, Operational requirements of electrical and electronic materials, Classification of solids on the basis of energy gap, Products – working principle and materials, Types of engineering materials, Levels of material structure. Spintronics and Spintronic materials, Ferromagnetic semiconductors, Left handed materials. Conductors: Conductor materials, Factors affecting conductivity, Thermal conductivity, Heating effect of current, Thermoelectric effect, Seebeck effect, Thomson effect, Wiedemann – Franz law and Lorentz relation, Problems.

UNIT II CONDUCTIVE MATERIALS AND APPLICATIONS 9

Mechanically processed forms of electrical materials, Types of conducting materials, Low resistivity materials, High resistivity materials, Contact materials, Fusible materials, Filament materials, Carbon as filamentary and brush material, Material for conductors, cables, wires, solder, sheathing and sealing.

Dielectrics: Introduction to dielectric materials, classification of dielectric materials, Dielectric constant, Dielectric strength and Dielectric loss. Polarization, Mechanisms of polarization, Comparison of different polarization process, Factors affecting polarization, Spontaneous polarization, Behaviour of polarization under impulse and frequency switching, Decay and build-up of polarization under ac field, Complex dielectric constant.

UNIT III INSULATING MATERIALS AND MAGNETIC MATERIALS 9

Insulating materials and applications – Ceramic, Mica, Porcelain, Glass, Micanite and Glass bonded mica. Polymeric materials – Bakelite, Polyethylene. Natural and synthetic rubber. Paper. Choice of solid insulating material for different applications, Liquid insulating materials – Requirements, Transformer oil, Bubble theory, Aging of mineral insulating oils. Gaseous insulating Materials – Air, Nitrogen, Vacuum.-Origin of permanent magnetic dipole, Magnetic terminology, Relation between relative permeability and magnetic susceptibility. Classification of magnetic materials, Diamagnetic, Paramagnetism, Ferromagnetism, Antiferromagnetism and the corresponding materials. Ferrimagnetism and ferrites – properties and applications, Soft and hard ferrites. Curie temperature, Laws of magnetic materials. Magnetization curve, Initial and maximum permeability. Hysteresis loop and loss, Eddy current loss.

UNIT IV SUPERCONDUCTIVE MATERIALS 9

Concept of superconductors, Meaning of phenomenon of superconductivity, Properties of superconductors, Types of superconductors, Critical magnetic field- and critical temperature, Effects of Isotopic mass on critical temperature, Silsbee rule, Depth of penetration and coherence length. Ideal and Hard superconductors, Mechanism of super conduction, London's theory for Type I superconductors, GLAG theory for Type I superconductors, BCS theory, Applications and limitations. Applications of high temperature superconductors, Superconducting solenoids and magnets, MRI for medical diagnostics.

UNIT V PLASTICS AND MATERIALS FOR OPTO ELECTRONIC DEVICES 9

Introduction, Thermoplastics, Rubbers, Thermosets, DC and AC properties, Mechanical properties and processing of plastic- Introduction, Optical phenomena, Reflection, Refraction, Transmittivity, Scattering, Optical absorption, Optical properties of non-metals, Optical properties of metals, Optical properties of semiconductors, Optical properties of insulators. Luminescence, Opto – Electronic devices, Photoconductivity, Photoconductive cell.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Explain the classification, properties, and applications of electrical and electronic materials.

CO2: Analyze the characteristics and applications of conductive and dielectric materials.

CO3: Select suitable insulating and magnetic materials for electrical applications.

CO4: Analyze the properties and applications of superconducting materials.

CO5: Explain the properties and applications of plastics and opto-electronic materials.

CO6: Evaluate and recommend engineering materials for electrical and electronic applications.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)

TEXT BOOKS:

1. K.M. Gupta, Nishu Gupta “Advanced Electrical and Electronics Materials; Processes and Applications” Wiley, First Edition, 2015
2. P.L Kapur “Electrical & Electronics Engineering Materials”, Khanna Publishers, Eight Edition, 2016.

