COIMBATORE INSTITUTE OF TECHNOLOGY, COIMBATORE – 641 014
(An Autonomous Institution affiliated to ANNA UNIVERSITY, CHENNAI)
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
REGULATIONS 2023 CHOICE BASED CREDIT SYSTEM

B.E. – ELECTRICAL AND ELECTRONICS ENGINEERING

VISION

To empower the graduates with "capabilities of Academic, Technical and Professional competence and to nurture them in the emerging fields of research, and innovative product development".

MISSION

- Nurture the talent and creativity of the students by making them to practice and realize the core and allied concepts
- Empower the students in the thrust area of electrical engineering through the collaboration with industries and research activities
- Inculcate the lifelong learning and ethics on realizing them as responsible engineers for developing the society and their future

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

PEO 1: To apply the knowledge of engineering and science to solve the complex engineering problems

PEO 2: To promote the ability in offering alternative and optimal design solutions for the societal problems

PEO 3: To promote the ability in offering alternative and optimal design solutions for the societal problems

PEO 4: To develop the leadership skills, professional communication skills and to inculcate the habit to develop the techno-commercial and socio-economic products

PROGRAM OUTCOMES (POs)

Twelve Graduate Attributes as given by NBA as per Washington Accord agreement should be considered for all the UG programmes without any change for POs.

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

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

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

4 **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5 **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6 **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

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

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

9 **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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

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

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

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: To select and apply the specific modern tools on engineering activities and to validate the solutions for the complex problems in electrical machines and drives, electrical power system, control and instrumentation system and power electronic systems.

PSO2: To design and develop the hardware with multidisciplinary approach for industrial automation, embedded systems, power and energy systems and computer communication systems.

MAPPING OF PROGRAMME EDUCATIONAL OUTCOMES WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

PEOs	PROGRAMME OUTCOMES												PSOs	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	3											3	
2			3	3		3								3
3					3	3	3	3					3	3
4									3	3	3	3		3

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REGULATIONS 2023 - CHOICE BASED CREDIT SYSTEM

B.E. – ELECTRICAL AND ELECTRONICS ENGINEERING

CURRICULUM AND SYLLABI

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23FYH111	Technical English	HSC	2	2	0	4	4
2	23FYM113	Linear Algebra and Calculus	BSC	3	1	0	4	4
3	23FYP113	Electron Devices	BSC	3	0	0	3	3
4	23FYC113	Electrochemical Technologies	BSC	3	0	0	3	3
5	23EE111	Basics of Civil and Mechanical Engineering	ESC	4	0	0	4	4
PRACTICALS								
6	23FPC122	Basic Sciences Laboratory	BSC	0	0	4	4	2
7	23EE121	Engineering Design Laboratory	ESC	0	0	4	4	2
8	23EE122	Engineering Graphics	ESC	0	0	2	2	1
ONE CREDIT COURSES								
9	23FYH121	Heritage of Tamils/□□□□□□ □□□□	OCC				15	1
MANDATORY COURSES								
10	23MC101	Induction Programme	MC				15 Days	-
11	23MC102	Soft Skills	MC				15	-
			TOTAL	**15**	**3**	**10**	**28**	**24**

SEMESTER II

COURSE CODE		COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23FYM213	Differential Equations and Numerical Methods	BSC	3	1	0	4	4
2	23EE211	Electric and Magnetic Circuits	PCC	3	0	0	3	3
3	23EE212	Electrical Measurements and Instrumentation	PCC	3	0	0	3	3
4	23EE213	Digital Electronics	ESC	3	0	0	3	3
5	23EE214	Analog Electronic Circuits	PCC	3	0	0	3	3
PRACTICAL								
6	23FYH221	English Communication and Competency Laboratory	HSC	0	0	4	4	2
7	23EE221	Analog and Digital Electronics Laboratory	PCC	0	0	4	4	2
8	23EE222	C Programming and Databases Laboratory	PCC	0	0	4	4	2
ONE CREDIT COURSES								
9	23FYC221	Environmental Science and Engineering	OCC				15	1
10	23FYH222	Tamils and Technology	OCC				15	1
11	23CC	Co-Curricular Activities*	OCC				15	1
		23CC221- NSS						
		23CC222- YRC						
		23CC223- RSP						
		23CC224- Sports						
			TOTAL	**15**	**1**	**12**	**28**	**25**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23M313	Complex Analysis and Transforms	BSC	3	1	0	4	4
2	23EE311	Electric Circuit Analysis	PCC	3	1	0	4	4
3	23EE312	Electromagnetic Fields	PCC	3	1	0	4	4
4	23EE313	DC Machines and Transformers	PCC	3	0	0	3	3
5	23EE314	Linear Integrated circuits	PCC	3	0	0	3	3
PRACTICALS								
6	23EE321	DC Machines and Transformers Laboratory	PCC	0	0	3	3	1.5
7	23EE322	Linear Integrated Circuits Laboratory	PCC	0	0	2	2	1
8	23EE323	OOPS and C++ Laboratory	PCC	0	0	3	3	1.5
ONE CREDIT COURSES								
9	23MC321	Human Values and Professional Ethics	OCC				15	1
10	23MC322	Design Thinking	OCC				15	1
MANDATORY COURSES								
11	23MC301	Induction Programme	MC				One week	-
			TOTAL	**15**	**3**	**8**	**26**	**24**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		AC Rotating Machines	PCC	3	0	0	3	3
2		Transmission and Distribution of Electrical Power	PCC	3	0	0	3	3
3		Signals and Networks	PCC	3	1	0	4	4
4		Control Systems	PCC	3	1	0	4	4
5		Digital System Design	PCC	3	0	0	3	3
PRACTICALS								
6		AC Rotating Machines Laboratory	PCC	0	0	3	3	1.5
7		Control & Instrumentation Laboratory	PCC	0	0	2	2	1
8		Digital System Design Laboratory	PCC	0	0	3	3	1.5
ONE CREDIT COURSES								
9		Value Added Course-I	OCC				15	1
MANDATORY COURSES								
10		Community Service and Engineering	MC				15	-
			TOTAL	**15**	**2**	**8**	**25**	**22**

SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		Power System Analysis	PCC	3	0	0	3	3
2		Power Electronics	PCC	3	1	0	4	4
3		Embedded System Design	PCC	3	0	0	3	3
4		Elective –I	PEC	3	0	0	3	3
5		Elective –II	PEC	3	0	0	3	3
PRACTICALS								
6		Power System Simulation Laboratory	PCC	0	0	2	2	1
7		Power Electronics Laboratory	PCC	0	0	2	2	1
8		Embedded System Design Laboratory	PCC	0	0	2	2	1
9		In-Plant Training	EEC	-	-	-		1
ONE CREDIT COURSES								
10		Value Added Course-II	OCC				15	1
11		Seminar and Technical Writing	OCC				15	1
			TOTAL	**15**	**1**	**6**	**22**	**22**

SEMESTER VI

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		Digital Protection of Power Systems	PCC	3	0	0	3	3
2		Electric Vehicles	PCC	3	0	0	3	3
3		Data Structures and Algorithms	PCC	3	0	0	3	3
4		Elective –III	PEC	3	0	0	3	3
5		Elective –IV	PEC	3	0	0	3	3
PRACTICALS								
6		Power and Energy Laboratory	PCC	0	0	2	2	1
7		Electric Vehicle Laboratory	PCC	0	0	2	2	1
8		IoT Laboratory	PCC	0	0	2	2	1
9		Mini Project	EEC	0	0	4	4	2
ONE CREDIT COURSES								
10		Hackathon	OCC				15	1
			TOTAL	**15**	**0**	**10**	**25**	**21**

SEMESTER VII

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		Generation of Electrical Energy	PCC	3	0	0	3	3
2		Solid State Drives and Control	PCC	3	0	0	3	3
3		Smart Grid	PCC	3	0	0	3	3
4		Elective -V	PEC	3	0	0	3	3
5		Elective -VI	PEC	3	0	0	3	3
PRACTICALS								
6		Electrical Drives Laboratory	PCC	0	0	3	3	1.5
7		Industrial Automation Laboratory	PCC	0	0	3	3	1.5
8		Reverse Engineering and Product Realization Laboratory	PCC	0	0	2	2	1
			TOTAL	**15**	**0**	**8**	**23**	**19**

SEMESTER VIII

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		Elective –VII	PEC	3	0	0	3	3
2		Elective -VIII	PEC	3	0	0	3	3
PRACTICALS								
3		PROJECT WORK AND VIVA-VOCE	EEC	0	0	12	12	6
			TOTAL	**6**	**0**	**12**	**18**	**12**

LIST OF PROFESSIONAL ELECTIVE COURSES:

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	CREDITS
I. ELECTRICAL MACHINES AND CONTROL								
1.		Design of Electrical Machines	PE	3	0	0	3	3
2.		Modeling and Analysis of Electrical Machines	PE	3	0	0	3	3
3.		Digital Control Systems	PE	3	0	0	3	3
4.		System Theory	PE	3	0	0	3	3
5.		Robust Control	PE	3	0	0	3	3
II. POWER AND ENERGY								
1.		Power and Energy Management	PE	3	0	0	3	3
2.		Energy Storage Technology	PE	3	0	0	3	3
3.		Electrical Safety	PE	3	0	0	3	3
4.		Energy Efficient Lighting System	PE	3	0	0	3	3
5.		Power system design	PE	3	0	0	3	3
6.		High Voltage Transmission Systems	PE	3	0	0	3	3
7.		Deregulated Power System	PE	3	0	0	3	3
8.		Utilization of Solar Energy	PE	3	0	0	3	3
III. ELECTRONIC DESIGN								
1.		Real Time Embedded Systems	PE	3	0	0	3	3
2.		VLSI Design	PE	3	0	0	3	3
3.		FPGA based System Design	PE	3	0	0	3	3
4.		Robotics and control	PE	3	0	0	3	3
5.		Digital Consumer technology	PE	3	0	0	3	3
6.		Electronic Product Design	PE	3	0	0	3	3
7.		Medical Electronics	PE	3	0	0	3	3
8.		Multimedia system	PE	3	0	0	3	3
9.		MEMS & NEMS	PE	3	0	0	3	3
10.		Wearable Sensors	PE	3	0	0	3	3
IV. COMPUTER AND COMMUNICATION								
1.		Computer architecture and parallel processing	PE	3	0	0	3	3

2.		Multi core architecture	PE	3	0	0	3	3
3.		Data Communication networks	PE	3	0	0	3	3
4.		Fog computing	PE	3	0	0	3	3
5.		Internet of Things	PE	3	0	0	3	3
6.		Data Analytics	PE	3	0	0	3	3
7.		Virtual instrumentation	PE	3	0	0	3	3
8.		Cyber Physical systems	PE	3	0	0	3	3
9.		Intelligent Techniques for Electrical Engineering	PE	3	0	0	3	3
10.		Industrial Automation	PE	3	0	0	3	3
11.		Deep Learning	PE	3	0	0	3	3
12.		Principles of Operating System	PE	3	0	0	3	3
13.		Analog and digital communication	PE	3	0	0	3	3
14.		Intelligent Vehicles	PE	3	0	0	3	3

LIST OF OPEN ELECTIVE COURSES OFFERED FOR THE STUDENTS OF OTHER UG PROGRAMMES:

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	C	UG PROGRAMME
1.		Energy Auditing	**OE**	**3**	**0**	**0**	**3**	**3**	**Mech**
2.		Solar and Wind Energy Systems	**OE**	**3**	**0**	**0**	**3**	**3**	**Mech and Chemical**
3.		Electrical Safety Procedures and Management	**OE**	**3**	**0**	**0**	**3**	**3**	**All Branches**
4.		Energy Efficient Illumination Systems	**OE**	**3**	**0**	**0**	**3**	**3**	**All Branches**
5.		Electric Vehicle Technology	**OE**	**3**	**0**	**0**	**3**	**3**	**All Branches except Civil and Chemical**

SUMMARY

Category; BSC – Basic sciences, HSC– Humanities and Social Sciences, ESC–Engineering sciences, PCC –Professional Core, PEC- Professional Elective, OEC-Open Elective Course, EEC –Employability Enhancement Course, MC – Mandatory Course

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING										
Sl. No.	**Subject Area**	**Credits per Semester**								**Credits Total**
		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	
1	HSC	4	2							**6**
2	BSC	12	4	4						**20**
3	ESC	7	3							**10**
4	PCC		13	18	21	13	12	13		**90**
5	PEC					6	6	6	6	**24**
6	OEC									
7	EEC					1	2		6	**9**
8	OCC	1	3	2	1	2	1			**10**
								TOTAL CREDITS		**169**

23FYH111	TECHNICAL ENGLISH	L	T	P	C
		2	2	0	4

MODULE I FOCUS ON LANGUAGE: GRAMMAR & VOCABULARY 6

Embedded Sentence – Numerical Adjectives - Subject Verb Agreement – If Conditionals – Active Passive Voice – Reported Speech - Idiomatic Expressions - Business and Job Related Vocabulary - Relative Clause – Pronouns – Adjectives - Degrees of Comparison - Technical Vocabulary – Avoidance of Jargon - Collocations - Formal and Informal Vocabulary – Verbal Analogy - Tenses - Prepositions – Articles – Homophones and Homonyms - One Word Substitutes –Linking Words

MODULE II TECHNICAL COMMUNICATION 6

Importance of Technical Communication - Objective & Characteristics of Technical Communication – General and Technical Communication – Process of Communication - Levels of Communication – Flow of Communication –Visual Aids in Technical Communication - Barriers to Communication: Noise – Classification of Barriers –Non-verbal Communication: Kinesics – Proxemics- Chronemics.

MODULE III READING& LISTENING 6

Reading Comprehension Techniques: Understanding Technical Articles – Skimming and Scanning – Summarizing**–**- Intensive & Extensive Reading- Note Making – SQ3R Reading Technique - Meaning and Art of Listening-Importance of Listening & Empathy in Communication – Reasons for Poor Listening – Traits of a good listener – Listening to Technical Talks – Listening to TED/INK Talks

MODULE IV WRITING 6

Paragraph Writing – Interpreting Charts and Graphs – Instructions – Checklists – Recommendations – Describing a Process – Extended Definitions – Essay Writing – Report Writing – Minutes of the Meetings -Email Writing - Essay Writing - Job Application Letters

MODULE V SPEAKING 6

Introducing Oneself- Asking for and Giving Directions – Seeking Clarification – Speaking about a Process – Introduction to Technical Presentation – Mechanics of Presentation – Achieving Confidence, Clarity & Fluency – Vocal Cues - Barriers to Speaking – Types of Speaking – Persuasive Speaking – Public Speaking

COURSEOUTCOMES

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

CO1: Categorize the barriers to communication and formulate solutions using appropriate vocabulary.

CO2: Apply the rules of the grammar and construct grammatically correct sentences.

CO3: Comprehend the nuances of Technical Communication

CO4: Make inferences and interpret texts using reading and listening strategies

CO5: Perceive the mechanics of business writing and presentation skills

CO6: Develop LSRW skills to excel in workplace communication

Tutorials and Practical Sessions based on the above syllabus

TOTAL:60 PERIODS

TEXTBOOKS:

1. Praveen Sam D & Shoba K N, “A Course in Technical English” CUP, 2020.
2. Meenakshi Raman, Sangeeta Sharma, “Technical Communication – Principles and Practice”, Oxford University Press, New Delhi, 2015, 2015

REFERENCES:

1. Sudharshana N. P & Savitha C, “English for Engineers”, CUP, 2018.
2. Steve Hart, Aravind R. Nair &Veena Bhambhani, “Embark – English for Undergraduates”, CUP, 2016.
3. Jack C Richerds, “Interchange - 2”, CUP, Fourth Edition, Chennai, 2015.
4. Lourdes Joavani Rayen & Shoba K N, “Communicative English”, CUP, 2018.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1									2	3		1			
2									2	3		1			
3									2	3		1			
4									2	3		1			
5									2	3		1			
6									2	3		1			
AVg.									**2**	**3**		**1**			

1-low, 2-medium,3-high

23FYM113	LINEAR ALGEBRA AND CALCULUS	L	T	P	C
		3	1	0	4

MODULE I MATRIX ALGEBRA **12**

Eigenvalues and Eigenvectors of a Real Matrix - Properties (Without Proof) - Diagonalization by an orthogonal transformation – Matrix Factorization- LU Factorization- Singular value decomposition - Eigenvalues of a matrix by Power method.

MODULE II VECTOR CALCULUS **12**

Vector Space–Subspace-linear transformation -linearly independent Sets, Bases- Dimension of a Vector Space- Inner Product – length –orthogonally- The Gram-Schmidt Process.

MODULE III MULTIPLE INTEGRALS **12**

Jacobins -Taylor's series for Functions of Two Variables-Maxima and Minima of Functions of Two Variables – Lagrange's Method of undertermined multipliers.

MODULE IV DIFFERENTIAL CALCULUS **12**

Double Integrals - Change of Order of Integration in Double Integrals -Change of Variables (Cartesian to Polar)-Triple Integrals- Applications: Area and Volume.

MODULE V VECTOR SPACES **12**

Gradient – Divergence- Curl- Line Integrals-Surface integrals –Green's theorem-Stoke's theorem-Gauss divergence theorem (Without Proof)- Applications involving Cube and Rectangular parallelepiped.

COURSEOUTCOMES

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

CO1: Use the matrix algebra methods for solving practical problems.

CO2:Know the basics of Vector Spaces and Inner Product

CO3:Apply differential calculus tools in solving various application problems.

CO4:Able to use differential calculus ideas on several variable functions.

CO5: Apply different methods of integration in solving practical problems.

CO6: Apply multiple integral ideas in solving areas, volumes and other practical problems

TOTAL:60 PERIODS

TEXTBOOKS:

1. David C.Lay, " Linear Algebra and its Applications" , Pearson ,22nd Edition , New Delhi, 2015.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, New Delhi, 2017.

REFERENCES:

1. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), 7th Edition, New Delhi, 2009.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2015.
3. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
4. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics",Narosa Publications, 5th Edition, New Delhi, 2017.
5. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1										1			
2	3	1										1			
3	3	1										1			
4	3	1										1			
5	3	1										1			
6	3	1										1			
AVg.	**3**	**1**										**1**			

1-low, 2-medium,3-high

23FYP113	ELECTRON DEVICES	L	T	P	C
		3	0	0	3

MODULE I PN JUNCTION DIODE **9**

Types of semiconductors - Energy band diagram, PN junction diode, Current equations, and Diffusion and drift currents - forward and reverse bias characteristics, Switching Characteristics- Diode Resistance – Transition or space charge Capacitance – Diffusion or storage capacitance-Breakdown in PN Junction Diodes..

MODULE II BIPOLAR JUNCTION TRANSISTOR **9**

NPN –PNP transistors-Early effect-Current equations – Input and Output characteristics of BJT in CE, CB, CC configurations. Method of transistor biasing –Fixed Bias Circuit, Emitter Bias Circuit, Voltage-Divider Bias. Transistor as switch –Bias stability–Bias compensation-Thermal runaway

MODULE III FIELD EFFECT TRANSISTORS **9**

JFET- Drain and Transfer Characteristics-Current equations-Pinch off voltage and its significance – Biasing of JFET.MOSFET- Characteristics- Threshold voltage -Channel length modulation, DMOSFET, E-MOSFET– Comparison of MOSFET with JFET –Biasing of Enhancement MOSFET.

MODULE IV SPECIAL SEMICONDUCTOR DEVICES **9**

Schottky barrier diode-Zener diode-Varactor diode –Tunnel diode- - Shockley Diode - LASER diode-LDR- UJT -VMOS and UMOS Power MOSFET-MESFET.

MODULE V VECTOR SPACES **9**

Gradient – Divergence- Curl- Line Integrals-Surface integrals –Green's theorem-Stoke's theorem-Gauss divergence theorem (Without Proof)- Applications involving Cube and Rectangular parallelepiped.

COURSEOUTCOMES

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

CO1: To describe the basic concept of energy levels in semiconductors.
CO2: To illustrate the construction and working principle of diodes and transistors.
CO3: To compare different types of transistors based on their characteristics.
CO4: To summarize the behavior of special semiconductor devices.
CO5: To design a simple BJT and FET biasing circuit for a given specification
CO6: To design simple circuits using diodes and transistors.

TOTAL:45 PERIODS

TEXTBOOKS:

1. Robert L. Boylstead and Louis Nashelsky ,"Electronic Devices and CircuitTheory",11th Edition, Prentice-HallofIndia, NewDelhi, 2015.
2. Jacob Millman, Christos C Halkias, Satyabrata Jit, "Electronic Devices and Circuits", TataMcGraw-Hill,FourthEdition,2015.

REFERENCES:

1. Salivahanan, "Electron Devices and Circuits", Second edition, Tata McGraw-Hill,NewDelhi,2011.
2. Donald A Neaman, "Semiconductor Physics and Devices", Fourth Edition, Tata McGraw Hill Inc.2017.
3. Allen Mottershed, "Electronic Devices and Circuits an Introduction", PHI Learning,2011.
4. ThomasL.Floyd, "ElectronicDevices",9th Edition,PearsonEducationAsia,2011.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1													
2	3	3	1	3							3	1			
3	3	3	1	3	2						3	1			
4	3	3	2	3	2						3	1			
5	3	3	3	3	3	3		2			3	2			
6	3	3	3	3	3	3		2			3	2			
AVg.	**3**	**2.7**	**2**	**3**	**2.5**	**3**		**2**			**3**	**1.4**			

1-low, 2-medium,3-high

23FYC113	ELECTROCHEMICAL TECHNOLOGIES	L	T	P	C
		3	0	0	3

MODULE I ELECTROCHEMISTRY **9**

Electrolytes, Electrolysis: Faraday's laws, application – electro plating, electro refining of metals, electro – manufacturing and electro – typing, origin of potential, electrochemical series, reference electrodes, Nernst equation, Kohlrausch's law and its applications.

MODULE II BATTERIES **9**

Basic concepts – Components of cells and batteries, Classification of cells and batteries, Specifications – Free energy, theoretical cell voltage, specific capacity, specific energy, internal resistance and coulombic efficiency. Construction, working and application of Primary and secondary batteries –alkaline cells, lithium primary batteries, lead-acid, and Lithium secondary batteries (Components, Chemistry and Performance characteristics). Applications of storage batteries.

MODULE III FUEL CELLS **9**

Basic principle, anodic and cathodic reaction, pressure and temperature effect. Types of Fuel Cells: Proton Exchange Membrane Fuel Cells, alkaline fuel cells, direct methanol fuel cells. Fuels for Fuel Cells: Hydrogen, methane, methanol - Sources and preparation, reformation processes for hydrogen – clean up and storage of the fuels, advantages and disadvantages of using hydrogen as fuel. Fuel cell - outlook and applications of fuel cells – Industrial and commercial.

MODULE IV DISPLAY AND SENSORS **9**

Display: Liquid crystals (LC's) - Introduction, classification, properties and application in Liquid Crystal Displays (LCD's). Properties and application of Organic Light Emitting Diodes (OLED's) and Quantum Light Emitting Diodes (QLED's).

Sensors:Introduction, working, principle and applications of Conductometric sensors, Electrochemical sensors, Thermometric sensors (Flame photometry) and Optical sensors (colorimetry). Electrochemical sensors for the pharmaceuticals and electrochemical gas sensors for SOx and NOx.

MODULE VE-WASTE AND BATTERY RECYCLING **9**

Introduction, sources of e-waste, Types, Characteristics, and Need of e-waste management. Toxic materials used in manufacturing electronic and electrical products, health hazards due to exposure to e-waste. Recycling and recovery - Different approaches of recycling (separation, thermal treatments, hydrometallurgical extraction, pyro-metallurgical methods, direct recycling).

COURSEOUTCOMES

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

CO1: Apply the concepts of electrochemistry.

CO2: Design the batteries and fuel cells.

CO3: Apply the suitable materials for electrodes, catalyst and membrane for the batteries and fuel cells.

CO4: Design stacks, fuels and reformation of fuels for fuel cells.

CO5: Apply the basic knowledge of sensors in analytical and biological applications.

CO6: Apply the concepts of recycling e-waste and their management.

TOTAL:45 PERIODS

TEXTBOOKS:

1. O G Palanna, "Engineering Chemistry", McGraw Hill Book Company, N.Y. 2017
2. Slobodan Petrovic, Peter Kurzweil, JurgenGarche, "Electrochemical Energy Storage: Batteries, Fuel Cells, and Hydrogen Technologies", 1st Edition, McGraw Hill Book Company, N.Y. 2022.
3. ShashiArya, Sunil Kumar, "Global E-waste Management Strategies and Future Implications", Elsevier Science, 2023

REFERENCES:

1. David Linden and Thomas. B. Reddy, “Hand Book of Batteries and Fuel cells”, 5th Edition, McGraw Hill Book Company, N.Y. 2019.
2. Atkins, “Physical Chemistry”, 11th Edition, Oxford, 2022.
3. M. G. Fontana, N. D. Greene, “Corrosion Engineering”, 3rd Edition McGraw Hill Publications, New York, 2017.
4. Oksana Ostroverkhova, “Handbook of Organic Materials for Optical and (Opto) Electronic Devices: Properties and Applications”, 1st edition, Woodhead Publishing, 2013
5. John O’M Bockris, Amulya K. N. Reddy and Maria Gamboa-Aldeco, “Modern Electrochemistry 2A: Fundamentals of Electrodics”, 2nd Edition, Kluwer Academic Publishers, Newyork, 2nd Edition reprint, 2018.
6. Robert A. Huggins, “Energy storage”, 2nd Edition, Springer Science & Business Media, 2014.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	2	3	3	1	1	3	1	3	2	2			
2	3	3	3	2	3	2	1	2	2	3	1	2			
3	3	3	3	2	3	2	1	2	3	3	2	3			
4	3	3	3	1	2	1	2	1	2	1	2	2			
5	3	2	3	1	2	2	1	2	1	1	1	3			
6	3	2	3	1	1	2	3	3	3	2	1	3			
AVg.	3	2.3	2.8	1.7	2.3	1.7	1.5	2.2	2	2.2	1.5	2.5			

1-low, 2-medium,3-high

23EE111	BASIC CIVIL AND MECHANICAL ENGINEERING PART A – BASIC CIVIL ENGINEERING	L	T	P	C
		2	0	0	2

MODULE I CONCEPT OF STRESS, STRAIN AND VIBRATION 10

Stress and Strain – Simple stresses and strains at a point – Normal and shear stresses – Hook's law – Young's Modulus – Bars subjected to Axial Forces – Thermal Stresses – Poisson's Ratio – Modulus of Rigidity – Surface and Volume Strains – Bulk Modulus – Relationship between Elastic Constants – Simple Problems. Introduction to vibrations – Simple Harmonic Motion, Mass-Spring System – Free and Forced Vibration – Damping (Concepts only)

MODULE II BUILDING MATERIALS AND BUILDING CONSTRUCTION 8

Building Materials – Classification of Stones, Bricks, Cement, Aggregates, Concrete and Steel. Building Components – Functions – Requirements. Green Building – Concept and Principles – Energy Efficient Materials.

MODULE III SUB-STRUCTURES AND SUPER-STRUCTURES 12

Basic principle, anodic and cathodic reaction, pressure and temperature effect. Types of Fuel Cells: Proton Exchange Membrane Fuel Cells, alkaline fuel cells, direct methanol fuel cells. Fuels for Fuel Cells: Hydrogen, methane, methanol - Sources and preparation, reformation processes for hydrogen – clean up and storage of the fuels, advantages and disadvantages of using hydrogen as fuel. Fuel cell - outlook and applications of fuel cells – Industrial and commercial.

COURSEOUTCOMES

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

CO1: Explain the stress and strain developed due to applied load in any structural member

CO2: Identify the components of building and differentiate various types of building materials depending on its function

CO3: Exhibit the knowledge on different sub-structures and super-structures of a building

TOTAL:30 PERIODS

TEXTBOOKS:

1. Bansal RK., "Strength of Materials", Laxmi Publications, New Delhi, 2010
2. Kaushik RK., "Strength of Materials", Dreamtech Press, 2019
3. Palanichamy M S., "Basic Civil Engineering" McGraw Hill Education; 4th edition, 2017
4. Duggal SK., "Building Materials" New Age Publishers; Fifth edition, 2019

REFERENCES:

1. Denny M., "Super Structures: The Science of Bridges, Buildings, Dams, and Other Feats of Engineering" Johns Hopkins University Press, 2010
2. Jain A K., "The Idea of Green Building" Khanna Publishers, 2014
3. Murthy V N S., "Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering" T&F/CRC Press, 2013.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	3	3	2	2	-	1	-	-	-	-	-			
2	2	3	3	2	2	-	2	-	-	-	-	-			
3	2	3	3	2	2	-	1	-	-	-	-	-			
AVg.	**2**	**3**	**3**	**2**	**2**		**1.3**								

1-low, 2-medium,3-high

23EE111	BASIC CIVIL AND MECHANICAL ENGINEERING PART B – MECHANICALENGINEERING	L	T	P	C
		2	0	0	2

MODULE IV INTERNAL COMBUSTION ENGINES, BOILERS ANDPOWER TRANSMISSION 15

Internal Combustion Engines: Classification of IC engines, construction and working principle of petrol and diesel engines, four stroke and two stroke cycles, comparison of four stroke and two strokeengines, petrol and diesel engines.

Boilers: Working principle of High Pressure Boilers (La Mont, Benson and Loeffler boilers), Low Pressure Boilers (Babcock and Wilcox Boilers).

Power Transmission Systems: Types of drives, construction and operation of belt drives, flat and V belts, rope drive, chain drive;Gear drives - spur, helical, bevel, worm and worm wheel, rack and pinion; Gear trains - simple and compound gear trains.

MODULE V PUMPS, TURBINES, REFRIGERATION AND AIR-CONDITIONING 15

Building Materials – Classification of Stones, Bricks, Cement, Aggregates, Concrete and Steel. Building Components – Functions – Requirements. Green Building – Concept and Principles – Energy Efficient Materials.

COURSEOUTCOMES

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

CO4: Explain the basics of mechanisms and principles of various mechanical engineering systems

CO5: Define the basic principles of IC engines, boilers and mechanical power transmission systems

TOTAL:30 PERIODS

TEXTBOOKS:

1. Venugopal, K; Raja, V Prabhu; Sreekanjana, G, Basic Civil and Mechanical Engineering, Anuradha Publications, 2020.
2. Mahesh M Rathore, Thermal Engineering, McGraw Hill Education, 2010.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
4	3	2	3	3	2	1	1	1	1	2		2			
5	3	2	2	2	2					2		2			
6	3	2	2	2	2		1			1		2			
AVg.	**3.0**	**2.0**	**2.3**	**2.3**	**2.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.7**		**2.0**			

1-low, 2-medium,3-high

23FPC122	BASIC SCIENCES LABORATORY	L	T	P	C
		0	0	4	2

LIST OF EXPERIMENTS:

1. Determination of band gap of semiconductors
2. Determination of Capacitance of a Capacitor
3. Determination of its efficiency of a solar cell using I-V characteristics of the cell
4. I-V characteristics of junction diode/Zener diode
5. Calibration of Ammeter and Voltmeter using Potentiometer
6. Determination of Earth's magnetic field using Tangent Galvanometer
7. Determination of Figure of Merit of Galvanometer
8. Determination of Specific Resistance of wire using Potentiometer
9. Determination of strength of given HCl using NaOH by pH measurement.
10. Determination of Alkalinity of water.
11. Determination of equivalent conductance of a strong electrolyte.
12. Estimation of Dissolved Oxygen in water sample.
13. Determination of sodium in water sample by flame photometry.
14. Estimation of iron in water sample by spectrophotometry.
15. Determination of corrosion rate of steel in acid media by weight loss method.
16. Estimation of ferrousion by potentiometric titration.

TOTAL:60 PERIODS

COURSEOUTCOMES:

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

CO1: Design and develop the methodology used to measure the band gap of a semiconducting material, to Estimate the capacitance of a capacitor and to Determine the efficiency of the solar cell.

CO2: Understand the characteristics and working of p-n junction diode/ Zener diode, to Calibrate the voltmeter and ammeter and to Determine the Magnetic induction of earth.

CO3: Determine the figure of merit and voltage sensitivity of a galvanometer and to Determine specific resistance of a metallic wire.

CO4: Apply the knowledge of detecting dissolved oxygen, alkalinity and metal ions in water sample

CO5: Implement different types of elemental analysis through titrations like volumetric, potentiometric and conductometry.

CO6: Handle analytical tools such as spectrophotometer, flame photometer and potentiometer and use the same for Engineering analysis.

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2							1			1
2	3	2							1			1
3	3	2							1			1
4	3	3	3	3	2	1	2	1	2	2	2	2
5	3	2	3	1	2	2	1	2	1	1	1	3
6	3	2	3	3	1	2	3	3	3	2	1	3
AVG	**3**	**2.2**	**3**	**2.3**	**1.7**	**1.7**	**2**	**2**	**1.5**	**1.7**	**1.3**	**1.8**

1-low,2-medium,3-high

23EE121	ENGINEERING DESIGN LABORATORY	L	T	P	C
		0	0	4	2

LIST OF EXPERIMENTS:

1. Component identification and procedure of PCB layout design and fabrication.
2. Design of PCB circuit for rectifiers.
3. Design of PCB circuit for voltage regulators.
4. Fabrication of PCB for simple circuits.
5. Verification of ohm's Law
6. Verification of KVL/KCL
7. Simple house wiring (Distribution box with CB, Stair case wiring, Motor and Light wiring)
8. Troubleshooting of electrical appliances – (Any Two from Fan, Induction Stove, Mixer, LED TV and Lamp, Electronic Choke, Washing Machine, Grinder)
9. Measurement of insulation resistance for cable and motor
10. Preparation of chemical earthing for domestic applications
11. Hybrid Solar - UPS system design for domestic application.
12. Study of Electrical Safety standards, tools and procedures
13. Measurement of Earth Resistance
14. Realization of BH Curve
15. Battery Charging and Discharging Curve
16. Electrical Drawing

TOTAL:60 PERIODS

COURSEOUTCOMES:

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

CO1: Infer the concepts of PCB design and fabrication.

CO2: Model and develop simple analog and digital circuits of PCB.

CO3: Demonstrate the electric circuit's laws.

CO4:acquire the practical knowledge of house wiring, components and safety standards

CO5: Develop the real time troubleshooting skills for domestic appliances

CO6: Measure the earth resistance, design a ups system and prepare the earthing system for domestic applications.

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2	1	3				3			
2	3	2	2	1	3				3			
3	3	2	2	1	3				3			
4	3	2	2	1	3							
5	3	2	2	1	3							
6	3	2	2	1	3							
AVG	**3**	**2**	**2**	**1**	**3**				**3**			

1-low,2-medium,3-high

23EE122	ENGINEERING GRAPHICS	L	T	P	C
		0	0	2	1

MODULE I INTRODUCTION TO COMPUTER AIDED ENGINEERING GRAPHICS 6

Principles of Engineering Graphics and their significance, Drawing Instruments and their uses, BIS conventions, lettering and Dimensioning Practice. AutoCAD User Interface – Menu system, draw, command, tool bars (draw, modify, annotations, layers etc.) – status bar (ortho, grid, snap, iso etc.)

MODULE II CONCEPT OF PROJECTIONS AND PROJECTION OF SOLIDS 10

Theory of projection – types of projections; orthographic Projections: – Conventions – First and Third Angle projections. Projections of Points, Projections of Lines, Projections of planes. Projections of Solids: Projections of regular solids prism and pyramid inclined to both planes. Practice with AutoCAD software.

MODULE III ISOMETRIC PROJECTIONS 14

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Simple Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa. Practice with AutoCAD software.

COURSEOUTCOMES

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

CO1: Incorporate the BIS and ISO standards in Engineering Drafting.

CO2: Imagine and visualize the geometric details of engineering objects.

CO3: Communicate ideas through technical drawings with the help of AutoCAD software

CO4: Interpret orthographic and isometric views of objects

CO5: Apply computer aided design and drafting tools to fulfil the design criteria of industry standards and practices

TOTAL:30 PERIODS

TEXTBOOKS:

1. S. Trymbaka Murthy, Computer Aided Engineering Drawing, International Publishing House Pvt. Ltd., New Delhi, 3rd revised edition-2013.
2. K. Venugopal, V. Prabhu Raja –Engineering Graphics, New Age International Publishers, 2017.

REFERENCES:

1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House.
2. Shah, M.B. &Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education.
3. Agrawal B. &Agrawal C. M. (2012), Engineering Graphics, TMH Publication.
4. Venugopal K (2007), Engineering Drawing and Graphics + AutoCAD, New Age International.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	2	3	3	1	1	1	1	2	3			
2	3	2	3	1	3	3		1			1	2			
3	2	2	3	1	3	2	1				1	3			
4	3	2	3	1	2	3	1		1		1	3			
5	3	2	3	1	3	3	1		1	1	1	3			
AVg.	2.8	2	3	1.2	2.8	2.8	1	1	1	1	1.2	2.8			

1-low, 2-medium,3-high

SEMESTER II

23FYM213	DIFFERENTIAL EQUATIONS AND NUMERICAL METHODS	L	T	P	C
		3	1	0	4

MODULE I ORDINARY DIFFERENTIAL EQUATIONS 12

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

MODULE II PARTIAL DIFFERENTIAL EQUATIONS 12

Formation of partial differential equations -Solutions of first order -Second and higher order homogeneous linear equations with constant coefficients- non-linear partial differential equations (standard types only) –-Lagrange's linear equation -Solutions of Linear partial differential equations of higher order with constant coefficients

MODULE III FOURIER SERIES 12

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

MODULE IV APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 12

Classification of PDE- – Method of separation of variables - Fourier series solutions of one dimensional wave equation (vibrations due to initial displacement)- One dimensional Heat Equations(Steady State conditions and Zero boundary conditions)- Steady state solution of two-dimensional equation of heat conduction (Cartesian coordinates only-Temperature distribution in finite plates)

MODULE V NUMERICAL ANALYSIS 12

Lagrange and Newton forms of interpolating polynomial, Newton forms of differentiation Numerical integration: Trapezoidal and Simpson 1/3 rule ,Numerical solution of initial value problems for ordinary differential equations: Modified Euler, Runge-Kutta method of order 4.

COURSEOUTCOMES

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

CO1: Calculate grad, div and curl and use Gauss, Stokes and Greens theorems to simplify calculations of integrals.

CO2: Apply various methods of solving differential equation which arise in many application problems.

CO3: Obtain the solutions of the partial differential equations using general methods.

CO4: Solve partial differential equations which arise in application problems.

CO5: Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to the algebraic and transcendental equations and to obtain approximate solutions to mathematical problems using interpolation.

CO6: Analyse and evaluate the accuracy of common numerical methods in solving ODE of First and Second order equations.

TOTAL:60 PERIODS

TEXTBOOKS:

1. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), 7th Edition, New Delhi, 2009.

2. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.

REFERENCES:

1. Ramana, B.V. "Higher Engineering Mathematics", Tata McGraw Hill, 11th Reprint, New Delhi, 2010.

2. “Peter V.O’Neil, “Advanced Engineering Mathematics”, Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi, 2012.
3. Glyn James, “Advanced Modern Engineering Mathematics”, Pearson Education, 4 th Edition, New Delhi, 2011.
4. Morton K.W. and Mayers D.F., “Numerical solution of partial differential equations”, Cambridge University press, Cambridge, 2002.
5. Burden, R.L., and Faires, J.D., “Numerical Analysis – Theory and Applications”, Cengage Learning, India Edition, New Delhi, 2009.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	1										1	2		
2	3	1										1	2		
3	3	1										1	2		
4	3	1										1	2		
5	3	1										1	2		
6	3	1										1	2		
AVg.	**3**	**1**										**1**	**2**		

1-low, 2-medium,3-high

23EE211	ELECTRIC AND MAGNETIC CIRCUITS	L	T	P	C
		3	0	0	3

MODULE I CIRCUIT ELEMENTS **9**

Electric circuit – System of units –Charge and Current– Voltage –Power and Energy —- Circuit Elements – Active and Passive Elements –Linear and bilateral elements - Independent and dependent current and voltage sources – Resistors, Inductors, and Capacitors – Stored Energy – Voltage, Current and Power Relationships of circuit elements – Series and Parallel combination of circuit elements – source transformation – star/delta transformation.

MODULE II DC CIRCUIT ANALYSIS **9**

Kirchhoff's laws - DC Analysis of Series, parallel and Series-parallel circuits – Voltage and Current division rules –Mesh current and node voltage methods of analysis of DC circuits.

MODULE III FUNDAMENTALS OF A.C. **8**

Generation of Alternating Voltages - Terms Related to Alternating Quantities - RMS or Effective Value - Average Value – Form factor – Peak factor - Phasor Representations of Alternating Quantities - Mathematical Representations of Phasor.

MODULE IV MAGNETIC CIRCUITS **10**

Magnetic Field – Magnetic Flux – Magnetic Field Strength – Flux Density – MMF – Reluctance and permeability - Laws of magnetic circuits : Biot-Savart's Law, Ampere's Circuital Law (derivation of laws only) – Fleming's Left hand rule – Hysteresis – Calculation of Ampere-turns for series and series-parallel magnetic circuits – Comparison of Electric and Magnetic circuits.

MODULE V ELECTROMAGNETIC INDUCTION **9**

Faraday's laws of electromagnetic induction – Lenz's Law- Direction of induced EMF – Fleming's Right Hand Rule – Statically induced EMF – dynamically induced EMF – self-inductance – mutual inductance – Coefficient of coupling – Dot convention – equivalent inductance of coupled coils connected in series and parallel.

COURSEOUTCOMES

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

CO1: Develop an understanding of the elements of electrical circuits and to learn the energy properties of electric elements.

CO2: Apply the knowledge of basic circuital laws to simplify the dc networks using mesh and nodal analysis.

CO3: Analyze different types of waveforms and find their rms and average values.

CO4: Understand the basics of magnetic circuits and the laws related to magnetic circuits**.**

CO5: Calculate the ampere-turns required for different types of magnetic circuits.

CO6: Understand the concepts related to Faraday's law, induced emf and coupled circuits.

TOTAL:45 PERIODS

TEXTBOOKS:

1. Charles K. Alexander, Mathew N. O. Sadiku, "Fundamentals of Electric Circuits", V Edition, McGraw-Hill Education (India) Private Limited, New Delhi 2013.

2. V.N. Mittle and Arvind Mittal, "Basic Electrical Engineering", II Edition, McGraw-Hill Education (India) Private Limited, New Delhi, 2006.