REFERENCES:

1. R.K. Shukla Archana Singh “Electronic Engineering Materials” McGrawHill, 8th Edition, 2012.
2. L Solymar et al “Electrical Properties of Materials” Oxford UniversityPress New Delhi, 9th Edition, 2014.
3. A.J. Dekker “Electrical Engineering Materials” Pearson, 3rd edition,2016.
4. S.O. Kasap “Principle of Electronic Materials and Devices” McGraw Hill 3rd Edition 2010.

MAPPING OF COs WITH POs AND PSOs

	CO-PO											**CO-PSO**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PS01**	**PSO 2**	**PSO 3**
CO 1	3	2	1	1	1	1	-	-	-	-	2	3	2	1
CO 2	3	3	2	2	1	1	-	-	-	-	2	3	3	2
CO 3	3	3	3	2	2	2	-	-	-	-	2	3	3	2
CO 4	3	3	2	3	2	1	-	-	-	-	3	3	2	3
CO 5	3	2	2	1	1	1	-	-	-	-	2	2	2	3
CO 6	3	3	3	3	2	1	-	-	-	-	3	3	3	3
Avg.	**3.00**	**2.67**	**2.17**	**2**	**1.5**	**1.17**	-	-	-	-	**2.33**	**2.83**	**2.5**	**2.17**

OPEN ELECTIVES

S. No.	Course Code	Course Name	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	OEE2401	Introduction to Electric Vehicles	OEC	3	0	0	3	3
2	OEE2402	Sustainable Energy Technologies	OEC	3	0	0	3	3
3	OEE2403	Foundation of Robotics	OEC	3	0	0	3	3
4	OEE2404	Smart AgriTech	OEC	3	0	0	3	3

OEE2401 INTRODUCTION TO ELECTRIC VEHICLES L T P C

3 0 0 3

COURSE OBJECTIVES:

- To introduce the basic concepts, types, and importance of electric vehicles.
- To provide knowledge on EV components such as motors, drives, batteries, and charging systems.
- To familiarize students with battery technologies, charging infrastructure, and hybrid vehicle systems.
- To develop understanding of EV performance, operating modes, and power flow.
- To enable students to understand government initiatives, challenges, and future trends in EV adoption.

UNIT I BASICS OF ELECTRIC VEHICLES **9**

Introduction to Electric Vehicles (EVs) – Need for EVs – Types of EVs: BEV, HEV, PHEV – Comparison of conventional and electric vehicles – Advantages and limitations of EVs – Basic design requirements: range, speed, acceleration, power requirement – Vehicle chassis and body design – EV recharging and refuelling systems.

UNIT II MOTORS AND DRIVES **9**

Basic components of EVs: motor, battery pack, controller, charger – Types of motors: DC, AC, PMSM, BLDC, Switched Reluctance Motor – Working principle and characteristics – Introduction to EV drives

– Four quadrant operation and operating modes.

UNIT III ENERGY SOURCES 9

Importance of batteries and fuel cells in EVs – Types of batteries: Lead-acid, Lithium-ion, NiMH – Basic characteristics: capacity, energy density, charging and discharging – Safety issues – Supercapacitors and Hydrogen fuel cells – Battery Management System (BMS) – Power flow in EVs.

UNIT IV CHARGING SYSTEMS & INFRASTRUCTURE 9

EV charging basics – Slow and fast charging – Charging levels: Level 1, Level 2, DC fast charging – Charging stations and infrastructure – Wireless charging – Grid connection and impact – Economics of EV charging – Environmental benefits.

UNIT V HYBRID AND ELECTRIC VEHICLES 9

Hybrid vehicle components and working principles – Configurations of hybrid vehicles – Power split devices – Operation modes and control strategies – Economy of hybrid vehicles – Government initiatives: FAME India Scheme, NITI Aayog – Challenges in EV adoption – Future trends in electric mobility.