REFERENCES:

1. Ravish R Singh, “Basic Electrical Engineering”, III Edition McGraw-Hill Education (India) Private Limited, New Delhi, 2019.
2. Fred Alan Fish, “Fundamental Principles of Electric and Magnetic Circuits”, II Edition, Sagwan Press, USA, 2018.
3. Kothari D.P and Nagrath I.J., Basic Electrical Engineering”, McGraw-Hill Education (India) Private Limited, IV Edition, New Delhi, 2019.
4. Mehta V.K and Rohit Mehta, “Principles of electrical engineering”, S. Chand & Company Private Limited, New Delhi, 2014.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2													
2		3													
3		3													
4	2														
5		2													
6	3	2													
AVg.	**2.6**	**2.4**													

1-low, 2-medium,3-high

23EE212	ELECTRICAL MEASUREMENTS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

MODULE I MEASUREMENT CONCEPTS **7**

Functional elements of an instrument - Static characteristics - errors in measurement - calibration and standards in measurement- Transducers: Factors influencing the transducer selection - Classification - Introduction to Intelligent Sensors –MEMS sensors – Nano sensors – System on chip.

MODULE II ELECTRICAL MEASUREMENTS **12**

Analog meters: PMMC and Moving Iron Instruments: Working, comparison and measurement of DC and AC Voltage and Current – Electrodynamometer type watt meter - Insulation resistance test - Measurement of earth resistance: Fall of potential method- Instrument Transformers; CT and PT – Applications.

Digital meters: Block diagram and functioning of Multi-Meter, Principles of Net metering- By- directional single phase energy meter –Frequency Meter.

AC Bridges: Wheatstone, Kelvin, Maxwell, Schering and Wein bridges.

MODULE III NON-ELECTRICAL MEASUREMENTS **12**

Transducers: - Linear and Angular displacement: Resistive (Potentiometer), inductive (LVDT) – Liquid Level: Capacitive - Force and torque sensors(Industry and Automobile)- Fulid flow meters: Electromagnetic and ultrasonic types – Air flow: Anemometer- Temperature: RTD, Thermistor Thermocouple, - Optical sensors: photo-diode, LDR, Opto-coupler- Thermography: Principle, thermal imaging and applications.

MODULE IV DISPLAY AND RECORDING INSTRUMENTS **6**

Functioning of Analog CRO - Dual Trace and Dual Beam CROs - Digital Storage Oscilloscopes (DSO) –- Signal Analyser - Spectrum Analyzer– Harmonic Analyzer – Mixed signal oscilloscopes (MSO) - Signal Generator – Function Generator – Recorders: X-t recorder- X-Y recorder.

MODULE V INTELLIGENT INDUSTRIAL INSTRUMENTATION **8**

Faraday's laws of electromagnetic induction – Lenz's Law- Direction of induced EMF – Fleming's Right Hand Rule – Statically induced EMF – dynamically induced EMF – self-inductance – mutual inductance – Coefficient of coupling – Dot convention – equivalent inductance of coupled coils connected in series and parallel.

COURSEOUTCOMES

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

CO1: interpret the functional elements of Industrial instrumentation to measure the process variables by using modern sensors.

CO2: identify the measuring instruments for electrical parameters such as voltage, current, power, energy and cable insulation.

CO3: Analyze the usage of laboratory instruments in measuring the values of R, L, C and HT power.

CO4: Select appropriate analog / digital instruments for measuring electrical and non-electrical parameters.

CO5: apply the laboratory display, recording instruments and the waveform generators in the relevant applications.

CO6: identify suitable monitoring systems for the industrial process control with intelligent instrumentation.

TOTAL:45 PERIODS

TEXTBOOKS:

1. Sawhney A.K., “A Course in Electrical and Electronic Measurements and Instrumentation”, Dhanpat Rai& Sons, New Delhi, 19th Edition, 2019.

2. Syed Akhtar.I and VibhavKumar.S, “Electronic Measurement and Instrumentation” I K International publishing House, 2018.

REFERENCES:

1. Ernest O.Doeblin“Measurement Systems – Applications and Design”, McGraw Hill, 2nd edition 2010.
2. Ramabhadran S., “Electrical Measurements and Instruments”, Khanna Publishers, New Delhi, 1993.
3. D.Cooper and A.D.Helfrik, “Modern Electronic Instrumentation and Measurement Techniques”, 2nd edition, Prentice Hall of India, New Delhi, 2008.
4. E. W. Golding & F. C. Widdis, “Electrical Measurement & Measuring Instrument”, 5thedition, A.H.Wheeler& co., India,2011.
5. Kalsi H.S.,“Electronic Instrumentation”, Tata McGraw Hill Co, 3rdEdition,2010.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	2							1				
2	3	2	2	2							1				
3	3	2	2	2							1				
4	3	2	2	2							1			2	
5	3	2	2	2							1				
6	3	2	2	2							1			2	
AVg.	3	2	2	2							1			2	

1-low, 2-medium,3-high

23EE213	DIGITAL ELECTRONICS	L	T	P	C
		3	0	0	3

MODULE I NUMBER SYSTEM AND CODES **10**

Binary, octal, and hexadecimal numbers – number-base conversions - Signed binary number - Fixed point representation of number – complement binary arithmetic: 1's complement and 2's complement arithmetic - Computer codes: BCD, excess-3, and gray codes - Error detecting and correcting codes: Parity code and Hamming code.

MODULE II BOOLEAN ALGEBRA AND LOGIC GATES **9**

Fundamental postulates of Boolean algebra – laws of Boolean algebra – DeMorgan's theorems – standard representation of logic functions – canonical and standard forms - minterm and maxterm - simplification of Boolean expression – digital logic gates – Implementation of Boolean functions using logic gates.

MODULE III GATE-LEVEL MINIMIZATION **8**

Karnaugh map (K-Map) method – Three, Four, and five variable maps – simplification of SOP and POS expression – don't care conditions – NAND-NAND and NOR-NOR implementation – Multilevel gate implementations.

MODULE IV COMBINATIONAL LOGIC CIRCUITS **10**

Analysis and design procedure for combinational logic circuit – Binary adder: half-adder, full adder, and parallel adder – Binary subtractor: half subtractor and full subtractor – BCD adder – Code converters – decoder – encoder – multiplexer – demultiplexer.

MODULE V TTL AND CMOS DIGITAL LOGIC FAMILIES **8**

TTL logic: TTL with totem-pole output – TTL with open collector output – Tristate TTL – TTL parameters – CMOS logic: CMOS inverter – CMOS NAND and NOR gates - Characteristics of CMOS - Comparison of TTL and CMOS families.

COURSEOUTCOMES

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

CO1: Understand different number systems and coding schemes and arithmetic operations on binary numbers.

CO2: Clarify the basic theorems and properties of Boolean algebra.

CO3: Utilize K- Map for gate level minimization of the given Boolean function.

CO4: Construct combinational logic circuits for the given requirement and implement using logic gates.

CO5: Analyze and predict the behavior of simple digital circuits.

CO6: Select suitable logic family for designing digital circuits to meet the design specifications.

TOTAL:45 PERIODS

TEXTBOOKS:

1. Morris Mano M, and Michael D. Ciletti, "Digital Design", VI Edition, Pearson Education, New Delhi, Hall of India Ltd, 2018.

2. Salivahanan S, and Arivazhagan, S, "Digital Circuits and Design", V Edition, Oxford University Press India, 2018.

REFERENCES:

1. Ronald J. Tocci, "Digital Systems - Principles and Applications", PHI Ltd., 11th Edition, 2011.

2. Godse A.P, and Godse D.A., “Digital Principles and System Design”, IV Edition, Technical Publications, 2012.
3. Kharate G.K., “Digital Electronics”, III Edition, Oxford University Press India, 2011.
4. Donald D. Givone., “Digital Principles and Design”, I Edition, McGraw Hill India, 2012.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2													
2		3													
3		3													
4	2												3	3	
5		2											3	3	
6	3	2											3	3	
AVg.	**2.6**	**2.4**											**3**	**3**	

1-low, 2-medium,3-high

23EE214	ANALOG ELECTRONIC CIRCUITS	L	T	P	C
		3	0	0	3

MODULE I DC POWER SUPPLIES **9**

Single phase rectifiers: Half wave, Full wave and Bridge rectifiers - Ripple factor - Rectification efficiency - TUF - PIV - Regulation - Filters: Inductor, Capacitor, L section and π section filters - Ripple factor - Regulators: Series and Shunt type - Protection circuits.

MODULE II BJT AND FET SMALL SIGNAL AMPLIFIERS **9**

BJT Amplifier : Small signal low frequency parameters and equivalent circuit - Small signal analysis of CE, CB and CC amplifiers with voltage divider bias using h - parameters. FET Amplifier: Small signal model and analysis of CS, CD and CG amplifiers- Differential Amplifiers.

MODULE III MULTISTAGE AMPLIFIERS AND LARGE SIGNAL AMPLIFIERS **9**

Multistage amplifier: RC Coupled - Transformer coupled amplifiers - Frequency response. Large signal amplifier: Class A power amplifier - Harmonic distortion - Class B amplifier - Push - pull amplifier - Complementary symmetry operation - Class AB amplifier, Class C amplifier and Class D amplifier.

MODULE IV FEEDBACK AMPLIFIERS **9**

Feedback concepts - General characteristics of Negative feedback amplifiers – Effect of Feedback on Amplifier characteristics-Ideal feedback topologies - Analysis of voltage and current: Series and Shunt feedback amplifier circuits.

MODULE V OSCILLATORS **9**

Barkhausen criterion – RC phase shift oscillator and Wien bridge oscillators LC type oscillators - Hartley Oscillator - Colpitts Oscillator - Crystal Oscillator- Frequency Stability.

COURSEOUTCOMES

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

CO1: Explain working principle of different electronic circuits and their application in real life.

CO2: Select proper semiconductor devices depending upon application.

CO3: Model the amplifier circuits to observe the performance parameter.

CO4: Evaluate the expected performance of various general-purpose electronic circuits.

CO5: Determine the frequency response of an electronic circuit.

CO6: Design different signal conditioning circuit and the use in industrial, real life and modern control system application.

TOTAL:45 PERIODS

TEXTBOOKS:

1. Jacob Millman, Christos C Halkias and Satyabrata Jit, "Electronic Devices and Circuits", Tata McGraw-Hill, 4th Edition, 2015..

2. Allen Mottershead, "Electronic Devices and Circuits - An Introduction", PHI learning, 2011.

3. Adel S. Sedra, Kenneth C. Smith, “Microelectronic Circuits”, Oxford University Press, Fifth Edition, 2005.

4. Thomas L. Floyd, David M. Buchla, Electronics Fundamentals: Circuits, Devices & Applications, 8th Edition, Pearson education, 2014.

REFERENCES:

1. Robert L. Boylstead and Louis Nashelsky, "Electronic Devices and Circuit Theory", Prentice - Hall of India, 11th Edition, New Delhi, 2015.

2. Donald E. Neaman, “Electronic Circuit, Analysis and Design”, Tata McGraw Hill Publishing Company Limited, Second Edition, 2006.
3. David A. Bell, “Electronic devices and Circuits”, 5th Edition, Oxford University Press India, 2008.
4. P. R. Gray, R. G. Meyer and S. Lewis, “Analysis and Design of Analog Integrated Circuits”, John Wiley & Sons, 2001.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	1	1	1	1						3	1			
2	3	1	1	1	1						3	1			
3	3	1	2	2	2						3	1	3		
4	3	3	3	3	3	2			2		3	1	3	2	
5	3	3	3	3	3						3	1	3	2	
6	3	3	3	3	3	3	3		3	3	3	1		3	
AVg.	**3**	**2**	**2.2**	**2.2**	**2.2**	**2.5**	**3**		**2.5**	**3**	**3**	**1**	**3**	**2.3**	

1-low, 2-medium,3-high

23FYH221	ENGLISH COMMUNICATION AND COMPETENCY LABORATORY	L	T	P	C
		0	0	4	2

Verbal Aptitude

Alphabet test – Alphabet Order, Alphabet Series - Letter Word Problem, Word Formation and Scramble - Series Completion –Para Jumbles- Synonyms and Antonyms - Sentence Completion - Logical Sequence of Words - Word Power Exercises - Common Errors in English - Sentence Correction

Speaking and Writing

Self-Introduction- Greeting - Thanking – Apologizing - Congratulating -Complaining - Giving Instructions - Advising and Sympathizing – Requesting and warning people - Introduction to Phonetics – Consonants and Vowels - Extempore - Just a Minute - Book Reviews - Describing an object -- Story Building – Creative Writing – Describing a Picture – Dialogue Writing – Paraphrasing

Reading and Listening

Reading Comprehension- Skimming and Scanning - Reading Prose – Bacon's Essays (Speaking Activity based on the essays) - Listening to Short Conversations – Listening to Monologues – Listening and Gap Filling.

Career Development Skills

Technical Presentation -Applications of MS Power Point- Group Discussion – Interview Skills – Telephoning Skills

LIST OF EXPERIMENTS BASED ON THE ABOVE SYLLABUS

1. Speech Sounds
2. Vocabulary
3. Reading Comprehension
4. Listening Practice – I
5. Dialogue Writing
6. Conversational Exercise – I
7. Focus on Language
8. Creative Writing
9. Conversational Exercise –II
10. Listening Practice – II
11. Greeting & Thanking
12. Complaining, Apologizing & Congratulating
13. Asking & Giving Directions
14. Alphabet Series & Letter Series Word Formation

TOTAL:60 PERIODS

COURSEOUTCOMES:

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

CO1: Solve timed objective questions on logical reasoning and verbal ability.

CO2: Use appropriate functional expression and converse effectively.

CO3: Assimilate meaning and comprehend text.

CO4: Perceive the nuances of Presentation, Interview and Group Discussion skills.

CO5: Generate language structures accurately and speak fluently.

CO6: Enhance LSRW Skills

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1									2	3		1
2									2	3		1
3									2	3		1
4									2	3		1
5									2	3		1
6									2	3		1
AVG									**2**	**3**		

1-low,2-medium,3-high

23EE221	ANALOG AND DIGITAL ELECTRONICS LABORATORY	L	T	P	C
		0	0	4	2

LIST OF EXPERIMENTS

1. Half wave and Full wave Rectifiers
2. RC coupled amplifier using BJT in CE configuration
3. FET amplifier using FET in CS configuration
4. Class B push-pull power amplifier
5. Phase shift oscillator using BJT
6. Basic logic gates using NAND and NOR gates
7. Half adder and full adder
8. Multiplexer and Demultiplexer
9. Encoder and Decoder
10. Logic gates using PN junction diodes

TOTAL:60 PERIODS

COURSEOUTCOMES:

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

CO1: Select various electronic instruments for conducting experiments.

CO2: Design and implement simple electronic circuits using BJT and FET to accomplish specific functions.

CO3: Observe the gain and frequency responses of amplification circuits.

CO4: Illustrate the realization of Boolean expression in SOP and POS form and design it using logic gates.

CO5: Design and test the combinational digital circuits.

CO6: Design, develop, and create simple digital electronic circuits for specific applications.

CO-PO& PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	1	1					3	2	3	1
2	3	2	2	2	2				3	2	3	1
3	3	2	2	2	2				3	2	3	1
4	3	2	2	2					3	2	3	1
5	3	3	3	3	3	3	3	1	3	2	3	1
6	3	3	3	3	3	3	3	1	3	2	3	1
AVG	**3**	**2.3**	**2.2**	**2.2**	**2.5**	**3**	**3**	**1**	**3**	**3**	**3**	**1**

1-low,2-medium,3-high

23EE222	C PROGRAMMING AND DATA BASES LABORATORY	L	T	P	C
		0	0	4	2

LIST OF EXPERIMENTS

1. Operators in C Programming
2. Decision statements in C Programming
3. Control statements in C Programming
4. Arrays in C Programming
5. Pointers in C Programming
6. Functions in C Programming
7. Structures in C Programming
8. Solving Electric Circuit using C Programming
9. Database creation, insertion and deletion
10. Alter Table statements
11. Primary Key and Foreign Key
12. Queries based on DML commands
13. Aggregate functions
14. Sub-queries and joins
15. Group by clause and Date functions

TOTAL:60 PERIODS

COURSEOUTCOMES:

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

CO1: Write, compile and debug C programs.

CO2: Develop C programs using decision making statements, decision constructs.

CO3: Construct C programs using arrays and structures.

CO4: Develop C programs using pointers and functions.

CO5 Write various MySQL commands to create database.

CO6: Perform various database operations and solve queries for given application.

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	2	3	2	1	3				2	3		3
2	2	3	3	1	3				2	3		3
3	2	3	3	1	3				2	3		3
4	2	3	3	1	3				2	3		3
5	2	3	2	1	3				2	3		3
6	2	3	3	1	3				2	3		3
AVG	**2**	**3**	**2.6**	**1**	**3**				**2**	**3**		**3**

1-low,2-medium,3-high

SEMESTER III

23M313	COMPLEX ANALYSIS AND TRANSFORMS	L	T	P	C
		3	1	0	4

MODULE I COMPLEX ANALYSIS 9+3

Analytic functions – Properties – Construction of analytic function by Millen's Method. Cauchy's integral theorem (without proof) – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem (without proof)

MODULE II LAPLACE TRANSFORM 9+3

Conditions and properties -Transform of standard functions -Transform of unit step, unit impulse function and periodic functions -Initial and final value theorems -Inverse transforms -Convolution theorem - Applications to solve ordinary differential equations.

MODULE III Z – TRANSFORMS 9+3

Introduction of Z-transforms – Properties – Simple Problems - Inverse Z-transforms -– Definition of difference equation - Solution of difference equation with constant coefficients.

MODULE IV RANDOM VARIABLES 9+3

Moments – Moment generating functions – Binomial, Poisson, Uniform and Exponential distributions – Joint distributions – Marginal and conditional distributions – Covariance – Correlation and regression

MODULE V RANDOM PROCESSES 9+3

Classification – Stationary Process- Wide Sense Stationary Process-Jointly WSS Processes- Gaussian Process - Poisson Process

COURSEOUTCOMES

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

CO1: Construct analytic functions and use their conformal mapping property in application problems.

CO2: Evaluate real and complex integrals using the Cauchy's integral formula and residue theorem

CO3: Apply Laplace transform methods for solving linear differential equations.

CO4: Analyze the functions as an infinite series involving sine and cosine functions.

CO5: Obtain Fourier transforms for the functions which are needed for solving application problems.

CO6: Manipulate discrete data sequences using Z transform techniques.

TOTAL:60 PERIODS

TEXTBOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, New Delhi, 2017
2. Johnson. R.A., Miller. I and Freund. J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 9th Edition, 2016.

REFERENCES:

1. Ramana, B.V. "Higher Engineering Mathematics", Tata McGraw Hill, 11th Reprint, New Delhi, 2010
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics",Narosa Publications, 5th Edition, New Delhi, 2017.
3. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education,2nd Edition, 5th Reprint, Delhi, 2009.
4. Sivarmakrishnadas.P ,Rukmangadachari.E , "Engineering Mathematics", Pearson Education 2nd Edition, Delhi, 2013.
5. Srimantha Pal and Bhunia.S.C, "Engineering Mathematics", Oxford Univeristy Press.,2015

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	1										1	2		
2	3	1										1	2		
3	3	1										1	2		
4	3	1										1	2		
5	3	1										1	2		
6	3	1										1	2		
AVg.	**3**	**1**										**1**	**2**		

1-low, 2-medium,3-high

23EE311	ELECTRIC CIRCUIT ANALYSIS	L	T	P	C
		3	1	0	4

MODULE I AC CIRCUITS **12**

Single phase ac series and parallel circuits – transforming a circuit into a phasor equivalent circuit-electrical power- power factor – impedance and power triangle-concept of complex power

MODULE II RESONANCE **10**

Series and Parallel Resonance –impedance and phase angle of a resonant circuit – bandwidth and quality factor – voltage and current in a resonant circuit – variation of impedance with frequency.

MODULE III CIRCUIT THEOREMS AND COUPLED CIRCUITS **15**

Mesh and Nodal analysis in AC circuits - Linearity of a circuit and Superposition Theorem - Thevenin's theorem - Norton's theorem - Maximum Power Transfer Theorem - Reciprocity Theorem – Millman's Theorem-Analysis of coupled circuits- conductively coupled circuits- single tuned and double tuned coupled circuit.

MODULE IV THREE PHASE CIRCUITS **12**

Advantages of three phase system - generation of three - phase voltages - phase sequence - inter connection of three – phase sources and loads - star and delta connections - line and phase quantities - analysis of three phase circuits with star and delta connected balanced and unbalanced loads-Three phase power measurement..

MODULE V CIRCUIT TRANSIENTS **11**

Transient concepts - differential equations and initial conditions in RLC networks - transient response of simple RL, RC, and RLC series circuits to step and sinusoidal inputs using Laplace transform method.

Note: 1. A term paper on "Computer Simulation of Electric Circuits" to be submitted during the course work for internal assessment using MATLAB/PSIM/pSpice/Multisim.

2. Design Problems and Practical Applications to be discussed for all the units and team activity may be given on the specific design tasks for internal assessment.

COURSEOUTCOMES

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

CO1: Apply &analyse the sinusoidal excitation of R, L, C under steady state and associated power relations

CO2: Comprehend frequency response of a resonant circuit and analyse the impact of quality factor, bandwidth on the frequency response.

CO3: Cognize the concept of linearity and apply the circuit theorems to solve complex electric circuits.

CO4: Recognize the significance of three phase systems with star & delta connected circuits to solve the three phase circuits for both domestics and industrial applications

CO5:Analyze first order and second order circuits under transient and steady-state conditions

CO6 :Learn and Simulate the electric circuits and its applications

TOTAL:60 PERIODS

TEXTBOOKS:

1. Charles K. Alexander and Matthew N.O.Sadiku, "Fundamentals of Electric Circuits" McGraw Hill Education (India) Private Limited, 7th Edition, 2021.
2. Herbert W. Jackson, Dale Temple,etal, "Introduction to Electric Circuits" Oxford University Press Canada, 10th Edition, 2019.