TOTAL PERIODS: 45

SUGGESTED ACTIVITY:

1. Case study on specification of electric and hybrid vehicles.

COURSE OUTCOMES

At the end of the course, students will have the ability to:
CO1: Explain the fundamentals, types, design requirements, and operation of electric vehicles.

CO2: Describe motors and drives used in electric vehicle applications.

CO3: Explain batteries, fuel cells, supercapacitors, BMS, and energy flow in EVs.

CO4: Describe EV charging methods, infrastructure, grid integration, and environmental benefits.

CO5: Explain hybrid vehicle configurations, control strategies, government initiatives, and future trends.

CO6: Evaluate the role of electric and hybrid vehicles in sustainable transportation.

TEXT BOOKS

1. Iqbal Husain, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 2nd Edition, 2011.
2. Mehrdad Ehsani, Yimin Gao, Ali Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2nd Edition, 2018.
3. James Larminie & John Lowry, “Electric Vehicle Technology Explained”, Wiley, 2nd Edition, 2012.

REFERENCE BOOKS

1. Chris Mi, M. Abul Masrur, David Wenzhong Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", Wiley, 2nd Edition, 2017.
2. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes (Elsevier), 1st Edition, 2001.
3. Sanjeevikumar Padmanaban, "Electric Vehicles and Energy Storage Systems", CRC Press, 1st Edition, 2020.
4. Lino Guzzella, " Vehicle Propulsion System" Springer Publications,2005
5. Ron HodKinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005.

MAPPING OF COs WITH POs

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	–	–	–	2	–	–	–	–	1
CO2	2	1	–	–	1	–	–	–	–	–	–
CO3	2	1	–	–	1	1	–	–	–	–	–
CO4	1	1	–	–	1	2	–	–	–	–	–
CO5	1	1	–	–	–	2	1	–	–	–	1
CO6	2	2	1	–	–	3	1	–	–	–	1
Avg.	**1.67**	**1.17**	**1**	**–**	**1**	**2**	**1**	**–**	**–**	**–**	**1**

OEE2402 SUSTAINABLE ENERGY TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To introduce the energy scenario, renewable energy potential, and energy policies for sustainable development.
- To provide knowledge on solar, wind, biomass, hydro, ocean, and geothermal energy technologies.
- To familiarize students with energy storage systems and their role in renewable energy utilization.

- To develop understanding of renewable energy institutions, government initiatives, and policy frameworks.

- To enable students to appreciate the role of sustainable energy technologies in energy security and environmental protection.

UNIT I ENERGY SCENARIO, POLICY & INSTITUTIONS 9

Indian and global energy scenario – Carbon Footprint – International Climate policies: The Kyoto Protocol (1997) and Paris Agreement (2015) – Conventional and renewable energy status in India – Renewable energy potential – Energy and economic development – Role of MNRE – International Energy Agency (IEA) – Government of India initiatives.

UNIT II SOLAR ENERGY TECHNOLOGY 9

Basics of solar radiation – Solar thermal systems: collectors and applications – Solar heating and cooling – Solar cooker and solar drying – Solar PV systems: standalone, grid-connected, and hybrid systems – Basic economics and maintenance – NISE, ISA, and Surya Mitra Scheme.

NIT III WIND ENERGY & BIOENERGY 9

Wind energy: Wind data assessment and site selection – Types of wind turbines (horizontal & vertical) – Uses and environmental effects – National Institute of Wind Energy (NIWE)
Bioenergy: biomass conversion, biomass gasifiers, biogas plants, cogeneration and trigeneration.

UNIT IV HYDRO, OCEAN, GEOTHERMAL & POWER STRUCTURE 9

Hydro power plant – Ocean energy: tidal, wave, and OTEC – Geothermal energy sources and applications – NIOT – TANGEDCO, TANTRANSCO, and TEDA.

UNIT V ENERGY STORAGE & GOVERNMENT POLICIES 9

Need for energy storage – Thermal and electrical storage systems – Batteries, hydrogen storage, flywheel, supercapacitors, CAES, hybrid storage – Net Metering Policy – Green Energy Corridor.

TOTAL PERIODS: 45

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)

COURSE OUTCOMES:
At the end of the course, students will have the ability to:

CO1: Explain the energy scenario, renewable energy potential, and the role of major energy institutions and government initiatives.

CO2: Describe solar thermal, solar PV systems, and related institutions and national programs.

CO3: Explain wind energy and bioenergy systems including turbines, biomass conversion, biogas, and cogeneration.

CO4: Describe hydro, ocean, and geothermal energy systems and supporting power sector organizations.

CO5: Explain energy storage systems, storage technologies, and government policies such as net metering.

CO6: Evaluate the role of sustainable energy technologies in energy security and environmental sustainability.

REFERENCES

1. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 2012.

2. Lovegrove K., Stein W., Concentrating Solar Power Technology, Woodhead Publishing Series in Energy, Elsevier, 1st Edition, 2012

3. John A. Duffie, William A. Beckman, Solar Engineering of Thermal Processes, John Wiley & Sons, 2013

4. Twidell, J.W. & Weir A., “Renewable Energy Resources”, EFNSpon Ltd., UK, 2015.

5. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.

6. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2nd edition, Springer, 2015

7. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications, 2012.

MAPPING OF COs WITH POs

COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	2	1	–	–	–	2	–	–	–	–	1
CO2	2	1	–	–	1	1	–	–	–	–	–
CO3	2	1	–	–	1	2	–	–	–	–	–
CO4	2	1	–	–	–	2	–	–	–	–	–
CO5	1	1	–	–	1	2	–	–	–	–	1
CO6	2	2	1	–	–	3	1	–	–	–	1
Avg.	**1.83**	**1.17**	**1**	**–**	**1**	**2**	**1**	**–**	**–**	**–**	**1**

OEE2403 FOUNDATION OF ROBOTICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To introduce robotics fundamentals, robot anatomy, classifications, and applications.
- To provide knowledge on robot kinematics and motion analysis of manipulators.
- To familiarize students with robot drives, actuators, end effectors, and grippers.
- To develop understanding of sensors, machine vision, and safety in robotic systems.
- To enable students to understand robot programming and industrial applications of robots.

UNIT I FUNDAMENTALS OF ROBOT 9

Robot – Definition – Robot Anatomy – Co-ordinate systems, Work Envelope, types and classification – specifications – Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and their functions – Need for Robots – Different Applications – Robotics for extreme environments: Decommissioning robotics, Ground based robotics, Submersible robotics.

UNIT II ROBOT KINEMATICS 9

Forward kinematics, inverse kinematics and the difference: forward kinematics and inverse Kinematics of Manipulators with two, three degrees of freedom (in 2 dimensional), four degrees of freedom (in 3 dimensional) – derivations. Homogeneous transformation matrices, translation and rotation matrices.

UNIT III ROBOT DRIVE SYSTEMS AND END EFFECTORS 9

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic grippers, vacuum grippers, internal grippers and external grippers, selection and design considerations of a gripper.

UNIT IV SENSORS IN ROBOTICS 9

Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors – safety considerations in robotic cell, proximity sensors, fail safe hazard sensor systems and compliance mechanism. Machine vision system – camera, frame grabber, sensing and digitizing image data – signal conversion, image storage, lighting techniques, image processing and analysis – data reduction, segmentation, feature extraction, object recognition, other algorithms, applications – Inspection, identification, visual serving and navigation.

UNIT V PROGRAMMING AND APPLICATIONS OF ROBOT 9

Teach pendant programming, lead through programming, robot programming languages – VAL programming – Motion Commands, Sensors commands, End-Effector Commands, and simple programs - Role of robots in inspection, assembly, material handling, underwater, space and medical fields.

TOTAL : 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)

- Tinkercad for actuator and sensor interfacing simulations.
- Arduino IDE for robot control experiments.
- Proteus for robotic control circuit simulation.

COURSE OUTCOMES:

At the end of the course, students will be able to:

CO1: Explain robot fundamentals, anatomy, coordinate systems, classifications, and applications.