REFERENCES:

1. William H. HaytJr, Jack E. Kemmerly, and Steven M.Durbin, "Engineering Circuit Analysis", McGraw Hill Education (India) Private Limited, Ninth Edition, 2020.
2. James W.Nilsson,SusanA.Riedel, “Electric Circuits” Pearson, 11th Edition, 2020
3. Robert.L.Boylestad, “Introductory Circuit Analysis” Pearson Education Limited, 14th Edition, 2024.
4. Joseph A. Edminister and MahmoodNahvi, "Electric Circuits", Schaum's Series, McGraw Hill Education (India) Private Limited, 7th Edition, 2018.
5. John E. Ayers, “A Practical Introduction to Electrical Circuits”CRC Press, 1st Edition,2024.
6. https://nptel.ac.in/courses/108104139/

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3									2	3	2	
2	3	3	3										3	2	
3	3	3	3	3									3	2	
4	3	3	3									2	3	2	
5	3	3	3	3									3	2	
6	3				3				3				3	2	
AVg.	**3**	**3**	**3**	**3**	**3**				**3**			**2**	**3**	**2**	

1-low, 2-medium,3-high

23EE312	ELECTROMAGNETIC FIELDS	L	T	P	C
		3	1	0	4

MODULE I VECTOR ANALYSIS 12

Vector algebra - Co - ordinate systems - Vector calculus: Dot product of vectors, Cross product of vectors, Transformation of vectors - Types of integral related to electromagnetic theory - Gradient, Divergence and Curl - Divergence theorem - Stoke's theorem.

MODULE II ELECTROSTATIC FIELDS 12

Coulomb's law - Electric field intensity of point, line and sheet of charges - Electric flux density - Gauss's law and its applications - Poisson's and Laplace equations - Electric potential - Potential gradient.

MODULE III ELECTRIC FIELD IN MATERIALS AND CAPACITANCE 12

Properties of Conductors and dielectric materials - Polarization in dielectrics - Boundary conditions for perfect dielectric materials - Electric dipole - Potential and field due to an electric dipole - Capacitance of parallel plate capacitor, spherical capacitor and cables with single dielectric - Electrostatic energy storage and Energy density.

MODULE IV MAGNETOSTATICS AND INDUCTANCE 12

Applications of Biot - Savart's law - Applications of Ampere's circuital law - Scalar and Vector magnetic potentials - Magnetization - Magnetic boundary conditions - Inductance of Transmission lines - Magneto static energy and energy density - Lifting force of a magnet.

MODULE V ELECTRODYNAMIC FIELDS AND ELECTROMAGNETIC WAVES 12

Conduction and displacement current densities - Maxwell's equations in differential and integral forms - Maxwell's equation for harmonically varying fields - Electromagnetic waves: Electromagnetic wave equations - Intrinsic impedance and Skin depth - Electromagnetic waves in good conductors, lossy and lossless dielectrics - Poynting vector and Poynting's theorem.

COURSEOUTCOMES

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

CO1: Illustrate Coulomb's law, Gauss law, and Poisson and Laplace equation and apply them to solve electrostatic field problems.

CO2: Demonstrate the behavior of Conductors and Dielectrics on the application of static electric field and perceive about Dielectric boundary conditions, electric dipoles

CO3: Apply Ampere's circuital law and Biot - Savart's law to solve magneto static field problems and elaborate scalar and vector magnetic potentials, Magnetic boundary conditions.

CO4: Determine the Capacitance and Inductance for various configurations in Electrostatic and Magnetostatic fields.

CO5:Acquire knowledge in Maxwell's equations of different forms (differential and integral) and apply them to diverse engineering problems.

CO6 :Solve electromagnetic wave equations and interpret the wave motion in conductors and insulators, significance of Poynting vector and Poynting theorem.

TOTAL:60 PERIODS

TEXTBOOKS:

1. Matthew N.O.Sadiku, "Elements of Electromagnetics", Oxford University Press, 6 thedition, 2015.
2. Gangadhar K.A. and Ramanathan P.M, "Electromagnetic Field Theory", Khanna Publishers, Delhi, 2015.

REFERENCES:

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

edition, 2014.
2. John D. Kraus and Daniel A. Fleisch, "Electromagnetics with Applications", Tata McGraw Hill, 4th Edition, 2010.
3. Ophelia burgess, “Principles of Electromagnetism”, Larsen & Keller Education, 2019..
4. Steven W. Ellingson,’Electromagnetics”,Volume 2, Virginia tech publishing, 2019
5. Joseph. A.Edminister, Schaums Outline of Electromagnetics, Fifth Edition (Schaums Outline Series), McGraw Hill, 2018.
6. Hai-Zhi Song, Kim Ho Yeap, Magdalene Wan ChingGoh, “Electromagnetic Field in Advancing Science and Technology”, IntechOpen, 2023

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	2	1	2	-	-	1	-	1	1	3	2	2
2	3	3	2	2	1	2	-	-	1	-	1	1	3	2	1
3	3	3	2	2	1	2	-	-	1	-	1	1	3	2	2
4	3	3	2	2	1	2	-	-	1	-	1	1	3	2	1
5	3	3	2	2	1	2	-	-	1	-	1	1	3	2	2
6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
AVg.	**3.0**	**3.0**	**2.2**	**2.2**	**1.3**	**2.2**	**3.0**	**3.0**	**1.3**	**3.0**	**1.3**	**1.3**	**3.0**	**2.2**	**1.7**

1-low, 2-medium,3-high

23EE313	DC MACHINES AND TRANSFORMERS	L	T	P	C
		3	0	0	3

MODULE I DC GENERATOR **10**

Basic structure of electrical machines - D.C Generator Construction – Magnetic circuit of a D.C. Generator - Principle of operation - Methods of excitation - Armature Windings - EMF equation - Armature reaction –- commutation - characteristics – Voltage buildup in Self-Excited Generators.

MODULE II DC MOTOR **8**

Motor principle – Back E.M.F – Equivalent circuit of a DC Motor armature – Torque equation – Types of DC Motors – Characteristics.

MODULE III SPEED CONTROL AND TESTING OF DC MOTORS **9**

Speed control of DC motors – starters for DC motors – three-point and four-point starters - Losses and Efficiency - Testing of DC machines – Brake test – Swinburne's test – Hopkinson's test - Electric braking of DC motors.

MODULE IV TRANSFORMERS **10**

Construction and operation of single phase transformers - EMF equation- voltage ratio and turns ratio - Phasor diagrams on no-load and loaded conditions - equivalent circuit - voltage regulation - losses and efficiency - All day efficiency- Predetermination of performance from open circuit and short circuit tests - Parallel operation of single-phase transformers.

MODULE V AUTOTRANSFORMERS AND THREE PHASE TRANSFORMERS **8**

Single-phase Autotransformer: construction - saving in conductor material – advantages, disadvantages, and applications - Three-phase transformer construction – connections –factors affecting the choice of connections - special Purpose Transformers: Pulse, welding, rectifier, and high frequency transformers.

COURSEOUTCOMES

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

CO1: Develop an understanding of the functionality of DC Generators and DC Motors with their classification.

CO2: Acquire knowledge on characteristics of DC Generators and DC Motors for different operating conditions

CO3: Illustrate the speed control methods, braking and testing of DC machines for industrial application.

CO4: Enlighten the construction of transformer and to compute the equivalent circuit parameters to evaluate its performance under various conditions.

CO5:Erudite the basic concept of three phase connections, principle of autotransformers and special purpose transformers.

CO6: Select DC machines and transformers for specific application.

TOTAL:45 PERIODS

TEXTBOOKS:

1. Ashfaq Husain, "Electrical Machines", III Edition, DhanpatRai& Co. (Pvt) Ltd, New Delhi, 2017.

2. SmarajitGhosh., "Electrical Machines I ", I Edition, Pearson Education, 2011.

REFERENCES:

1. Nagrath I.J. and Kothari D.P., "Electrical Machines", II Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2000.
2. Murugesh Kumar, K, "DC Machines and Transformers", II Edition, Vikas Publishing House PVT Ltd, New Delhi, 2004.
3. Bhattacharya, S.K., "Electrical Machines", Tata McGraw Hill, 2017.
4. Gupta J.B., "Electrical Machines", S.K. Kataria& Sons, 15th Edition, 2022.

5. Theraja B.L and Theraja A.K., “A Text Book of Electrical Technology Volume II: AC and DC Machines”, S. Chand and Publishing Company, 2014.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2													
2		3													
3		3													
4	2														
5		2													
6	3	2													
AVg.	**2.7**	**2.4**													

1-low, 2-medium,3-high

23EE314	LINEAR INTEGRATED CIRCUITS	L	T	P	C
		3	0	0	3

MODULE I IC FABRICATION 9

IC classification, fundamental of monolithic IC technology, epitaxial growth, masking and etching, diffusion of impurities.Realisation of monolithic ICs and packaging.Fabrication of diodes, capacitance, resistance, FETs and PV Cell.

MODULE II CHARACTERISTICS OF OPERATIONAL AMPLIFIERS 9

Functional block diagram – Equivalent circuit - Open loop gain - CMRR - Inverting and Non-inverting amplifier- Input bias and offset currents - Input and Output offset voltages - Offset compensation techniques - Frequency response - Stability - Limitation - Frequency compensation techniques - Slew rate.

MODULE III APPLICATIONS OF OPERATIONAL AMPLIFIERS 9

Summing amplifier - Voltage follower - Differential amplifier - Voltage to Current and Current to Voltage converters - Instrumentation amplifier.Integrator and Differentiator.Solution to Integro-differential equations- Active filters and Oscillators.

MODULE IV COMPARATORS AND CONVERTERS 9

Comparator- Zero crossing detector - Schmitt trigger - Sample and Hold circuit - D/A converters - A/D converters - Precision rectifiers - Peak detectors - Clipper and Clamper - Log and Antilog amplifier - Multiplier and Divider - Waveform generators.

MODULE V SPECIAL INTEGRATED CIRCUITS 9

IC Voltage regulators - IC 78XX, 79XX - IC 723 - Current limiting and Current boosting – IC565 Phase Locked Loops - IC 566 Voltage controlled oscillators - IC 555 timer - Monostable and Astable mode of operations – PWM Applications.

COURSEOUTCOMES

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

CO1: Explain the internal architecture and basic operation of an op-amp.

CO2: Design compensation for the non-ideal DC/AC characteristics of Op-amp.

CO3: Compare open loopand closed loop mode operation of the operational amplifier..

CO4: Design analog circuits using op-amp IC741.

CO5:Design analog circuits such as voltage regulator, VCO and Multivibrators using special integrated circuits.

CO6 :Design analog circuits to find the solution of Integro Differential equations.

TOTAL:45 PERIODS

TEXTBOOKS:

1. David A. Bell, ‘Op-amp & Linear ICs’, Oxford, Third Edition,
2. Roy Choudhury D and Shail Jain, "Linear Integrated Circuits", 5th Edition, New Age Science Ltd., 2018.
3. RamakantA.Gayakward, ‘Op-amps and Linear Integrated Circuits’, IV edition, Pearson Education, PHI 2021.

REFERENCES:

1. Fiore,”Opamps& Linear Integrated Circuits Concepts & applications”, Cengage, 2010.
2. Floyd,Buchla,”Fundamentals of Analog Circuits, Pearson, 2013.
3. Jacob Millman, Christos C.Halkias, ‘Integrated Electronics - Analog and Digital circuits system’, McGraw Hill, 2nd Edition, 2017
4. Robert F.Coughlin, Fredrick F. Driscoll, ‘Op-amp and Linear ICs’, Pearson, 6th edition,2012.

5. Sergio Franco, ‘Design with Operational Amplifiers and Analog Integrated Circuits’, McGraw Hill, 2016 – Fourth Edition.
6. Muhammad H. Rashid,’ Microelectronic Circuits Analysis and Design’ Cengage Learning, 2nd Edition, 2012.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1									3	1	3	3	
2	3	3	1	3							3	1		2	
3	3	3	1	3	1						3	1	2		
4	3	3	3	3	3	3	2				3	1		2	
5	3	3	3	3	3	3	2				3	1			
6	3	3	3	3	3	3	2	1			3	1	1		
AVg.	**3**	**2.7**	**2.8**	**3**	**2.5**	**3**	**2**	**1**			**3**	**1**	**2**	**2.3**	

1-low, 2-medium,3-high

23EE321	DC MACHINES AND TRANSFORMERS LABORATORY	L	T	P	C
		0	0	3	1.5

LIST OF EXPERIMENTS:

1. Open circuit characteristics and critical speed of DC Shunt Generator
2. No load speed control and Swinburne's Testof DC shunt motor.
3. Load test on
   a. DC Shunt Motor
   b. DC Shunt Generator.
   c. DC series motor
   d. DC series Generator
   e. DC compound motor
4. Hopkinson's Test
5. OC and SC test on Single phase Transformer
6. Predetermination of performance characteristics of Single-phase Transformer
7. Load test on Single phase transformer (R, L, C loads)
8. Three phase transformer connections
9. IoT based motor monitoring system

TOTAL:45 PERIODS

COURSEOUTCOMES:

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

CO1: Understand the performance of DC motors/generators by conducting direct load test experimentally

CO2: Understand the performance of the transformer by conducting a direct load test experimentally.

CO3: Predetermine the performance of DC machines by conducting Swinburne's test and Hopkinson's Tests.

CO4: Compare the performance characteristics obtained experimentally on various types of DC machines and select suitable DC machines for industrial applications.

CO5: Draw the equivalent circuit and predetermine the performance of transformers by conducting open circuit and short circuit tests.

CO6: Choose a suitable speed control method for DC shunt motors.

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3										
2	3	3										
3	3	3										
4	3	3										
5	3	3										
6	3	3										
AVG	**3**	**3**										

1-low,2-medium,3-high

23EE322	LINEAR INTEGRATED CIRCUITS LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS:

1. Linear applications of Operational Amplifier
2. Second order Low Pass and High Pass Filters
3. Astable and MonostableMultivibrator using IC 555
4. Precision Rectifier and Zero Crossing Detector
5. Instrumentation Amplifier
6. Square, Triangle and Ramp Waveform Generators
7. Analog to Digital Converters
8. Digital to Analog Converters
9. Voltage Regulator using IC 723
10. Wien bridge oscillator

TOTAL:30 PERIODS

COURSEOUTCOMES:

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

CO1: Regulated power supplies for the given specifications using IC723, IC7805.

CO2: Waveform generators and wave shaping circuits using IC741 for the given specifications.

CO3: Frequency response of first and second order filters using IC741.

CO4: Analog to Digital and Digital to Analog converters for the given specifications using IC741.

CO5: Astable and monostablemultivibrator using IC555 timer for the given specification.

CO6: Various analog circuits for arithmetic operations using IC741.

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	1	1	1	1				3		2	1
2	3	2	3	3	3	1			3		2	1
3	3	3	3	3	3				3		2	1
4	3	3	3	3	3				3		2	1
5	3	3	3	3	3		2		3		2	1
6	3	3	3	3	3				3		2	1
AVG	**3**	**2.5**	**2.7**	**2.7**	**2.7**	**1**	**2**		**3**		**2**	**1**

1-low,2-medium,3-high

23EE323	OOPS AND C++ LABORATORY	L	T	P	C
		0	0	3	1.5

LIST OF EXPERIMENTS:

1. Functions and overloaded function
2. Concept of class
3. Friend function
4. Static, dynamic and array of objects
5. Constructors and destructors
6. Data hiding (public, private and protected)
7. Overloading unary operators
8. Overloading binary operators
9. Inheritance
10. File operations
11. Calculation of Power in simple DC network by OOP concepts
12. Analysis by Mesh analysis technique using OOP concept
13. Analysis by Nodal analysis technique using OOP concept
14. Calculation of Tariff using OOP concept
15. Calculation of efficiency and voltage regulation in transmission lines using OOP concept

TOTAL:45 PERIODS

COURSEOUTCOMES:

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

CO1: Distinguish object oriented Programming and traditional programming techniques.

CO2: Develop, compile and debug programs.

CO3: Infer the concept of constructor and destructor.

CO4: Illustrate key concepts such as encapsulation and polymorphism.

CO5: Illustrate key concepts such as inheritance and abstraction.

CO6: Write C++ program for practical electrical applications

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1		3	1	1	3					2	2	3
2	3	3	3	3	3	3		1	3	2	3	3
3	3	1	2	2	3	2				2	2	3
4	3	1	2	2	3	2				2	2	3
5	3	1	2	2	3	2				2	2	3
6		3	3	3	3	3		1	3	2	3	3
AVG	**3**	**2**	**2.2**	**2.2**	**3**	**2.4**		**1**	**3**	**2**	**2.3**	**3**

1-low,2-medium,3-high

SEMESTER IV

	AC ROTATING MACHINES	L	T	P	C
		3	0	0	3

MODULE I SYNCHRONOUS GENERATORS 10

Construction –advantages of rotating field alternator – Synchronous speed and frequency - EMF equation – Armature windings – Pitch factor and distribution factor – Armature reaction – synchronous impedance - Phasor diagram – predetermination of voltage regulation by EMF, MMF, and Potier Methods - Two-reaction model of salient pole synchronous machine – Slip test.

MODULE II PARALLEL OPERATION OF ALTERNATORS AND SYNCHRONOUS MOTORS 9

Parallel operation of alternators – synchronization and load division – principle of operation of synchronous motor – starting methods – Phasor diagram – effect of load – V and inverted V curves – hunting – synchronous condenser.

MODULE III THREE PHASE INDUCTION MOTORS 10

Construction and operation of three-phase induction motors–comparison of cage and wound rotors – production of rotating field –relationship between rotor copper loss and rotor input – torque of an induction motor – torque-slip characteristics – equivalent circuit – circle diagram - no-load and blocked rotor tests - Predetermination of performance from no-load and blocked rotor tests.

MODULE IV STARTING, SPEED CONTROL, AND BRAKING OF 3-PHASE INDUCTION MOTORS 8

Starting methods of cage and wound rotor motors – speed control of induction motors –crawling – cogging – electric braking – Induction generator: Torque-speed characteristics of an induction machine - Isolated induction generator – Applications of induction generator.

MODULE V SINGLE-PHASE INDUCTION MOTORS 8

Principle of single-phase induction motor – double-revolving field theory – equivalent circuit – starting methods and types of single-phase induction motors – split-phase induction motor – capacitor-start motor – capacitor start and run motor – shaded pole motors – universal motor.

COURSEOUTCOMES

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

CO1: Develop an understanding of the functionality of Induction and Synchronous Machines with their classification.

CO2: Acquire knowledge on the characteristics of AC machinesfor different operating conditions.

CO3: Predetermine the voltage regulation of Alternators and analyze the load sharing of alternators.

CO4: Describe the starting methods and equivalent circuit of AC motors.

CO5: Illustrate the speed control methods, braking and testing of AC machines for industrial application..

CO6: Determine the performance of Induction motors from equivalent circuit and circle diagram.

TOTAL:45 PERIODS

TEXTBOOKS:

1. Ashfaq Husain, “Electrical Machines”, III Edition, Dhanpat Rai & Co. (Pvt) Ltd, New Delhi, 2017.

2. Murugesh Kumar, K, “Induction and Synchronous Machines”, II Edition, Vikas Publishing House PVT Ltd, New Delhi, 2004.

REFERENCES:

1. Nagrath I.J. and Kothari D.P., “Electrical Machines”, II Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2000.
2. Smarajit Ghosh., “Electrical Machines I “, I Edition, Pearson Education, 2011.
3. Bhattacharya, S.K., “Electrical Machines”, Tata McGraw Hill, New Delhi, 2017.

4. Theraja B.L and Theraja A.K., “A Text Book of Electrical Technology Volume II: AC and DC Machines”, S. Chand and Publishing Company, 2014.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2											3		
2	3	3											2		
3	3	3											2		
4	3	2											3	3	
5	3	2											2	3	
6	3	2		2									2	3	
AVg.	3	22											2.3	3	

1-low, 2-medium,3-high

	TRANSMISSION AND DISTRIBUTION OF ELECTRICAL POWER	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO LINE PARAMETERS 9

Layout of AC power supply scheme by single line diagram - Introduction to EHV AC and HVDC transmission –HVDC systems- Comparison between HVAC and HVDC – Comparison of conductor materials in overhead systems. Line Parameters: Resistance of conductors - Skin effect - Inductance of a conductor due to internal and external flux - Inductance and capacitance of single-phase, three phase lines with symmetrical and unsymmetrical spacing, Bundled conductor lines and Double circuit three phase lines - Effect of earth on line capacitance.

MODULE II LINE PERFORMANCE AND CORONA 9

Regulation and Efficiency of short lines - Medium lines represented by nominal T and π methods - Long lines - Rigorous solution - ABCD constants - Ferranti effect - Tuned power lines. Phenomenon of corona- Disruptive critical voltage - Visual critical voltage - Corona loss - Radio frequency interference.

MODULE III MECHANICAL DESIGN OF OVERHEAD LINES 9

Insulator materials - Insulator types - Voltage distribution over insulator string - Methods of improving string efficiency - Insulator failure - Testing of insulators - Line supports - Types of steel towers - Cross arms - Span, Conductor configuration, spacing and clearances - Sag and Tension calculations- Effect of wind, temperature and ice - Support at different levels - String chart - Conductor vibration.

MODULE IV UNDERGROUND CABLES 9

Comparison between overhead line and underground cable for transmission - Types of cables - Types of insulating materials - Insulation resistance - Potential gradient - Grading of cables - Capacitance of single and three core cables - Faults and fault location by loop test - Sheath effect - Cable installation - Current rating of cables -Operating problems with underground cables.