CO2: Apply forward and inverse kinematics and homogeneous transformation concepts.

CO3: Describe robot drives, actuators, end effectors, and gripper selection.

CO4: Explain sensors, machine vision systems, and safety mechanisms in robotics.

CO5: Describe robot programming methods, VAL commands, and robotic applications.

CO6: Evaluate the use of robots for automation, safety, and productivity improvement.

TEXT BOOKS:

1. Ganesh.S.Hedge,"A textbook of Industrial Robotics", Lakshmi Publications, 2006.

2. Mikell.P.Groover , "Industrial Robotics – Technology, Programming and applications" McGraw Hill 2ND edition 2012.

REFERENCES:

1. Fu K.S. Gonalz R.C. and ice C.S.G."Robotics Control, Sensing, Vision and Intelligence", McGraw Hill book co. 2007.

2. YoramKoren, "Robotics for Engineers", McGraw Hill Book, Co., 2002.

3. Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill 2005.

4. John. J.Craig, "Introduction to Robotics: Mechanics and Control" 2nd Edition, 2002.

5. Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer India reprint, 2010.

MAPPING OF COs WITH POs

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	–	–	–	1	–	–	–	–	1
CO2	2	2	1	1	1	–	–	–	–	–	1
CO3	2	1	–	–	1	–	–	–	–	–	–
CO4	2	1	–	–	1	1	–	–	–	–	–
CO5	1	1	–	–	1	–	–	–	1	–	1
CO6	2	2	1	–	1	2	–	–	–	–	1
Avg.	**1.83**	**1.33**	**1**	**1**	**1**	**1.33**	**–**	**–**	**–**	**–**	**1**

OEE2404 **SMART AGRITECH** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To introduce smart agriculture, precision farming, and the role of sensors and IoT.
- To provide knowledge on drones, UAV components, and their agricultural applications.
- To familiarize students with autonomous systems and the integration of robotics and drones in agriculture.
- To develop understanding of data-driven farming, machine learning, and autonomous navigation.
- To enable students to appreciate sustainable agriculture and emerging technologies in agritech.

UNIT I **FUNDAMENTALS OF SMART AGRICULTURE** **9**

Introduction to precision agriculture – Need for smart agriculture: productivity, sustainability – Sensors in agriculture: soil moisture, temperature, humidity, nutrient sensors – IoT in agriculture: data collection and monitoring – Automated irrigation systems – Benefits of data-driven agriculture.

UNIT II **DRONES FOR AGRICULTURE** **9**

Introduction to UAVs / drones – Types of drones (fixed-wing, multirotor, hybrid) – Drone components: frame, motors, sensors, cameras – Drone applications in agriculture: Crop monitoring and mapping, Spraying fertilizers and pesticides, Soil and crop health analysis.

Challenges and safety considerations.

UNIT III INTRODUCTION TO AUTONOMOUS SYSTEMS 9

Definition and scope of autonomous systems – Examples: self-driving vehicles, robotic arms, drones – Components of autonomous systems: sensors, actuators, controllers – Basics of control systems for automation – Role of AI and IoT in autonomous systems – Applications beyond agriculture.

UNIT IV INTEGRATION OF AUTONOMOUS SYSTEMS AND DRONES 9

Combining robotics, drones, and sensors for smart agriculture – Autonomous navigation for agricultural robots and drones – Data collection, analysis, and decision-making – Case studies: autonomous harvesting, crop monitoring drones – Role of machine learning for predictive farming – Challenges and practical considerations

UNIT V FUTURE TRENDS AND SUSTAINABILITY 9

Smart farming for sustainable agriculture – Energy-efficient and eco-friendly autonomous systems – Swarm drones and collaborative robotics – Policy and ethical considerations for autonomous farming – Emerging technologies: AI, IoT, blockchain in agriculture – Opportunities for research, startups and entrepreneurship.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)

COURSE OUTCOMES:

After completing this course, students will be able to:

CO1: Explain precision agriculture, agricultural sensors, IoT monitoring, and automated irrigation systems.