MODULE V DISTRIBUTION SYSTEMS AND SUBSTATIONS 9

Introduction to Grid system - AC distribution - Radial and Ring main systems - Ring main distributors with interconnectors - Methods of solving AC distribution systems - Tariff calculations- Wheeling Charges - Substation - Types of substations - Layout and location of substations - Busbar arrangements - Introduction to substation automation protocols - Smart Distribution of Power.

COURSEOUTCOMES

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

CO1: Assess HVAC , HVDC transmission, determine the RLC parameters of single phase transmission line and three phase symmetrical and unsymmetrical line,

CO2: Model the transmission line to find voltage regulation, line losses and transmission efficiency and criticize the phenomenon of corona.

CO3: Design the overhead transmission line insulators and evaluate the string efficiency, Sag, Span of the line for different weather conditions.

CO4: Illustrate the types of cables, grading of cables and compute the capacitance in single, three core cables and locate the cable fault using loop tests.

CO5: Describe AC distribution system and solve the AC distribution system problems..

CO6: Demonstrate the types, layout and working of substation.

TOTAL:45 PERIODS

TEXTBOOKS:

1. C.L.Wadhwa, "Electrical Power Systems", New Age International, 8th edition,2017.
2. V. K. Mehta and Rohit Mehta, "Principles of Power system", S. Chand and Company Ltd., New Delhi, 2022.

REFERENCES:

1. Luces M.FualKeribeery and Watter Coffer, "Electrical Power Distribution and Transmission", Pearson Education, 2009.
2. J.Nagrath and D.P.Kothari, "Power Systems Engineering", Tata McGraw Hill, 2019
3. M.L. Sony, P.V.Gupta, V.S Bhatnagar and A.Chakraborti, "A Text Book on Power Systems Engineering", Dhanpat Rai and Co., Delhi, 2016
4. Toren Gonen, "Electrical Power Distribution", CBC, 2014.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	1	3	3				3		3		3		
2	3	2		3	3				3		3		3		
3	3	2	3	3	3				3		3			3	
4	3	2	3	3	3				3		3		2		
5	3	2		3	3				3		3			2	
6	3	2		3	3				3		3	3		3	
AVg.	**3**	**2**	**2.3**	**3**	**3**				**3**		**3**	**3**	**2.3**	**2.6**	

1-low, 2-medium,3-high

	SIGNALS AND NETWORKS	L	T	P	C
		3	1	0	4

MODULE I SIGNALS AND SYSTEMS 13

Representation of continuous and discrete time signals, shifting and scaling properties, linear time invariant and causal systems, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals. Fourier series representation of continuous and discrete time periodic signals, sampling theorem. Applications of Fourier Transform for continuous and discrete time signals.

MODULE II NETWORK TOPOLOGY 11

Linear oriented graphs - incidence matrix of a linear oriented graph –Kirchhoff"s laws in incidence matrix formulation - circuit matrix of a linear oriented graph - tree and its properties - Kirchhoff"s laws in fundamental circuit matrix formulation – Loop analysis of electric networks - cut sets - - cut set matrix of a linear oriented graph - Kirchhoff"s laws in fundamental cutest formulation – Node-pair analysis of networks – Analysis using generalized branch model.

MODULE III NETWORK FUNCTIONS AND TWO PORT NETWORKS 13

Concept of complex frequency - Network functions - Driving point and transfer functions and their properties - Poles and Zeros and their significance - Time domain behavior from pole - zero plot – Impulse response of network functions - Two port networks - Z, Y, ABCD and h parameters - Condition for reciprocity and symmetry - Parameter conversion - Interconnection of two port networks - Analysis of typical two port networks - Input and Output impedances of terminated two port networks - Image impedances.

MODULE IV ELEMENTS OF REALIZABILITY AND SYNTHESIS OF ONE-PORT NETWORKS 12

Hurwitz polynomials - Positive real functions - Frequency response of reactive one port network - Synthesis of reactive one port networks by Foster method and Cauer method - Synthesis of RL and RC networks by Foster method and Cauer method.

MODULE V FILTERS 11

The decibel scale - bode plots - passive filters: low pass, high pass, band pass, and band reject filters. Active filters: first order low pass, high pass, band pass, and band reject (or Notch) filter - Scaling: magnitude scaling - frequency scaling - magnitude and frequency scaling - applications.

COURSEOUTCOMES

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

CO1: Classify signals and systems according to their properties.

CO2: Represent signals in the form of Fourier series and transform.

CO3: Apply the concept of complex frequency in studying network functions and analyze two-port network parameters using various models.

CO4: Identify the given function for positive realness and synthesize LC, RC, and RL one-port networks using Foster and Cauer forms.

CO5: Design active and passive filters.

CO6: Solve circuit theory problems using graph theory concepts.

TOTAL:60 PERIODS

TEXTBOOKS:

1. Ravish R. Singh, “Network Analysis and Synthesis”, TMH, New Delhi, 3rd Edition, 2018.
2. Roy D.Choudhury, "Networks and Systems", New Age Publications, New Delhi, 2nd Edition, 2014.
3. Alan Oppenheim, Alan Willsky, Hamid, “Signals and Systems”, Prentice-hall, 2nd Edition 2015..

REFERENCES:

1. Charles K. Alexander and Mathew N.O. Sadiku, “Fundamentals of Electric Circuits” McGraw Hill Education (India) Pvt Ltd, VI Edition, 2019.
2. Franklin F. Kuo, "Network Analysis and Synthesis" Wiley India Pvt. Ltd., New Delhi, 2nd Edition, 2012.
3. Sudhakar A. and Shyammohan S.P., "Circuits and Networks: Analysis and Synthesis", TMH, New Delhi, 2011.
4. Ramesh Babu P. and Anandanatarajan, R., “Signals and Systems”, SciTech Publications (India) Pvt Ltd, V Edition, 2011
5. Simon Haykin, Barry Van Veen, “Signals and Systems”, 2nd Edition, Wiley 2002.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	1				2	1		1	2		
2	3	3	3	2	1				2	1		1	3		
3	3	3	3	3	1				2	1		1	3		
4	3	3	3	3	1				2	1		1		2	
5	3	3	3	3	1				2	1		1		3	
6	3	3	3	2	1				2	1		1		3	
AVg.	**3**	**3**	**3**	**2.5**	**1**				**2**	**1**		**1**		**2.6**	

1-low, 2-medium,3-high

	CONTROL SYSTEMS	L	T	P	C
		3	1	0	4

MODULE I INTRODUCTION TO CONTROL SYSTEMS **12**

Control theory concepts - Open loop and feedback control systems-linear and non-linear control systems- Mathematical model of physical systems – electrical analogies- Analysis of control systems using Laplace transforms – Block diagram algebra – Signal flow graph - Controller components – types.

MODULE II TIME RESPONSE ANALYSIS **12**

Test Signals - Analysis of transient and steady state behavior of control systems - Time response of first order and second order systems -Time domain specifications - Steady state errors - Error criterion - Performance indices.

MODULE III STABILITY AND ROOT LOCUS TECHNIQUE **12**

Stability concepts – Conditions for stability – Routh, Hurwitz stability criteria – Relative stability analysis - Root locus concepts - Construction of root loci – Effect of pole zero additions on the root loci- Root contours – Systems with transportation lag.

MODULE IV FREQUENCY RESPONSE ANALYSIS AND COMPENSATOR DESIGN **12**

Analysis and design procedure for combinational logic circuit – Binary adder: half-adder, full adder, and parallel adder – Binary subtractor: half subtractor and full subtractor – BCD adder – Code converters – decoder – encoder – multiplexer – demultiplexer.

MODULE V STATE VARIABLE ANALYSIS **12**

Introduction - State space representation using physical variables – Phase variables and canonical variables – Derivation of transfer function from state model – Solving the time invariant state equation – State transition Matrix – Its properties and computation. Introduction to controllability and observability.

COURSEOUTCOMES

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

CO1: Recognize various control system types and analog systems.

CO2: Evaluate the system's response and time domain specifications.

CO3: Design and analyze the stability and performances of control systems.

CO4: Implement the frequency domain ideas into practice to assess the system's stability.

CO5: Design the compensators

CO6: Infer the concept of state variable techniques.

TOTAL:60 PERIODS

TEXTBOOKS:

1. Nagrath and M.Gopal," Control Systems Engineering", New Age International Publishers,5h Edition,NewDelhi,2012.

2. Katsuhik o Ogata," Modern Control Engineering", Prentice Hall of India Private Ltd.,New Delhi,2013.

REFERENCES:

1. Norman S. Nise,"Control System Engineering", 4th edition, Wiley Student Edition, 2008.

2. B.C.Kuo "Automatic control systems", 8th edition, Wiley Student Edition, 2008

3. D.K.Cheng, Analysis of linear systems" Narosa Publishing House, New Delhi,2002.

4. Richard Dorf and Robert Bishop, "Modern control system", Pearson Education, 12th Edition, 2014.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2											3		
2		3											3		
3		3	3	3	2								3		
4	2													3	
5		2	3	3	2									3	
6	3	2												3	
AVg.	2.3	2.4	3	3	2								3	3	

1-low, 2-medium,3-high

	DIGITAL SYSTEM DESIGN	L	T	P	C
		3	0	0	3

MODULE I SEQUENTIAL LOGIC CIRCUITS 10

Flip Flops - counters - asynchronous and synchronous types - Modulo counters - Shift registers - Ring counter and twisted ring counter-Mealy and Moore Models - State table - excitation table - State diagram - State reduction - State assignment -Analysis and Design of synchronous sequential circuits - Design of sequence detectors, sequence generators and counters using flip-flops.

MODULE II MEMORY AND PROGRAMMABLE LOGIC 8

Introduction - Basic memory structure – ROM -PROM – EPROM – EEPROM, RAM – Static and dynamic RAM – Programmable Logic Devices – Programmable Logic Array (PLA) – Programmable Array Logic (PAL) – Field Programmable Gate Arrays (FPGA) – Implementation of combinational logic circuits using PLA, PAL Types of Memories, Memory Decoding, error detection and correction, RAM and ROMs. Programmable Logic Array, Programmable Array Logic, Sequential Programmable Devices.

MODULE III HARDWARE DESCRIPTION LANGUAGES 9

Features of Verilog-Design flow using Verilog-Basic conventions and operators-Ports-Data types and assignments-Types of Verilog coding-User defined primitives-System task and functions (Display, Write, Monitor, Finish, Stop and Time)- Blocking and non-blocking assignments-Forever and repeat constructs-Number representation and parameter encoding.

MODULE IV GATE LEVEL AND DATA FLOW MODELLING 9

Basics of design of combinational circuits-Begin and end statements- Gate level and data flow level HDL for half adder, full adder and ripple carry adder,4-bit binary adder/subtractor, Four bit comparator-Decoder, Encoder, Multiplexer and Demultiplexer.

MODULE V BEHAVIOUR LEVEL MODELLING 9

Procedural blocks- Statements **(**If else, Case, Forever, For)-HDL for combinational circuits by behaviour level modelling- HDL for flip flops, shift registers, universal shift registers, counters, sequence detector.

COURSEOUTCOMES

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

CO1: Design and analyze synchronous sequential circuits using flip-flop.

CO2: Differentiate various type of memories and their applications.

CO3: Interpret the constructs and their application in combinational and sequential circuits.

CO4: Develop gate level and data flow modelling for combinational circuits

CO5: Devise behaviour level modelling Verilog code for combinational and sequential circuits.

CO6: Analyse and Verify the functionality of digital circuits/systems using test benches.

TOTAL:45 PERIODS

TEXTBOOKS:

1. Morris Mano M, Michael D. Ciletti, "Digital Design: with an Introduction to the Verilog HDL", Prentice Hall of India Ltd, 6th Edition, 2019.

2. T. R. Padmanabhan and B. Bala Tripura Sundari, “Design through Verilog HDL”, Wiley, 2008.

REFERENCES:

1. John M. Yarbrough, "Digital Logic Applications and Design", PWS Publishing Company, 2020.

2. Samir Palnitkar,”Verilog HDL: A Guide to Digital Design and Synthesis”, Prentice Hall, 2nd edition,2003

3. Samuel C. Lee, ‘Digital Circuits and Logic Design’, PHI Learning, 1st Edition, 2008.

4. William I. Fletcher, ‘An Engineering Approach to Digital Design’, Prentice Hall, 2009
5. Michael D. Ciletti, “Advanced Digital Design with Verilog HDL”, Pear son education, 2nd Edition 2017.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	3	2	3				1	1		3	3	2	3
2.	3	2	1	2	3				1	1		3	3	2	1
3.	3	2	1	2	3				1	1		3	3	2	1
4.	2	2	3	2	3				1	1		3	2	2	3
5.	2	2	3	2	3				1	1		3	2	2	3
6.	2	2	3	2	3				1	1		3	2	2	3
AVg.	**2.5**	**2**	**2.3**	**2**	**3**				**1**	**1**		**3**	**2.5**	**2**	**2.3**

1-low, 2-medium,3-high

	AC ROTATING MACHINES LABORATORY	L	T	P	C
		0	0	3	1.5

LIST OF EXPERIMENTS

1. Predetermination of regulation characteristics of 3-phase non-salient pole alternator using
   - EMF (or Synchronous Impedance/Pessimistic) Method
   - MMF (or Ampere-turns/Optimistic) Method
   - ZPF Method
2. Predetermination of regulation characteristics of 3-phase salient pole alternator using slip test
3. Determination of V- curves and inverted V-curves of synchronous motor.
4. Predetermination of performance characteristics
   - three phase squirrel cage induction motor by equivalent circuit method.
   - three phase squirrel cage induction motor by circle diagram method.
   - single-phase induction motor by equivalent circuit method.
5. Load Test on
   - 3-phase Squirrel-cage induction motor.
   - cascaded induction motors
   - single-phase capacitor-start induction motor
6. Separation of no-load losses of 3-phase squirrel-cage induction motor.
7. IoT Based Motor Monitoring System.

TOTAL:45 PERIODS

COURSEOUTCOMES:

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

CO1: Evaluate three-phase and single-phase induction machine performance through direct and indirect experimentation.

CO2: Select suitable AC machines for an industrial application by experimentally verifying the performance characteristics.

CO3: Predetermine the voltage regulation ofnon-salient pole alternator by EMF, MMF, ZPF methods and experimentally.

CO4: Predetermine the voltage regulation ofsalient pole alternator using slip test

CO5: Draw the V - curves and Inverted V - curves of synchronous motor.

CO6: Analyze the motor performance using IoT.

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3	2	1	3				2	3		2
2	3	3	2	1	3				2	3		2
3	3	3	2	1	3				2	3		2
4	3	3	1	2	1				3	3		3
5	3	3	1	2	1				3	3		3
6	3	3	1	3	1				3	3		3
AVG	**3**	**3**	**1.5**	**1.7**	**2**				**2.5**	**3**		**2.5**

1-low,2-medium,3-high

	CONTROL AND INSTRUMENTATION LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

Instrumentation

1. Calibration of electrical instruments and sensor/transducers.
2. High current and voltage measurements using CT and PTs in LT supply.
3. Study of LVDT transducer characteristics.
4. Measurement of non-electrical parameters.
5. Design and test a signal conditioning circuit for a transducer.

Control

6. Modeling and analysis of physical systems.
7. Determination of transfer function of a 2-phase AC Servo Motor and assessment of its stability.
8. Transfer function of a magnetic levitation system in open loop mode.
9. Stability analysis of given LTI system using frequency and time domain methods.
10. Ziegler–Nichols method for tuning PID controllers
11. System Identification and speed control of PMDC motor.
12. Position control of PMDC motor/single-link manipulator.
13. Closed loop control of magnetic levitation system.

TOTAL:30 PERIODS

COURSEOUTCOMES:

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

CO1: Calibrate sensor, transducer and measuring instrument to estimate error and static characteristics.

CO2: Select various transducers for the measurement of electrical and non-electrical quantities with signal shaping..

CO3: Illustrate the realization of Boolean expression in SOP and POS form and design it using logic gates..

CO4: Validate of designed controllers of a given system.

CO5: Tune PID control parameter using Zigler-Nichols approach for the given system

CO6: Analyse the process flow and test the signal points with data acquisition system of a continuous process control industry.

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3	2	1	3				2	3		2
2	3	3	2	1	3				2	3		2
3	3	3	2	1	3				2	3		2
4	3	3	1	2	1				3	3		3
5	3	3	1	2	1				3	3		3
6	3	3	1	3	1				3	3		3
AVG	**3**	**3**	**1.5**	**1.7**	**2**				**2.5**	**3**		**2.5**

1-low,2-medium,3-high

	DIGITAL SYSTEM DESIGN LABORATORY	L	T	P	C
		0	0	3	1.5

LIST OF EXPERIMENTS

Group A (Hardware)

1. Registers
2. PRBS Generators
3. Asynchronous Counters
4. Synchronous Counters

Group B (Verilog)

5. Modeling different types of gates of (a) 2-input NAND (b) 2-input OR gate (c) 2-input NOR gate (d) NOT gate (e) 2-input XOR gate
6. Half-adder and Full-adder
7. Half Subtractor and Full Subtractor
8. 8-Bit Arithmetic Logic Unit
9. Code converters and Magnitude comparator.
10. Multiplexer and Demultiplexer
11. Decoder and Encoder.
12. Flip-flops
13. Shift Registers
14. Synchronous counters and Asynchronous counters
15. Sequence detectors and Sequence generators.
16. HDL program for Real time application.

TOTAL:45 PERIODS

COURSEOUTCOMES:

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

CO1 Design sequential circuits using Digital ICs

CO2: Interpret the basics of Hardware Description Languages..

CO3 Design basic digital circuit using HDL concept.

CO4: Analyze and Verify the functionality of digital circuits/systems using test benches.

CO5: Design, Simulate and Synthesize various Verilog descriptions for Combinational and Sequential circuits.

CO6: Design and develop a digital logic circuit for any real time application.

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3	1	3	3				3		3	3
2	1	1	3	3	3				3		3	3
3	1	1	3	3	3				3		3	3
4	1	1	3	3	3				3		3	3
5	1	1	3	3	3				3		3	3
6	1	1	3	3	3				3		3	3
AVG	**1.3**	**1.3**	**2.6**	**3**	**3**				**3**		**3**	**3**

1-low,2-medium,3-high

SEMESTER V

	POWER SYSTEM ANALYSIS	L	T	P	C
		3	0	0	3

MODULE I POWER SYSTEM COMPONENTS AND NETWORK MODELING 9

Single line diagram - per unit quantities - per unit impedance / reactance diagrams - Complex Power - Representation of Loads - π equivalent circuit of transformer with off nominal tap ratio - Bus admittance matrix – Formulation of Ybus-Formation of Zbus using step-by-step building algorithm.

MODULE II LOAD FLOW STUDIES 9

Load flow equations and methods of solutions - Gauss-Seidel method for load flow studies – Newton Raphson method for load flow studies - Introduction to Bus Voltage Control Methods using STATCOM and UPFC Devices.

MODULE III FAULT CALCULATIONS 9

Balanced and unbalanced faults - Types of faults - Symmetrical faults - Consideration of prefault load current - Symmetrical components - Sequence impedances and sequence networks for synchronous machines, transmission lines, transformers - formation of sequence networks - Unsymmetrical fault analysis - single line to ground fault, line to line fault, double line to ground fault- Asymmetrical Fault Analysis using Zbus Method.

MODULE IV POWER SYSTEM TRANSIENTS 9

Travelling waves on transmission lines - Wave equations - Surge impedance - Equivalent circuit for travelling wave studies -Reflection-Refraction - Forked line - Arcing grounds -Switching Transients-Capacitance switching.

MODULE V POWER SYSTEM STABILITY 9

Steady state and transient state stability of power systems - Stability limits - Swing equation for single machine infinite bus system - Solution of swing equation by equal area criterion - Methods of improving transient stability.

COURSEOUTCOMES

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

CO1: Mathematically model and assess the power system network under healthy and faulty conditions.

CO2: Apply mathematical methods to solve the load flow problems and interpret active and reactive power flows.

CO3: Identify the fault and assess the fault conditions using symmetrical components.

CO4: Illustrate the transient behavior of the power system network under open circuit and short circuited conditions.

CO5: Derive the equation to analyze the dynamics of power systems.

CO6: Examine the reliability of electric power systems.

TOTAL:45 PERIODS

TEXTBOOKS:

1. D.P. Kothari, I.J.Nagrath, "Modern Power System Analysis", 5th Edition, Tata McGraw Hill, 2022.

2. John J. Grainger, W.D. Stevenson, "Elements of Power System Analysis", Tata McGraw Hill, 2017

REFERENCES:

1. C.L.Wadhwa, "Electrical Power Systems", New Age International (P) Ltd., 2017.

2. B.R.Gupta, "Power System Analysis and Design", IIIrd Edition, Wheeler Publishers, 2005.

3. Hadi Saadat, "Power System Analysis", Tata McGraw Hill, IIIrd Edition, reprint, 2008.

4. T.K. Nagsarkar, M.S. Sukhija, “Power System Analysis”, Oxford University Press, 2007.
5. B.M. Weedy, "Electric Power Systems", John Wiley, New York, 2012.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	2						2	2	2	2	
2	3	3	2	3	2						2	2	2	2	
3	3	2	2	2	2		2				2	2	2	2	
4	3	2	2	3								2	2	2	
5	3	3	3	3	2	2	2		2	2	2	3	3	3	
6	3	3	3	3	3	2	2	2	2	2	2	3	3	3	
AVg.	**3**	**2.6**	**2.5**	**2.6**	**1.8**	**2**	**2**	**2**	**2**	**2**	**2**	**2.5**	**2.3**	**2.3**	

1-low, 2-medium,3-high

	POWER ELECTRONICS	L	T	P	C
		3	1	0	4

MODULE I POWER SEMICONDUCTOR DEVICES 12

Generic Power Converter - Power Semiconductor Switches - Power diodes - Thyristor family of devices: SCR - TRIAC - GTO - IGCT -Transistor family of devices: Power MOSFETs - IGBTs- steady state and dynamic characteristics – Switching and Conduction losses - Intelligent Power Modules -protection circuits - Heat sink calculations- - Introduction of SiC and GaN based power devices – Introduction to driver circuits-Synchronization and Isolation-Study of data sheet of power semiconductor devices (Qualitative Treatment only).