CO2: Describe drone types, components, and applications in crop monitoring and spraying.

CO3: Explain autonomous systems, sensors, actuators, controllers, and the role of AI and IoT.

CO4: Examine the integration of drones, robotics, and autonomous systems in smart agriculture.

CO5: Describe future trends, sustainability, and emerging technologies in agriculture.

CO6: Evaluate smart agritech solutions for sustainable and productive farming.

TEXTBOOKS:

1. Rajesh Singh, IoT and Drones in Smart Agriculture, CRC Press, 1st Edition, 2021
2. Ramesh Kumar, Autonomous Robots and UAVs for Agriculture, Springer, 1st Edition, 2020
3. Michael Burri, Introduction to Robotics: Mechanics and Control, MIT Press, 4th Edition, 2019

REFERENCE BOOKS:

1. Anil Kumar, Precision Agriculture and Smart Farming, Elsevier, 1st Edition, 2020
2. Dragan Nikolić, Drones in Agriculture: Applications and Case Studies, Wiley, 1st Edition, 2021
3. John Deere (Technical Guides), Smart Agriculture Technologies, John Wiley & Sons, 2019

4. Bikram Kar; Amit Kumar, "Smart AgriTech," in Smart Agritech: Robotics, AI, and Internet of Things (IoT) in Agriculture , Wiley, 2024, pp.227-259.

MAPPING OF COs WITH POs

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	–	–	1	2	–	–	–	–	1
CO2	2	1	–	–	1	1	–	–	–	–	–
CO3	2	1	–	–	1	1	–	–	–	–	1
CO4	2	2	1	–	1	2	–	–	–	–	1
CO5	1	1	–	–	–	2	1	–	–	–	1
CO6	2	2	1	–	–	3	1	–	–	–	1
Avg.	1.83	1.33	1	–	1	1.83	1	–	–	–	1

Minor in Electric Vehicle Technology

[Any 6 Courses (18 Credits)]

1. PEE2411 - Electric Vehicle Architecture and Dynamics
2. PEE2412 - Electric and Hybrid Vehicles
3. PEE2413 - Design of Motor and Power Converters for EVs
4. PEE2414 - Battery Management System and Charging Technologies
5. PEE2415 - Design of Electric Vehicle Charging System
6. PEE2416 - Grid Integration of Electric Vehicles
7. PEE2417 - Intelligent Control of Electric Vehicles
8. PEE2418 - Testing and Thermal Management of Electric Vehicles
9. PEE2437 - Embedded System for Automotive Applications
10. PEE2445 - Electrical Machines for Special Applications

Or NPTEL Courses on Electric Vehicle (Can replace upto maximum 3 courses in the above list depending on the credit weightage of the NPTEL course)

AUDIT COURSES

PERSPECTIVES OF SUSTAINABLE DEVELOPMENT **L T P C**
2 0 0 2

COURSE OBJECTIVES:

- To introduce sustainability principles, history, and its importance in engineering and society.
- To provide knowledge on environmental sustainability, climate change, and resource conservation.
- To familiarize students with social and economic sustainability, CSR, and circular economy.
- To develop understanding of sustainable energy systems and clean energy technologies.
- To enable students to understand e-waste management and sustainable development practices.

UNIT I INTRODUCTION **6**

Principles & Historical perspectives, Importance and need for sustainability in engineering and technology, impact and implications. United Nations Sustainability Development Goals (SDG), UN summit – Rio & outcome, Sustainability and development indicators.

UNIT II ENVIRONMENTAL SUSTAINABILITY **6**

Climate change, Biodiversity loss, Pollution and waste management, Renewable vs. non-renewable resources, Water and energy conservation, Sustainable agriculture and forestry. National and international policies, Environmental regulations and compliance, Ecological Footprint Analysis.