MODULE II DC-DC CONVERTERS 12

Principle of chopper operation - Control strategies– Non-isolated Converter Circuits: Buck Converter, Boost Converter, Buck-Boost Converter- CüK Regulator – SEPIC Converter- Synchronous and Bi-directional Converters.

Isolated Switch Mode Power Supplies: Flyback Converter-Bridge Converter- Switch Mode Power Supplies with multiple outputs- Device selection- Development of control circuit (Block Diagram only)- Introduction to resonant power converters (Qualitative Treatment only).

MODULE III AC-DC CONVERTERS 12

Controlled AC-DC Converters – Semi and Full Bridge Converters - Dual Converters — Twelve Pulse Converters – Estimation of performance parameters for continuous current operation. Device selection - Development of control circuit (Block Diagram only).

MODULE IV AC-AC CONVERTERS 12

Controlled AC-AC Converters: AC voltage Controllers - Principle of ON - OFF control and phase angle control - Single phase and Three phase voltage controllers.

Cycloconverters - Basic principle of operation - Single phase and Three phase cyclo converters

Device selection -Development of control circuit (Block Diagram only)

MODULE V INVERTERS AND AC CONVERTERS BASED ON COMPLETELY CONTROLLABLE SWITCHES 12

Principle of operation - classifications of inverters - Voltage source inverters and Current source inverters- - Single phase and Three phase bridge configurations - Estimation of performance parameters – Voltage control of inverters - Harmonic reduction. Introduction to multi-level inverters.

PWM Rectifier- AC Voltage Controllers with PWM Control -Matrix Converter-Development of control circuit (Block Diagram only)-Applications (Qualitative Treatment - Block Diagram only): UPS - LED Drivers –Solid State Transformer.

Note:

1. *A term paper on "Computer Simulation of Electric Circuits" to be submitted during the course work for internal assessment using MATLAB/PSIM.*
2. *Design Problems and Practical Applications to be discussed for all the units and team activity may be given on the specific design tasks for internal assessment.*

COURSEOUTCOMES

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

CO1: Describe the role of Power Electronics as an enabling technology in various applications and to understand the characteristics of the power semiconductor devices.

CO2: Select the suitable power semiconductor device, based on the converter type and topology for the given specification and applications.

CO3: Establish the steady state operation of the power electronic converters based on different operational modes subject to continuous and discontinuous operations.

CO4: Seek and reach consensus on formulation of solution methodologies to design the power electronic converters for given applications.

CO5: Design, simulate, develop and evaluate the efficiency of power electronic systems such as motion control systems and power supplies for given specifications.

CO6: Realize the applications of power electronic systems.

TOTAL:60 PERIODS

TEXTBOOKS:

1. M.H.Rashid, "Power Electronics", Pearson Education, New Delhi, 4th Edition, 2017.
2. Mohan.N.Tore. M.Undeland, and William.P.Robbins, "Power Electronic Converters, Applications and Design", John Wiley and Sons, New York, 3rd Edition, 2017.

REFERENCES:

1. Robert W.Erickson and Dragan Maksimovic, "Fundamentals of Power Electronics", Springer International, 3rd Edition, 2021.
2. G.K.Dubey., et al, "Thyristorised Power Controllers", New Age Pub
3. L.Umanand, "Power Electronics: Essentials & Applications", Wiley India Pvt. Limited. New Delhi,2009
4. P. S. Bimbhra, “Power Electronics” Khanna Book Publishing Company, 7th Edition,2022
5. *http://nptel.ac.in/courses/webcourse - contents / IIT% 20 Kharagpur / Power%20 Electronics/New_index1.html for Web type,*
6. *http://nptel.ac.in/courses/108101038/ for Video Type.*
7. *http://ocw.mit.edu/courses/electrical - engineering - and - computer - science/6 - 334 – power electronics - spring – 2007*

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	2	2	2				3		3	3	
2	3	3	3	3	2						3		3	3	
3	3	3	3	3							2		3	3	
4	3	3	3	3	3	2	2	2	3	2	3	3	3	3	
5	3	3	3	3	3	3	2	2	2	3	3	2	3	3	
6	3	3	3	3	3	2	3	2	2	2	3	2	3	3	
AVg.	**3**	**3**	**3**	**2.8**	**2.6**	**2.3**	**2.3**	**2**	**2.3**	**2.3**	**2.8**	**2.3**	**3**	**3**	

1-low, 2-medium,3-high

	EMBEDDED SYSTEM DESIGN	L	T	P	C
		3	0	0	3

MODULE I PIC ARCHITECTURE **9**

PIC18F458 microcontroller architecture - CISC and RISC Features -Program and Data Memory-Register file structure- Configuration Registers - I/O Ports- Interrupts - Capture and compare and PWM module.

MODULE II PIC PROGRAMMING **9**

Introduction to Assembly language programming -Assembling and Linking a PIC program - PIC instruction set and addressing modes- I/O Port programming - I/O Bit manipulation programming - Interrupt, Timer and counter programming.

MODULE III ARM ARCHITECTURE **9**

Evolution of arm processor - ARM cortex M4 processor's architecture - ARM programmer's model, operating modes, program status register, ARM 3 stage pipeline- Interrupts Handling and Vector Table, ARM development tools.

MODULE IV ARM PROGRAMMING **9**

Data processing instructions-Data transfer instructions- Branch instructions - Conditional execution-multiply instructions-multiple register transfer instructions. Simple Assembly language programming.

MODULE V SYSTEM DESIGN **9**

Keypad Interfacing, ADC Interfacing, LCD Interfacing, Stepper Motor Interfacing , DC Motor Interfacing, - Serial Communication:I2C, SPI, CAN, RS232 and RS485,USB. Wireless communication: Bluetooth, Wi-Fi.

COURSEOUTCOMES

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

CO1: Interpret register functionalities and identify the architectural features of PIC18Fxxx microcontroller and ARM processor.

CO2: Apply appropriate instructions and addressing modes to develop an assembly language program.

CO3: Infer the memory organization in embedded systems

CO4: Illustrate the processor operations by citing examples with pre - conditions and post - conditions, describing registers and memory before and after the instruction execution.

CO5: Examine the principles and operation of various communication protocols, including I2C, SPI, CAN, RS232, RS485, and USB.

CO6: Design an embedded system for the given requirements

TOTAL:45 PERIODS

TEXTBOOKS:

1. Muhammad Ali Mazidi, "PIC Microcontroller and Embedded Systems" 1st edition, Pearson Education, 2008.
2. Steve Furber, "ARM System-on-Chip Architecture" Pearson Education Limited, 2012.

REFERENCES:

1. Tim Wilmshurst,"Designing Embedded Systems with PIC Microcontrollers-Principles and applications, Second Edition , Elsevier Inc., 2009.
2. Rob Toulson, Tim Wilmshurst "Fast and Effective Embedded Systems Design. Applying the ARM mbed" Second Edition , Elsevier Inc., 2017.

3. William Hohl and Christopher Hinds “ARM Assembly Language: Fundamentals and Techniques”,Second Edition,CRC Press,2014.
4. ARM Architecture, Reference Manual, ARM Ltd.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	2	1				2	1		1	2		
2	3	3	3	2	1				2	1		1	3		
3	3	3	3	3	1				2	1		1	3		
4	3	3	3	3	1				2	1		1		2	
5	3	3	3	3	1				2	1		1		3	
6	3	3	3	2	1				2	1		1		3	
AVg.	**3**	**3**	**3**	**2.5**	**1**				**2**	**1**		**1**		**2.6**	

1-low, 2-medium,3-high

	POWER SYSTEM SIMULATION LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

1. Computation of Transmission Line Parameters (A,B,C,D Parameters)
2. Formation of Bus Admittance (YBUS) Matrices
3. Formation of Bus Impedance Matrices (ZBUS) and Solution of Networks
4. Power Flow Analysis using Gauss-Seidel Method
5. Power Flow Analysis using Newton Raphson Method
6. Simulation of Symmetric and unsymmetrical faults
7. Varley Loop test by using cable fault locator
8. Power Quality Analysis (Sag and THD) using simulation software.
9. Analysis of EMI.
10. Transient stability analysis of SMIB System
11. Load – Frequency Dynamics of Single- Area and Two-Area Power Systems
12. Compensation of Reactive power using FACTS devices using simulation software.

TOTAL:30 PERIODS

COURSEOUTCOMES:

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

CO1: Determine the A,B,C,D parameters and understand the performance of the transmission lines.

CO2: Acquire knowledge on formation of Bus Admittance and Impedance Matrices and provide solutions of Networks.

CO3: Assess the power flow using GS and NR method

CO4: Identify, analyze and locate Symmetric and Unsymmetrical faults

CO5: Investigate and employ the suitable reactive power compensation techniques

CO6: Explore the electromagnetic transients and harmonics in power system using simulation softwares & Perform various load flow and performance analysis

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3	2	2	2							2
2	3	3	3	3	2							2
3	3	2	2	2	2		2		2	2		2
4	3	2	2	3	3							2
5	3	3	3	3	2	2	2	2	2	2	2	3
6	3	3	3	3	3	2	2	2	2	2	2	3
AVG	**3**	**2.6**	**2.6**	**2.6**	**2.3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**

1-low,2-medium,3-high

	POWER ELECTRONICS LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

1. Steady State and Dynamic Characteristics of Power Electronic Devices.
2. Design of Universal PWM technique and Generation of different types of PWM signals for Power Electronic Converters.
3. Design of Gate drive and Isolation circuits of MOSFET/IGBT
4. Load Test on Single Phase Half / Fully Controlled Bridge Converters
5. Load Test on Three Phase Half / Fully Controlled Bridge Converters and Power Quality Study.
6. Load Test on Buck, Boost and Buck - Boost Converter
7. Study of Single-Ended Primary-Inductor Converter (SEPIC).
8. Load Test on Single Phase PWM Inverter and Cascaded Multi Level Inverter (MLI).
9. Load test on AC Phase Control using SCR and TRIAC
10. Study of IV characteristics of Solar PV Modules (Series, parallel and Series - Parallel combinations).
11. Harmonic Analysis using Power Quality Analyzer.
12. Study of Matrix Converter control using dSpace.
13. Design, estimation and monitoring of Power Electronic Converters using IoT.
14. Design of DC-DC converter for EV Battery charging application
15. Simulation of Power Electronic Converters and development of controller using dSpace.

TOTAL:30 PERIODS

COURSEOUTCOMES:

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

CO1: Apprehend the static and dynamic characteristics of the power semiconductor devices and their selection for a given application.

CO2: Realize and develop the pulse width modulation techniques for power converters. Also Design and test the control and gate driver circuits for level triggered devices

CO3 Acquire knowledge and analyse the operation of the various types of the power electronic converters and to understand their performance parameters.

CO4: Evaluate I - V & P - V characteristics, Estimate energy generation of solar PV modules and their applications

CO5: Realize the usage of true RMS meters and Power Quality Analyzers for power electronic measurements.

CO6 Simulate the power electronic converters using compatible softwares

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3	3	3	3	3	3			3	3	3
2	3	3	3	3	3		3				3	3
3	3	3	3	3	3		3		3			
4	3	3	3	3	3	3	3	3				3
5	3	3	3	3	3	3	3	3				
6	3	3	3	3	3					3		
AVG	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1-low,2-medium,3-high

	EMBEDDED SYSTEM DESIGN LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

1. I/O Port programming
2. Time out generation using on - chip timer module.
3. Counter Programming
4. Code conversion (BCD to ASCII) for RTC implementation
5. Parity checking for error detection
6. Display interface (LED, LCD, Seven segment display)
7. Generating a sinusoidal and Saw tooth waveform
8. Controlling PWM period with analogue input (POT)
9. Interfacing DC motor
10. Interrupt programming
11. Configuring ADC Module (Sensor interfacing)
12. Stepper motor interfacing
13. Display a message using internal UART
14. Master slave communication using SPI protocol

TOTAL:30 PERIODS

COURSEOUTCOMES:

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

CO1 Design sequential circuits using Digital ICs

CO2: Interpret the basics of Hardware Description Languages..

CO3 Design basic digital circuit using HDL concept.

CO4: Analyze and Verify the functionality of digital circuits/systems using test benches.

CO5: Appraise the use of interrupt driven programming over polling

CO6: Experiment with various communication protocols

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3	1	3	3				3		3	3
2	1	1	3	3	3				3		3	3
3	1	1	3	3	3				3		3	3
4	1	1	3	3	3				3		3	3
5	1	1	3	3	3				3		3	3
6	1	1	3	3	3				3		3	3
AVG	**1.3**	**1.3**	**2.6**	**3**	**3**				**3**		**3**	**3**

1-low,2-medium,3-high

	IN-PLANT TRAINING	L	T	P	C
		0	0	0	1

COURSEOUTCOMES:

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

CO1: Understand the organizational environment and recognize the requirement of the organization and cope with the organizational scenario.

CO2: Identify career paths taking into account their individual strengths and aptitude

CO3: Develop the employability skills with modern tool usage and Start-Up skills to increase his/her ability to engage in life-long learning.

CO4: Develop individual confidence to handle various engineering assignments and acquire life skills to meet societal challenges.

CO5: Assess interests and abilities in their field of study.

CO6: Prepare a report about the work experience in the organization.

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3	3	3		3						2
2	3	3	3	3		3		3				2
3	3	3	3	3	3	3	3					3
4	3	3							3		3	2
5	3	3								3	3	2
6	3	3										2
AVG	3	3	3	3	3	3	3	3	3	3	3	2.2

1-low,2-medium,3-high

SEMESTER VI

	DIGITAL PROTECTION OF POWER SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I POWER SYSTEM PROTECTION: FUNDAMENTALS AND COMPONENTS 11

Need for Protective Systems- Causes and Effect of Faults - Classification of Protective Relays- Components of Protection System - Zones of Protection, Primary and Backup Protection - Calculation of time discrimination and fault clearing time.

Components: Construction and Operation of Instrument Transformers(PT, CT), Digital Relay, ICT, CVT, Circuit Breaker (SF6, Oil and Air blast) , Isolators - Introduction of Solid-State Transformer.

MODULE II PROTECTION OF MACHINES, TRANSFORMERS AND BUSZONE 9

Overcurrent Protection - Distance Protection-Pilot Relaying Schemes-Differential Protection-Rotating Machines Protection Transformer and Bus zone Protection. SCADA Based protection - Introduction of Synchro phasor.

MODULE III NUMERICAL PROTECTION 9

Digital Filtering - Algorithms: Mann-Morrison Technique-Differential Equation Technique- Least Square method- Fourier Analysis : DFT, FFT - Walsh Functions - Wavelet Transform -Microprocessor Based Numerical Protection for Overcurrent, Distance, Differential scheme.

MODULE IV PROTECTION AGAINST OVERVOLTAGES 7

Causes of Over voltages- Lightning Phenomenon - Devices for protection against lightning and Travelling waves -Lightning Arresters: Types and Limitations - Surge Absorber - Fuses.

MODULE V RECENT TECHNIQUES IN DIGITAL PROTECTION 9

Application of Artificial Intelligence to Power System Protection- Application of Big Data analytics of Application in power system Protection - Cyber Security issues in power system protection - Modern Trends in Power System

COURSEOUTCOMES

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

CO1: Summarize the need for protection and the importance of digital protection.

CO2: Review the characteristics and functions of various power system components and relay communication systems.

CO3: Illustrate the different protection schemes for machines, transformers, and bus zone.

CO4: Identify the suitable digital algorithms for digital protection schemes.

CO5: Select the suitable devices for protection against lightning and traveling wave issues in transmission line

CO6: Review the role AI-based numerical protection, importance of data analytics and Issues of Cyber-attacks in digital power system protection.

TOTAL:45 PERIODS

TEXTBOOKS:

1. A.T.Johns and S.K.Salman, “Digital Protection for Power Systems”, Institution of Electrical Engineers, UK, 2000.
2. Badri Ram and D.N.Vishwakarma, "Power System Protection and Switchgear", 2nd Edition, Tata McGraw Hill publishing company Ltd., New Delhi, 2022.

REFERENCES:

1. B.Ravindranath and M.Chander, "Power System Protection and Switchgear", 5th Edition, New Age

International Pvt. Ltd., New Delhi, 2014.
2. Y.G. Paithankar, “Power System Protection”, PHI, 2nd Edition, 2010
3. M.L.Soni, P.V.Gupta and U.S.Bhatnagar, "A Course in Electrical Power", 9th Edition, Dhanpat Rai and Sons, 2011.
4. Bhavesh Bhalja and Vijay H. Makwana, ""Transmission Line Protection Using Digital Technology,"" Springer Science+Business Media Singapore Pte. Ltd; Singapore, January 2016.
5. Stanley H.Horowitz and Arun G.Phadke, "Power System Relaying", 4th Edition, John Wiley and Sons Ltd., 2014..

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	2						2	2	2	2	
2	3	3	2	3	2						2	2	2	2	
3	3	2	2	2	2		2				2	2	2	2	
4	3	2	2	3								2	2	2	
5	3	3	3	3	2	2	2		2	2	2	3	3	3	
6	3	3	3	3	3	2	2	2	2	2	2	3	3	3	
AVg.	**3**	**3**	**2.3**	**2.6**	**2.2**	**2**	**2**	**2**	**2**	**2**	**2**	**2.3**	**2.3**	**2.3**	

1-low, 2-medium,3-high

	ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

MODULE I EV FUNDAMENTALS **9**

An Overview of Conventional, Battery, Hybrid and Fuel Cell Electric Systems - Conventional IC Engine Vehicle - BEVs - HEVs - Series HEV - Parallel HEV - Series-Parallel HEV - FCEV - EV subsystems - Vehicle Dynamics: Vehicle Load Forces - Basic Power, Energy, and Speed Relationships – Aerodynamic Drag - Aerodynamic Drag and Fuel Consumption - Rolling Resistance – Gradeability.

MODULE II ENERGY STORAGE **9**

Introduction to Batteries - Energy Storage Requirements in Electric Vehicles: Batteries Types: Battery Operation - Battery Parameters and Comparisons -Battery Packs - Battery Sizing –Battery Management System- SOC Estimation - Safety in Battery Design, Battery Pack Safety-Electrolyte Spillage and Electric Shock-various energy storage technologies-Fuel Cells and its types- Super capacitors- Hybridization of different energy storage devices.

MODULE III POWER TRAIN **9**

Power Electronics in HEVs: Power electronics circuits used for control and distribution of electric power for HEV. Electric Machines and Drives in HEVs: Fundamental of Drives and Control of EV Using DC motor, Induction Motor- Permanent Magnet Motor- Switched Reluctance Motor- BLDC motor- Design and Sizing of Traction Motors-Supporting Subsystems-Performance analysis and Standards.

MODULE IV EV CHARGING TECHNOLOGIES **9**

Classification of different charging technology-On-board & off-board charging, The Fast Charging Process, Fast Charging Strategies, The Fast Charger Configuration, EV charging station- single line diagram -introduction to Grid-to-Vehicle- Vehicle to Grid (V2G) or Vehicle to Buildings (V2B) or Vehicle to Home (V2H) operations- bi-directional EV charging systems- energy management strategies used in hybrid and electric vehicle- Wireless power transfer (WPT) technique for EV charging(Block Diagram only)-Performance analysis and EV charging Standards.

MODULE V EV- PERFORMANCE AND SAFETY ISSUES **9**

Electric vehicle verses IC engine vehicle comparison: efficiency comparison – pollution comparison – capital and operating cost comparison – GHG emission – emission standards and comparison - United Nations Framework Convention on Climate Change (UNFCCC) – Kyoto protocol – UNFCCC Paris climate change summit (COP 21) - legislation and standardizations for electric vehicles – EV performance testing – safety requirements of electric vehicles.

COURSEOUTCOMES

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

CO1: Identify the various electric vehicles technologies and their performance parameters.

CO2: Compare the different types of energy storage systems.

CO3: Design of power train components for electric vehicle application.

CO4: Illustrate the different charging technique and its standards.

CO5: Select a novel and alternate energy sources that could be used in EVs.

CO6: Review of various standards and safety requirements for EV.

TOTAL:45 PERIODS

TEXTBOOKS:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel

Cell Vehicles: Fundamentals, Theory and Design, 2 nd edition CRC Press, 2018.

2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 3 rd Edition, CRC Press, 2021.

REFERENCES:

1. Ali Emadi, Mehrdad Ehsani, “Vehicular Electric Power Systems” Marcel Dekker, Inc., New York, 2014.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, 2 nd edition, Wiley, 2012.
3. Chris Mi, M. Abul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, John Wiley & Sons Ltd., 2011.
4. Hybrid and electric vehicle solutions guide – released by Texas Instruments, 2011 available in *www.ti.com/hev*.
5. Indian vehicle emission standards: *https://www.dieselnet.com/standards/in/2wheel.php*
6. Jain, A. K., Electric Vehicles - Part 1, NPTEL Course Material, Department of Electrical Engineering, IIT Delhi, https://nptel.ac.in/courses/108/102/108102121/
7. Kumar, P., Majhi, S., Introduction to Hybrid and Electric Vehicles, NPTEL Course Material, Department of Electronics and Communication Engineering, IIT Guwahati, https://nptel.ac.in/courses/108/103/108103009/

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	2	2	2				3		3	3	
2	3	3	3	3	2						3		3	3	
3	3	3	3	3							2		3	3	
4	3	3	3	3	3	2	2	2	3	2	3	3	3	3	
5	3	3	3	3	3	3	2	2	2	3	3	2	3	3	
6	3	3	3	3	3	2	3	2	2	2	3	2	3	3	
AVg.	**3**	**3**	**3**	**2.8**	**2.6**	**2.3**	**2.3**	**2**	**2.3**	**2.3**	**2.8**	**2.3**	**3**	**3**	

1-low, 2-medium,3-high

	DATA STRUCTURES AND ALGORITHMS	L	T	P	C
		3	0	0	3

MODULE I ARRAY AND LINKED LIST **9**

Arrays – Definition - Representation - Characteristics - Array of Structures– Sparse matrices – Row major- Column major- Transpose and Multiplication of Sparse Matrices in Three Tuple Form - Linked List – Operations on Linked List - Doubly- Linked Lists – Circular Linked List.

MODULE II STACK AND QUEUE **9**

Fundamentals of Stacks, Queues, and Dequeues – Priority Queue - Array and Linked list implementation - Application of Stacks - Conversion of Infix to Postfix and Prefix Expressions - Evaluation of Expressions.

MODULE III TREE DATA STRUCTURE **9**

Trees: Binary Tree – tree traversals – binary search trees – AVL trees – splay trees – B tree - Quake heaps – treap - van Emde Boas Trees.

MODULE IV GRAPH DATA STRUCTURE **9**

Representations of graph – graph types - graph traversals – topological ordering – single source shortest paths – minimum spanning trees - union find data structure.

MODULE V SORTING AND SEARCHING TECHNIQUES **9**

Insertion Sort – Quick Sort – Heap Sort – Merge Sort- Radix Sort - Bucket sort- Linear Search – Binary Search- hashing – hash functions - rehashing.

COURSEOUTCOMES

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

CO1: Explain the concept of linear data storage techniques.

CO2: Recognize the need for nonlinear data storage.

CO3: Use linear and nonlinear data structures for numerical problems

CO4: Identify searching and sorting techniques for numerical problems**.**

CO5: Develop programs to implement data structures.

CO6: Develop programs to implement sorting and searching.

TOTAL:45 PERIODS

TEXTBOOKS:

1. ReemaThareja , “Data Structures Using C”, Oxford University Press, 2014.

2. D. Malhotra, N. Malhotra,”Data Structures and Program Design Using C”,Mercury Learning & Information,2018.

REFERENCES:

1. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C++”, Fourth Edition,Pearson Education, 2014.
2. Aho, Hopcroft, and Ullman, “Data Structures and Algorithms”, Pearson Education India, 2002.
3. J.A. Storer,,”An Introduction to Data Structures and Algorithms”, Springer, 2002
4. A. K. Sharma,”Data Structures using C”, 2nd Edition, Pearson Education, Incorporated, 2013
5. Peter Brass,”Advanced Data Structures”, Cambridge University Press,2019.
6. Amol M. Jagtap, Ajit S. Mali , “ Data Structures using C: A Practical Approach for Beginners”, CRC Press, 2021

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	1	2		1			1		1	3		
2	3	3	2	2	2		1			1		1	2		
3	3	3	3	1	3				1	1		2	2		
4	3	2	1	1	2		1			1		1		2	
5	3	2	1	2	1				1	1		2		3	
6	3	2	1	1	1		1			1		1		3	
AVg.	**3**	**2.5**	**1.6**	**1.3**	**1.8**		**1**		**1**	**1**		**1.3**	**2.3**	**2.6**	

1-low, 2-medium,3-high

	POWER AND ENERGY LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

1. Determination of Break-Down Voltage (BDV) of transformer oil.
2. Load sharing of parallel connected alternators
3. Phase Sequence detection using Static Relay.
4. Over Current detection using Static Over Current Relay & Electromechanical relay
5. Over/Under Voltage detection using Static Relay.
6. Over/Under Frequency detection using Static Relay
7. Earth Fault detection using a static relay.
8. Differential Protection of transformer using a static relay
9. Analysis of Hybrid solar and Wind power systems
10. FPGA & IoT Based over current relay.
11. LG -LL and three phase fault analysis of three phase synchronous machine
12. Characteristics of Fuse
13. Characteristics of Buchholz relay

TOTAL:30 PERIODS

COURSEOUTCOMES:

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

CO1: Design and Select suitable Plug Setting Multiplier and test the overcurrent protective relay.

CO2: Identify and locate the fault in power system.

CO3: Measure experimentally the negative sequence components in unbalanced systems.

CO4: Analyze the IDMT characteristics of over/under voltage relay

CO5: Examine relay settings for safe operating of power systems.

CO6: Analyze the characteristics of fuse and buchholz relay.

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3	2	2	2							
2	3	3	3	3	2							
3	3	2	2	2	2							
4	3	2	2	3	3							
5	3	3	3	3	2							
6	3	3	3	3	3							
AVG	**3**	**2.6**	**2.5**	**2.6**	**2.3**							

1-low,2-medium,3-high

	ELECTRIC VEHICLE LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

1. Testing of Permanent Magnet Synchronous Motor
2. Analyse the electric vehicle battery charge and discharge characteristics
3. Designing a solar PV based EV charging
4. Generation of phase shift modulation for dual active bridge DC-DC converter using Embedded Controller
5. Regenerative Charging and Braking Systems
6. VVVF Drive Training Systems
7. Characterization of power, torque and efficiency for EV over drive cycle
8. Simulation of power train system and determines its efficiency and Power flow in EV powertrain during charging, V2G feeding, motoring and braking
9. Simulation of speed control of AC and DC motors
10. Develop a model that could estimate the SOC of a Li-ion battery
11. Power Quality and Harmonic analysis of an Inverter (Drive train and Charger)
12. Machine Learning Model for Electronic Steering
13. Synchronized PWM techniques for high-power and high-speed IM drives
14. Simulation of Power line disturbance due to penetration of Electric Vehicle
15. Testing of safety compliance for electrical products
16. Study of various sensor outputs and its characterization
17. Performance evaluation of 2/3/4 W
18. Design and simulate a motor controller for hybrid electric vehicle applications
19. Design and simulation of DC/DC and DC/AC converter for electric vehicle application
20. Demonstrate a wiring layout for electric vehicle
21. Thermal analysis of Li-ion battery
22. Simulation of boost converter and calculating gain and phase margin from the transfer function.
23. Design and simulation of PI/PID controller for Electric Vehicle
24. Design and simulate speed controller for induction motors in EV and analyses its dynamic and steady state performance
25. Simulation of a wireless power charging station for EV charging
26. Design and simulate a battery management system for electric vehicle application
27. Simulate a fuzzy logic controller based energy storage system for EV

TOTAL:30 PERIODS

COURSEOUTCOMES:

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

CO1: Modeling and thermal analysis of Li-ion battery with an appropriate Battery Management System.

CO2: Speed Control of AC and DC motor drive.

CO3 Control of Converters using PWM techniques.

CO4: Design a power train system, calculate its efficiency and also check the wiring layout for electric vehicle.

CO5: Able to design a charging station, wired, wireless charger and bidirectional charging of an Electric Vehicle.

CO6: Able to apply Artificial Intelligence and Machine Learning techniques for Automotive Electronics, Power Quality, Energy and Data Analytics.

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3	3	3	3	2	1	1	3	2	3	2
2	3	3	3	3	3	2	1	1	3	2	3	2
3	3	3	3	3	3	2	1	1	3	2	3	2
4	3	3	3	3	3	2	1	1	3	2	3	2
5	3	3	3	3	3	2	1	1	3	2	3	2
6	3	3	3	3	3	2	1	1	3	2	3	2
AVG	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**3**	**2**	**3**	**2**

1-low,2-medium,3-high

	IoT LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

1. Interfacing sensors ESP8266, Arduino in Tinkercad software.
2. Networking Simulation using CISCO Network Packet Tracer
3. Temperature and moisture Data uploading in the cloud platform.
4. Uploading Data to different Cloud Platforms.
5. Fire protection using sensors and Arduino UNO.
6. Security Testing Programs.
7. Home Appliances Control
8. Data Analyzing Techniques.
9. Traffic light controller.
10. Creating intranet using Local Server / client.
11. Program to use hybrid cloud.
12. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smart phone using Bluetooth.

TOTAL:30 PERIODS

COURSEOUTCOMES:

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

CO1: Perceive the basic IoT Components, Various cloud platforms

CO2: Distinguish the usage of networking components and LAN, WAN networks.

CO3: Assess the data from sensors.

CO4: Application of IoT for home, commercial buildings.

CO5: Interpret Ethical Hacking methods

CO6: Build Suitable security codes in IoT.

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3	1	3				2				
2	1	1	3	3				2				
3	1	1	3	3				2				
4	1	1	3	3				2				
5	1	1	3	3				2				
6	1	1	3	3				2				
AVG	**1.3**	**1.3**	**2.7**	**3**				**2**				

1-low,2-medium,3-high

COURSE CODE	MINI PROJECT	L	T	P	C
		0	0	4	2

COURSEOUTCOMES:

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

CO1: Analyze the problems in societal and environmental contexts and to provide the technical support for sustainable development without affecting the nature.

CO2: Develop practical knowledge within the chosen area of technology for project development with professional ethics

CO3: Identify, analyze, formulate and design a real time project with a comprehensive and systematic approach by using modern tools and to have sustainable environment.

CO4: Take part in a team and as an individual in the development of technical projects and to improvetheir effective team management and financial management skills through project activities.

CO5: Develop effective communication skills for presentation

CO6: Develop plagiarism free technicalreport preparation.

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3	3	3		3						2
2	3	3	3	3		3		3				2
3	3	3	3	3	3	3	3					2
4	3	3							3		3	2
5	3	3								3	3	2
6	3	3										2
AVG	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**

1-low,2-medium,3-high

SEMESTER VII

	GENERATION OF ELECTRICAL ENERGY	L	T	P	C
		3	0	0	3

MODULE I LOAD ANALYSIS 9

Demand for electric power - Load Curves and Load curve analysis - Reliability Evaluation - Outages, Causes and Interruptions - Cost versus Reliability - Short and Long range planning - Load demand - Diversity and Plant factors - Cost and Economic Evaluation.

MODULE II CONVENTIONAL GENERATION SCHEMES 9

Hydroelectric power plants - Pumped storage plants - Thermal power plants: Steam power stations, Gas turbine stations and Diesel generators – Nuclear power plants - Safety aspects - Environmental concerns.

MODULE III SOLAR PV AND SOLAR THERMAL SYSTEMS 9

Solar radiation and measurement - Influence of insulation and Temperature - Block diagram of solar photo voltaic system - Solar PV Cell - Characteristics and Types - Arrays and Panels - DC power conditioners - Maximum power point tracking algorithms - AC power conditioners - Line commutated thyristor inverters - Synchronized operation with grid supply - Standalone inverters. Solar PV Applications: Water pumping and Street lighting. Energy Storage: Batteries, types and its parameters Introduction to Solar Collectors, Solar Heating and Cooling Systems.

MODULE IV WIND ENERGY SYSTEMS 9

Basic principle of wind energy conversion - Nature of wind power in the wind - Site selection considerations - Components of Wind Energy Conversion System (WECS) - Classification of WECS - Generating Systems - Schemes of electrical generation. Applications - Water pumping and Village electrification.

MODULE V COGENERATION AND MICROGRID 9

Distributed generation versus traditional power systems - Concepts of micro grid - Additional sources of micro grids: Biomass - fuel cells - Structure and Configuration of AC and DC micro grid - Modes of operation and Control of micro grid: Grid connected and Islanded mode - Active and Reactive power control and protection issues.

COURSEOUTCOMES

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

CO1: Classify different types of loads and recognize the load demand - supply curve.

CO2: Identify the areas of agreement and disagreement in safety aspects and environmental concern of conventional power generation schemes.

CO3: Design and develop solar PV based grid tied, off grid and hybrid systems for domestic applications.

CO4: Examine the possibilities of wind energy systems in the particular locality.

CO5: To identify the power converters for grid connected solar PV systems.

CO6: Assess, design, evaluate and justify the solar PV, wind, fuel cell and battery sources of energy for micro - grid installation for a given requirements.

TOTAL:45 PERIODS

TEXTBOOKS:

1. B.R.Gupta, " Generation of Electrical Energy", EurAsia Publishing House, 7th Edition, 2017.

2. Mukund R. Patel, "Wind and Solar Power Systems" CRC Press, New York, 2009.

3. S. Chowdhury and P. Crossley, "Microgrids and Active Distribution Networks", Institution of Engineering and Technology (IET Press), 2014.

4. Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI , Delhi, 2015.

REFERENCES:

1. Digambar M. Tagare, "Electricity Power Generation: The Changing Dimensions", John Wiley & Sons, 2011.
2. C.L.Wadhwa, "Electrical Power Systems", New Age International, 8th Edition, 2022.
3. Joshua Earnest and Tore Wizelius, "Wind Power Plants and Project Development", PHI Learning Private Limited, New Delhi, 2011.
4. Adolf Goetzberger and Volker Hoffmann, "Photovoltaic Solar Energy Generation", Springer - Verlag Berlin Heidelberg, 2005.
5. Roger Messenger and Jerry Venture, "Photovoltaic Systems Engineering", CRC Press, New York, 2007.
6. P Breeze, "Power Generation Technologies", Elsevier, 2nd Edition, 2014

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	2						2	2	2	2	
2	3	3	2	3	2						2	2	2	2	
3	3	2	2	2	2		2				2	2	2	2	
4	3	2	2	3								2	2	2	
5	3	3	3	3	2	2	2		2	2	2	3	3	3	
6	3	3	3	3	3	2	2	2	2	2	2	3	3	3	
AVg.	**3**	**2.6**	**2.3**	**2.6**	**2.2**	**2**	**2**	**2**	**2**	**2**	**2**	**2.3**	**2.3**	**2.3**	

1-low, 2-medium,3-high

	SOLID STATE DRIVES AND CONTROL	L	T	P	C
		3	0	0	3

MODULE I CHARACTERISTICS OF ELECTRICAL DRIVES AND LOADS 7

Electrical Drives-An Introduction-Advantages of Electrical Drives-Development of drive Systems - Comparisons - Concept of electric drive - Block diagram representation –- Classification - AC and DC drives – Dynamics of Electrical Drives- Principle factors affecting the choice of drive - Speed - Torque characteristics of drive motor and load - Joint speed - torque characteristics - Selection of motor power rating for drive motor based on thermal overloading and Load variation factors.

MODULE II DC DRIVES 9

Introduction - Speed control of DC motors - Ward - Leonard scheme and its draw backs - Solid state control - Advantages - Performance parameters.

Converter fed DC drives - Single phase and Three phase drives - Performance characteristics - Single, Two and Four quadrant operation - Supply side harmonics - Power factor and Effect of ripple on motor performance.

Chopper fed DC drives - Chopper fed control of separately excited DC motor, DC Shunt and DC Series motor – Performance characteristics - Quadrants of Operation.

MODULE III INDUCTION MOTOR DRIVES 12

Three Phase Induction Motor Analysis and Performance-Operation under unbalanced Condition and non-sinusoidal voltage supply. Methods of speed control of three phase induction motor.

Stator Side Control: Stator voltage control - Stator frequency control - V/F control - Solid - state speed control schemes with AC voltage controllers - DC link inverters (Phase Controlled and PWM rectifier based) - Cyclo converters - Matrix converter - CSI fed IM variable frequency drives - Introduction to vector control.

Rotor Side control: Rotor resistance control - Static rotor resistance control - Injection of voltage in the rotor circuit - Slip power recovery schemes: Static Scherbius - Modified Kramer drive.

MODULE IV SYNCHRONOUS MOTOR DRIVES 9

Speed control of three phase synchronous motor - True synchronous and Self - controlled modes - Inverter fed synchronous motor drives - Cyclo converter control - Brushless DC motor drives - Current source inverter fed synchronous motor drive - Synchronous reluctance motor drive.

MODULE V SPECIAL DRIVES AND APPLICATIONS 10

DC Servo drives principle of operation - AC Servo drives principle of operation - Principle and control Stepper motor drives - Comparison between Servo drive and Stepper drive - Introduction to PLC based drives - Energy Efficient drives – Switched Reluctance motor drives - Solar and Battery powered drives.

Selection of drive and Control schemes for Steel industry - Textile industry - Mining - Paper industry - Cement mils.

COURSEOUTCOMES

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

CO1: Analyze the characteristics of motors, load dynamics and performance parameters of DC drives and selection of motor power rating under different load conditions.

CO2: Analyze the conventional method of DC drive and solid-state Drives for DC motors.

CO3: Analyze the performance characteristics of three phase Induction motor and the various methods of speed control based on solid state drives.

CO4: Get an insight of various power electronic circuitry to drive synchronous motor, brushless DC motor and SRM.

CO5: Select the suitable drive according to industrial, environmental standards and develop the control schemes for any electric drive.

CO6: Describe the concept and application of special machines in modern electric drives.

TOTAL:45 PERIODS

TEXTBOOKS:

1. G. K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2014.
2. Bose B K, "Modern Power Electronics and AC Drives", Pearson Education (Singapore) Pvt. Ltd, New Delhi, 2014.
3. .K. Dubey, “Power Semiconductor Controlled Drives”, Prentice Hall, 1989.

REFERENCES:

1. Vedam Subramaniam, "Electrical Drives and Applications", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2010.
2. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC Motor Drives", CRC Press Taylor & Francis Group, 2010.
3. S.K. Pillai, "A First Course on Electrical Drives", New Age International Publishers, 2nd Edition, 2010.
4. M.S.Berde, "Electric Motor Drives", Khanna publishers, New Delhi 1997.
5. P.C. Sen, "Thyristor DC Drives", John Wiley and Sons, New York, 1981.
6. J.M.D. Murphy, "Thyristor Control of AC Motor", Paragon Press, London, 1978.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	2	2	2				3		3	3	
2	3	3	3	3	2						3		3	3	
3	3	3	3	3							2		3	3	
4	3	3	3	3	3	2	2	2	3	2	3	3	3	3	
5	3	3	3	3	3	3	2	2	2	3	3	2	3	3	
6	3	3	3	3	3	2	3	2	2	2	3	2	3	3	
AVg.	**3**	**3**	**3**	**2.8**	**2.6**	**2.3**	**2.3**	**2**	**2.3**	**2.3**	**2.8**	**2.3**	**3**	**3**	

1-low, 2-medium,3-high

	SMART GRID	L	T	P	C
		3	0	0	3

MODULE I FUNDAMENTALS OF SMART GRID 8

Smart grid architecture: functions and characteristics of smart grid components – opportunities and challenges of smart grid – Smart grid market drivers – Smart grid benefits: Utility benefits, consumer benefits and environmental benefits - Features of smart grid: Interoperability, Self healing and resilient - National initiatives in smart grid.

MODULE II SMART GRID TECHNOLOGIES 10

Transmission system: smart substation - Substation automation: Components and functions of SCADA, RTU and IEDs – Phasor measurement unit.

Distribution system: Fault location, isolation and service restoration (FLISR) - Demand side management and demand response.

Monitoring and Measurements: Smart metering: Key components and hardware used, Communication infrastructure and protocols – Advanced metering infrastructure – Wide area monitoring system.

MODULE III POWER AND ENERGY MANAGEMENT IN SMART GRID 10

Power electronics for smart grid: Renewable energy integration with smart grid – Power quality issues: concept of active filtering – concept of reactive power compensation – Power quality conditioners - Distribution system automation – Energy management system configuration.

MODULE IV COMMUNICATION AND NETWORKING 10

Communication infrastructure and protocols: HAN, WAN, BPL, meter data management system, protocols for communication - Introduction of cloud computing and cyber security for smart grid - Information security for the smart grid: Encryption, decryption, authentication and cyber security standards. Smart grid standards: IEC 61970, IEC 61850 and IEC 62351.

MODULE V SMART GRID PROJECTS IN INDIA 7

Pilot projects : Functionalities, benefits, key facts and project status – Over view of Smart grid demonstration project in Assam, Haryana, Puducherry, Mysore ; Projects: over view of Sub Division 5 Under CED Chandigarh and 6 Towns Under JVVNL Rajasthan – Project status ; Smart grid vision, road map and achievements in India – Tracking of smart Grid as per IEA report – Smart home and smart city concepts.

COURSEOUTCOMES

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

CO1: Infer the fundamentals of smart grid and the smart grid projects in India.

CO2: Infer the concepts of smart grid technologies in transmission and distribution systems.

CO3: Interpret the monitoring and measurements techniques and energy storage techniques in smart grid

CO4: Identify the applications of power electronics in smart grid and to analyze the impact of EV in smart grid.

CO5: Organize the communication architecture of the smart grid.

CO6: Classify the standards for communication network and security in the smart grid.

TOTAL:45 PERIODS

TEXTBOOKS:

1. James Momoh, "Smart Grid - Fundamentals of Design and Analysis", IEEE Press, John Wiley & Sons, INC., New Jersey, 2012

2. Janaka. E. Kanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu and Akihiko Yokoyama, "Smart Grid: Technology and Applications", John Wiley & Sons Ltd., West Sussex, 2012.