UNIT III SOCIAL & ECONOMIC SUSTAINABILITY **6**

Equity and justice, Community development, Smart cities and sustainable infrastructure, Cultural heritage and sustainability, Ethical considerations in sustainable development. Triple bottom line approach, Sustainable economic growth, Corporate social responsibility (CSR), Green marketing and sustainable product design, Circular economy and waste minimization,Green accounting and sustainability reporting.

UNIT IV SUSTAINABLE ENERGY **6**

Smart and micro grid – energy storage – energy efficiency and conservation in Industrial process Electrification of Transport sector Hydrogen and Fuel cell for energy generation – Polygeneration technologies for rural and coastal communities – Carbon capture and storage.

UNIT V E-WASTE MANAGEMENT 6

Sustainable Software: What, Why and How – Social and Individual Sustainability in SE – Choosing energy– efficient programming languages. Types and sources of e-waste – Environmental and health impacts of e– waste – E– waste regulations and policies – Techniques for recycling IT equipment – Safe disposal methods – E– waste stream management – Concepts of circular economy – Role of IT in promoting circular economy.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / etc)

Suggested Practices not limited to:

- Energy efficiency – how to save energy (energy efficient equipment, energy saving behaviours). cloud
- Chemical use and storage – the choice of chemicals being procured, the safe disposal of leftover chemicals, the impact of chemicals on the environment and long– term health impacts on humans.
- Green building, green building materials, green building certification and rating: green rating for integrated habitat assessment (GRIHA), leadership in energy and environmental design (LEED)
- Tools for Sustainability – Environmental Management System (EMS), ISO14000, life cycle assessment (LCA)
- Ecological footprint assessment using the Global Footprint Network spreadsheet calculator
- National/Sub national Status of Sustainable Development Goals.
- Develop a campus sustainability plan and prototype, integrating sustainable IT practices and energy– efficient solutions.
- Develop AI– driven solutions for efficient water management, demonstrating the role of IT in smart environmental monitoring.
- Assessment and Feasibility related to sustainability

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Explain sustainable development principles, SDGs, and the importance of sustainability.

CO2: Describe environmental sustainability, climate change, biodiversity, and resource conservation.

CO3: Explain social and economic sustainability, CSR, circular economy, and green accounting.

CO4: Describe sustainable energy technologies such as smart grids, storage, and clean energy systems.

CO5: Explain e-waste management, recycling methods, regulations, and circular economy practices.

CO6: Evaluate sustainable development strategies for environmental and social well-being.

REFERENCES:

1. Allen, D., & Shonnard, D. R. (2011). Sustainable engineering: Concepts, design and case studies. Prentice Hall.

2. Munier, N. (2005). Introduction to sustainability (pp. 3558-6). Amsterdam, The Netherlands: Springer.

3. Blackburn, W. R. (2012). The sustainability handbook: The complete management guide to achieving social, economic and environmental responsibility. Routledge.

4. Clini, C., Musu, I., &Gullino, M. L. (2008). Sustainable development and environmental management. Published by Springer, PO Box, 17, 3300.

5. Bennett, M., James, P., &Klinkers, L. (Eds.). (2017). Sustainable measures: Evaluation and reporting of environmental and social performance. Routledge.

6. Seliger, G. (2012). Sustainable manufacturing for global value creation (pp. 3-8). Springer Berlin Heidelberg.

7. Stark, R., Seliger, G., & Bonvoisin, J. (2017). Sustainable manufacturing: Challenges, solutions and implementation perspectives. Springer Nature.

8. Davim, J. P. (Ed.). (2013). Sustainable manufacturing. John Wiley & Sons.

9. Down, R. D., & Lehr, J. H. (Eds.). (2005). Environmental instrumentation and analysis handbook. John Wiley & Sons.

10. Borlase, S. (Ed.). (2012). Smart grids: infrastructure, technology, and solutions. CRC press.

11. Roslan, M. F., Hannan, M. A., Ker, P. J., & Uddin, M. N. (2019). Microgrid control methods toward achieving sustainable energy management. Applied Energy, 240, 583-607.

12. Mulder, K. (Ed.). (2017). Sustainable development for engineers: A handbook and resource guide. Routledge.

13. Ibrahim Dincer and Calin Zamfirescu, Sustainable Energy Systems and Applications, Springer, 2021

MAPPING OF COs WITH POs

COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	1	1	–	–	–	3	1	–	–	–	1
CO2	1	1	–	–	–	3	1	–	–	–	–
CO3	1	1	–	–	–	2	1	–	–	–	1
CO4	2	1	–	–	–	3	–	–	–	–	1

CO5	1	1	–	–	–	2	1	–	–	–	1
CO6	2	2	–	–	–	3	1	–	–	–	1
Avg.	1.33	1.17	–	–	–	2.67	1	–	–	–	1

ENERGY CONSERVATION AND SUSTAINABILITY **L T P C**

2 0 0 2

COURSE OBJECTIVES:

- To introduce basic concepts of energy, energy resources, and the energy scenario.
- To provide knowledge on energy conservation, energy efficiency, and basic energy audit concepts.
- To familiarize students with renewable energy sources and sustainable energy development.
- To develop understanding of energy-efficient devices, storage systems, and demand-side management.
- To enable students to appreciate sustainability concepts and daily energy conservation practices.

UNIT I ENERGY BASICS & SCENARIO **6**

Energy and types (renewable & non-renewable) Primary and secondary energy sources – Global and Indian energy scenario – Energy demand in sectors (domestic, industry, transport, agriculture) – Environmental impacts of energy use (pollution, climate change basics) – Introduction to sustainability and sustainable development, Energy Pyramid.

UNIT II ENERGY CONSERVATION PRINCIPLES **6**

Meaning and importance of energy conservation – Difference between energy conservation and energy efficiency – Simple energy saving methods in: Homes (lighting, appliances), Industry (motors, boilers), Transport (fuel saving practices). Energy audit – basic concept and types (preliminary & detailed) – Energy management and role of energy managers

UNIT III RENEWABLE ENERGY SOURCES **6**

Introduction to renewable energy – Solar energy (basic working of solar thermal & solar PV). Wind energy (basic concept and applications) – Biomass energy (biogas, simple biomass use) – Small hydro energy – Advantages and limitations of renewable energy.

UNIT IV ENERGY EFFICIENCY & STORAGE **6**

Energy efficient devices: LED lighting, Star-rated appliances – Basics of electrical energy saving – Thermal insulation – Introduction to energy storage: Batteries, Thermal storage (water heating) – Introduction to Demand-side management

UNIT V SUSTAINABILITY, POLICIES & PRACTICES 6

Concept of sustainable development – 3Rs: Reduce, Reuse, Recycle – Carbon footprint – Climate change and global warming – Government initiatives in India: Ministry of New and Renewable Energy (MNRE) & Bureau of Energy Efficiency (BEE) – Simple energy conservation practices for daily life

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)

COURSE OUTCOMES:

After completing this course, the student will be able to:

CO1: Explain energy basics, energy sources, demand patterns, and environmental impacts.

CO2: Describe energy conservation, energy efficiency, energy-saving methods, and energy audit concepts.

CO3: Explain renewable energy sources such as solar, wind, biomass, and small hydro systems.

CO4: Describe energy-efficient devices, storage systems, and demand-side management concepts.

CO5: Explain sustainability concepts, 3Rs, carbon footprint, climate change, and government initiatives.

CO6: Evaluate energy conservation practices for sustainable and responsible energy use.

MAPPING OF COs WITH POs

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	1	–	–	–	3	1	–	–	–	1
CO2	2	1	–	–	–	2	–	–	–	–	1
CO3	2	1	–	–	1	2	–	–	–	–	–
CO4	1	1	–	–	1	2	–	–	–	–	–
CO5	1	1	–	–	–	3	1	–	–	–	1
CO6	2	2	–	–	–	3	1	–	–	–	1
Avg.	1.5	1.17	–	–	1	2.5	1	–	–	–	1