REFERENCES:

1. Muhammad Kamran, " Fundamentals of Smart Grid Systems", Academic Press, Elsevier, First edition, 2023.
2. ErsanKabalci, Yasin Kabalci, "From Smart Grid to Internet of Energy", 1st edition, Elsevier Science,2019.
3. K S Manoj,"Smart Grid, Concepts To Design", Notion press India ,2020.
4. https://onlinecourses.nptel.ac.in/noc23_ee60
5. https://www.nsgm.gov.in/en/sg-pilot,
6. https://www.iea.org/energy-system/electricity/smart-grids

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2				1	2					1	1		
2	3	3	1	1		1			1			1	1		
3	3	3	1	1		1			1			1	1		
4	3	3	1	1		1	2		1			1		2	
5	3	1	1			1			1			1		2	
6	3	1				1		1				1		2	
AVg.	**3**	**2.1**	**1**	**1**		**1**	**2**	**1**	**1**			**1**	**1**	**2**	

1-low, 2-medium,3-high

	ELECTRICAL DRIVES LABORATORY	L	T	P	C
		0	0	3	1.5

LIST OF EXPERIMENTS

1. Dynamic Braking Characteristics of DC Shunt Motor
2. Reverse Current Braking Characteristics of Three - Phase Induction Motor
3. Dynamic Braking Characteristics of Three - Phase Induction Motor
4. Load Test on Induction Generator by Feeding Back to Mains
5. Speed Control of Three Phase Induction Motor using Scalar and Vector Controlled Drive.
6. DSP Based Speed Control of Three Phase Squirrel Cage Induction Motor
7. Chopper Based Speed Control of DC Shunt Motor Using DSP Controller
8. PLC Based Speed Control of Three Phase Induction Motor Drive
9. Stator voltage control of Three Phase Squirrel Cage Induction Motor with Eddy Current Loading.
10. Performance and Harmonic Measurements of Air Compressor using AC drive
11. Speed Control of Three Phase Induction Motor using Matrix Converter Drive
12. Speed Control of Switched Reluctance Motor Drive
13. Speed Control of Servo Motor Drive and Study of BLDC Drives
14. Load Test on DC Shunt Motor Using Single Phase Dual Converter Drive
15. Performance analysis of Solar PV based DC and AC Pump

TOTAL:45 PERIODS

COURSEOUTCOMES:

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

CO1: Decide a suitable drive for a particular application based on power rating and characteristics of the application.

CO2: Determine the braking characteristics of DC shunt motor and Induction motor.

CO3: Assess the converter topologies, inverter topologies control principles and modern tools used in DC drives, AC drives and special electric drives.

CO4: Demonstrate the speed control of DC motors using converters and chopper fed drive and to demonstrate the speed control of AC motors by using inverter fed AC drive.

CO5: Integrate the drive-based energy saving technique through experimental verification

CO6: Perform the speed control techniques for special electric machines.

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3	2	2	2							
2	3	3	3	3	2							
3	3	2	2	2	2							
4	3	2	2	3	3							
5	3	3	3	3	2							
6	3	3	3	3	3							
AVG	**3**	**2.8**	**2.5**	**2.5**	**2.3**							

1-low,2-medium,3-high

	INDUSTRIAL AUTOMATION LABORATORY	L	T	P	C
		0	0	3	1.5

LIST OF EXPERIMENTS

1. Access of Analog and Digital I/Os via Industrial IoT 2040 using Python
2. Access of Analog and Digital I/Os via Industrial IoT 2040 using C/C++ compiler
3. Interfacing of IoT 2040 Gateway with Android Application.
4. Hardware configuration of PCS7 - combinational logics
5. Design logic for traffic light controller using PCS7
6. Design a level process with PID controller for a real time plant
7. Study of Distributed Control System architecture and ES/OS Configuration of AS410 CPU in PCS7.
8. RF Communication and control of two end Nodes
9. Application server and End device Communication
10. Real time Data Monitoring and Device Control
11. Smart meter interfacing using LoRa
12. IoT based 1 phase PWM inverter
13. Control of mobile robot
14. ON/OFF Logic control using PLC
15. Control applications using timers in PLC.

TOTAL:45 PERIODS

COURSEOUTCOMES:

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

CO1: Apply an industrial IoT to access the data via industrial IoT.
CO2: Develop a controller for a plant/actuator using PCS7.
CO3: Implement PID controller for real time plant
CO4: Develop control applications using industrial automation protocols
CO5: Develop applications using warless network
CO6: Implement a control application program to PLC.

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	2	2	2	1	3				2	3		2
2	3	2	2	1	3				2	3		2
3	3	2	2	1	3				2	3		2
4	3	2	2	1	3				2	3		2
5	2	2	2	1	3				2	3		2
6	2	2	2	1	3				2	3		2
AVG	**2.5**	**2**	**2**	**1**	**3**				**2**	**3**		**2**

1-low,2-medium,3-high

	REVERSE ENGINEERING AND PRODUCT REALISATION LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

1. Select a System of Interest under any of the categories
   a) Home Appliance
   b) Desktop Computers
   c) Mobile Phone
   d) Power System –
      i) Generating System Design – Renewable or Conventional
      ii) Distribution System Design
      iii) Substation Design
      iv) Relay and Circuit Breaker Design
   e) Power Electronics System –
      i) Converters
      (ii) Inverters.
2. Identify the Block Diagram and the Components, circuits used
3. Observe the functionality of each sub system
4. Disassemble and analyse
5. Assemble and prepare the report to meet the CO 4,5,6

TOTAL:30 PERIODS

COURSEOUTCOMES:

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

CO1: Identify parts that are no longer available and Create missing documentation

CO2: discover the technological principles of a device or system through analysis of its structure, function, and operation

CO3: Disassembe and re-assemble the device, taking care to document, test, analyze and report on the study of its function

CO4: Re-design to modify and improve products

CO5: Determine the technology in competitive products

CO6: Replace old components with new ones

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3	1	3				2				
2	1	1	3	3				2				
3	1	1	3	3				2				
4	1	1	3	3				2				
5	1	1	3	3				2				
6	1	1	3	3				2				
AVG	**1.3**	**1.3**	**2.6**	**3**				**2**				

1-low,2-medium,3-high

SEMESTER VIII

	PROJECT WORK AND VIVA-VOCE	L	T	P	C
		0	0	12	6

COURSEOUTCOMES:

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

CO1: Demonstrate the technical skills to provide feasible solutions for real - life problems relevant tothe society.

CO2: Analyze, estimate and manage a project within a stipulated project time line and communicate effectively on complex engineering activities

CO3: Apply engineering ethical principles in societal and environmental contexts and to realize the importance of project management tools, estimation and costing.

CO4: Enhance the management skills to achieve the project goal by working as a team.

CO5: To develop a product as a solution for complex engineering problems and a need for sustainable development with modern tool usage.

CO6: Develop plagiarism free technicalreport.

CO-PO&PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	3										2
2	3	3		3						3		2
3	3	3				3		3				2
4	3	3							3		3	2
5	3	3	3		3		3					2
6	3	3										2
AVG	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**

1-low,2-medium,3-high

PROFESSIONAL ELECTIVE COURSES: I. ELECTRICAL MACHINES AND CONTROL

	DESIGN OF ELECTRICAL MACHINES	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Design factors - Limitation in design - Various Conducting materials, Insulating materials and Magnetic materials. Design of Magnetic Circuits: MMF calculation for Air gap and Teeth - Iron losses and Magnetizing current calculations. Design of Armature Windings: Types of Winding for AC and DC Machines. Introduction to machine design software: Speed, JMAG, Maxwell.

MODULE II D.C. MACHINES **9**

Output equation - Choice of Specific loadings - Choice of poles and speed - Main Dimensions - Length of Air gap - Design of Armature - Design of Field System - Commutator and Brush Design .

MODULE III SYNCHRONOUS MACHINES **9**

Choice of Electric and Magnetic loadings - Main dimensions - Length of Air gap - Short circuit ratio - Stator core design and Rotor core Design for salient pole and turbo alternators - Design of Pole and Field winding - Design of damper windings.

MODULE IV THREE PHASE INDUCTION MOTORS **9**

Output equation - Choice of Electric and Magnetic loadings - Main dimensions - Stator core design - Length of Air gap - Rotor core Design - No load current calculation - Stator and Rotor Resistance calculations - Introduction to Energy Efficient Motors..

MODULE V SINGLE PHASE INDUCTION MOTOR **9**

Single phase induction motor: Main dimensions - Design of stator - Rotor design- Introduction to CAD.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Classify the materials used for the construction of electrical machines and also to determine the MMF in magnetic parts of rotating machines.

CO2: Decide the appropriate parameters and design the major parts of DC machines.

CO3: Determine and choose appropriate parameters for the design of major parts of synchronous machines for given specifications.

CO4: Decide and select appropriate parameters for the design of stator and rotor of three phase induction machines.

CO5: Decide the appropriate parameters and design the major parts of single phase induction motor.

CO6: Design the electrical machines as per the given criteria

TOTAL:45 PERIODS

TEXTBOOKS:

1. A.K. Sawhney, "A course in Electrical Machine Design", Dhanpat Rai & Sons, Reprint, 2010.
2. K.G.Upadhaya, "Design of Electrical Machines", New Age International, 1st Edition, 2008.
3. K.Sen, "Principles of Electrical Machine Design" - Oxford & IBH pub. Co. Pvt. Ltd., 2nd Edition, 2001.
4. K.M.V.Murthy,"Computer Aided Design of Electrical Machines",BS Publications,2008.

REFERENCES:

1. R.K.Agarwal, "Principles of Electrical Machine Design" - S.Kataria & Sons, 5th Edition, New Delhi, Reprint, 2014.
2. V.N. Mittle, "Design of Electrical Machines", Standard Publishers Distributors, 5th Edition, 2014.
3. Juha Pyrhones, Tapans Jokines,"Design of Rotating Electrical Machines", John Wiley and Sons, 2009.
4. M.V. Deshpande, "Design and Testing of Electrical Machines", PHI Learning Private Limited, Delhi, 2013.
5. A.Shanmugasundaram, G.Gangadharan,R.palani, "Electrical machine Design data book, New Age Pvt. Ltd, Reprint of 1st Edition 2007.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3											2		
2	3	3											2		
3	3	3											2		
4	3	3													
5	3	3													
6	3	3	3											3	
Avg.	**3**	**3**	**3**										**2**	**3**	

1-low, 2-medium,3-high

	MODELING AND ANALYSIS OF ELECTRICAL MACHINES	L	T	P	C
		3	0	0	3

MODULE I PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION 9

Magnetic circuits - Stored magnetic energy - Co - energy - Force and Torque - Singly and doubly excited system - MMF pattern for DC and AC machines - Calculation of air gap mmf and per phase machine inductance using physical machine data.

MODULE II DC MACHINES 9

Voltage and Torque equations - Dynamic characteristics of permanent magnet and shunt DC motors state equations - Solution of dynamic characteristics by Laplace transformation.

MODULE III REFERENCE FRAME THEORY 9

Static and Rotating reference frames - Transformation of variables - Reference frames - Transformation between reference frames - Transformation of a balanced set - Balanced steady state phasor and voltage equations - Variables observed from several frames of reference.

MODULE IV INDUCTION MACHINES 9

Voltage and Torque equations in machine variables - Transformation in arbitrary reference frame - Voltage and Torque equation in reference frame variables - Analysis of steady state operation - Free acceleration characteristics - Dynamic performance for load variations - Computer simulation.

MODULE V SYNCHRONOUS MACHINES 9

Voltage and Torque equation in machine variables - Transformation in rotor reference frame (Park's equation) - Voltage and Torque equation in reference frame variables - Analysis of steady state - Dynamic performance for load variations - Computer simulation .

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Describe the fundamentals of electromagnetic energy conversion for singly and doubly excited systems.

CO2: Analyze standard methods to determine accurate modeling/simulation parameters for DC machines.

CO3: Illustrate reference frame theory.

CO4: Examine the steady state operation and dynamic operation for load variation of induction machines.

CO5: Illustrate the behavior of synchronous machines under transient and steady state conditions.

CO6: Apply the simulation concepts for the electrical machines

TOTAL:45 PERIODS

TEXTBOOKS:

1. Paul C.Krause, Oleg Wasyzczuk and Scott D.Sudhoff, "Analysis of Electrical Machinery and Drive systems", IEEE Press, 2nd Edition, 2005.

2. R.Krishnan, "Electrical Motor Drives, Modelling, Analysis and Control", Prentice Hall of India, 2002.

3. Mrittunjay Bhattacharyya,"Electrical machines: modeling and analysis , PHI learning Pvt. Ltd,2016.

REFERENCES:

1. A.E.Fitzgerald, Charles Kingsley, Jr. and Stephen D.Umans, "Electric Machinery", TataMcGraw Hill, 5th Edition, 1992.
2. Subramanyam V., "Thyristor Control of Electric Drives", Tata McGraw Hill Publishing Company Limited, New Delhi 1998.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3											2		
2	3	3											2		
3	3	3											2		
4	3	3												2	
5	3	3												2	
6	3	3												3	
Avg.	**3**	**3**											**2**	**2.3**	

1-low, 2-medium,3-high

	DIGITAL CONTROL SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **10**

Basic concepts of digital control systems - block diagram - analog to digital and digital to analog conversion - sampling and hold devices - multiplexing - sampling and sampling theorems.

MODULE II Z TRANSFORM **8**

Definition and evaluation - basic properties - inverse Z transform - pulse transfer function - starred Laplace transform - applications.

MODULE III MAPPING BETWEEN Z PLANE AND S PLANE **9**

Representation of poles and zeros in the Z plane - relation between Z plane and S plane - mapping - correspondence between pole location in the Z plane and system time response - analysis of simple loop containing a discrete time controller.

MODULE IV STABILITY ANALYSIS AND DESIGN **10**

Jury's stability test -Schurcohn Stability test - discrete root locus - frequency response methods – bilinear transformation - LMI techniques - design using root locus and Bode plot- discrete Nyquist stability criterion.

MODULE V DISCRETE STATE SPACE ANALYSIS **8**

Introduction - state space representation of discrete systems - canonical forms - state transition matrix - solving discrete time state equations.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Understand the concepts and advantages of digital control over analog control.

CO2: Derive the pulse transfer function of digital control systems using Z-transform techniques.

CO3: Define the mapping between s-plane and z-plane.

CO4: Analyze systems in discrete-time domain.

CO5: Design a stable system using root locus and Bode plot technique.

CO6: Determine the stability of the system in discrete-time domain and apply discrete-time state space methods in system analysis.

TOTAL:45 PERIODS

TEXTBOOKS:

1. Katsuhiko Ogata, "Discrete-Time Control Systems", IV Edition, Pearson Education Asia, Singapore, 2009
2. Gopal M, "Digital Control and State Variable Methods", III Edition, Tata Mc-Graw Hill Publishing Co. Ltd. New Delhi, 2009.

REFERENCES:

1. Gene F. Franklin J. David Powell and Michael Workman, “Digital Control of Dynamic Systems”, III Edition, Ellis-Kagle Press, 2022.
2. Benjamin C. Kuo, "Digital Control Systems", II Edition, Oxford University Press, 2007.
3. Sami Fadali and Antonio Visioli, "Digital Control Engineering: Analysis and Design", II Edition, Elsevier, 2013.
4. Anastasia Veloni and Nikolaos Miridakis, "Digital Control Systems: Theoretical Problems and Simulation Tools”, I Edition, CRC Press, 2021.

5. Loan D.Landau and GianlucaZito, "Digital Control Systems", II Edition, Springer, 2010.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2											2		
2		3											2		
3		3											2		
4	2												2		
5		2												3	
6	3	2												3	
Avg.	**2.6**	**2.4**											**2**	**3**	

1-low, 2-medium,3-high

	SYSTEMS THEORY	L	T	P	C
		3	0	0	3

MODULE I STATE VARIABLE REPRESENTATION 8

Introduction-Concept of State-Space equations for Dynamic Systems -Time invariance and linearity- Non uniqueness of state model- Physical Systems and State Assignment - free and forced responses- State Diagrams .

MODULE II SOLUTION OF STATE EQUATIONS 8

Existence and uniqueness of solutions to Continuous-time state equations - Solution of Nonlinear and Linear Time Varying State equations - State transition matrix and its properties – Evaluation of matrix exponential- System modes- Role of Eigen values and Eigen vectors.

MODULE III PROPERTIES OF THE CONTROL SYSTEM 8

Controllability and Observability - Stabilizability and Detectability-Test for Continuous time Systems-Time varying and Time invariant case - Output Controllability-Reducibility - System Realizations.

MODULE IV NON-LINEARITIES AND STABILITY ANALYSIS 11

Equilibrium Points-Stability in the sense of Lyapunov - BIBO Stability-Stability of LTI Systems Types of nonlinearity – Phase plane analysis – Singular points – Limit cycles – Construction of phase trajectories – Describing function method – Derivation of describing functions. Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems - Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems- Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems-Krasovskii and Variable-Gradient Method.

MODULE V MODAL ANALYSIS 10

Controllable and Observable Companion Forms - SISO and MIMO Systems – Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Model the given physical system in state space.

CO2: educate on modeling and representing systems in state variable form.

CO3: train on solving linear and non-linear state equations.

CO4: illustrate the properties of control system.

CO5: classify non–linearity and examine stability of systems in the sense of Lyapunov's theory

CO6: educate on modal concepts, design of state, output feedback controllers and estimators.

TOTAL:45 PERIODS

TEXTBOOKS:

1. M. Gopal, "Modern Control System Theory", New Age International, 2005.

2. K. Ogata, "Modern Control Engineering", PHI, 2002.

REFERENCES:

1. D. Roy Choudhury, "Modern Control Systems", New Age International, 2005.

2. Z. Bubnicki, "Modern Control Theory", Springer, 2005.

3. John S. Bay, "Fundamentals of Linear State Space Systems", McGraw-Hill, 1999.

4. John J. D'Azzo, C. H. Houpis and S. N. Sheldon, "Linear Control System Analysis and Design with

MATLAB", Taylor Francis, 2003.
5. M. Vidyasagar, "Nonlinear Systems Analysis', 2nd edition, Prentice Hall, Englewood Cliffs, New Jersey, 2002

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3		2										2	2	
2		3											2		
3		1											3		
4	2														
5		2		1											
6	3	2												2	
Avg.	2.6	2	2	1									2.3	2	

1-low, 2-medium,3-high

	ROBUST CONTROL	L	T	P	C
		3	0	0	3

MODULE I OVERVIEW AND PRELIMINARIES 12

Overview on Robust control, Basics from Matrix Algebra, Norms of signals and systems . Classical Control, Root locus, Nyquist plots, Robustness and Disturbance rejection in SISO systems . Multivariable Linear Systems: Continuous time State space models, Discrete time state models. Transfer-functions, Frequency response, Poles, Zeros and Modes . Stability, Change of Basis, Controlloability Observability and Observer Feedback Performance .

MODULE II LINEAR QUADRATIC CONTROL 9

The Linear Quadratic Regulator (LQR) problem: LQR solution using the minimum principle, Generalization of LQR; LQR properties with classical interpretations; Optimal observer design- Kalman-Bucy filter. The Linear Quadratic Gaussian (LQG) problem: Introduction, LQG problem formulation and solution, Performance and Robustness of optimal state feedback, Loop Transfer Recovery (LTR).

MODULE III MODERN H_2 AND H_∞ AND OPTIMAL CONTROL 12

Modern H_2 **and** H_∞ optimal controller design and to LMI-based synthesis techniques for such controllers and for multi-objective design. Optimal regulator problem with finite time horizon, Riccati differential equation. Singular value plots, input and output directions; Mixed sensitivity design, H_∞loop shaping, choice of weighting filters.

MODULE IV LINEAR MATRIX INEQUALITIES 6

Design specifications as LMI constraints (H_2 , H_∞ and pole region); Controller synthesis by solving LMI problems, multi-objective design.

MODULE V ROBUST CONTROL OF UNCERTAIN SYSTEMS 6

Small gain theorem, representation of parameter uncertainty; Balanced realization and model order reduction.

COURSEOUTCOMES

After completing the course successfully, the students will be able to, (Minimum 3; Maximum 5)

CO1: Identify type of system as linear, nonlinear, SISO and MIMO.

CO2: Design a robust control using classical and state space approach.

CO3: Design a roust control using linear quadratic approach.

CO4: Design a robust control using H-infinity methods

CO5: Devise Synthesize controller by solving LMI problem for the given design specifications.

CO6: Design a robust control for uncertain systems.

TOTAL:45 PERIODS

TEXTBOOKS:

1. K. Zhou, J. Doyle, and K. Glover, Robust and Optimal Control, Prentice-Hall, 2006.
2. G. E. Dullerud and F. Paganini, A Course in Robust Control Theory: a convex approach, Vol. 36, Springer Science & Business Media, 2013.
3. Gene F. Franklin, J. David Powell, Abbas Emami-Naeini, “Feedback Control of Dynamic Systems”, Pearson, Ed. 8, 2018.

REFERENCES:

1. J J. Ackermann, “Robust Control – Systems with Uncertain Physical Parameters”, Springer-Verlag, 1993.
2. S. P. Bhattacharya, H. Chapellat and L. H. Keel, “Robust Control: The Parametric Approach”, Prentice-

Hall, PTR, NJ07458, 1995
3. Andrzej Bartoszewicz, Robust Control: Theory and Applications, InTech, 2011.
4. Basil Kouvaritakis, Mark Cannon, “Model Predictive Control – Classical, Robust and Stochastic”, Springer, 2015.
5. Katsuhiko Ogata, “Modern Control Engineering”, Prentice Hal, Ed. 5, 2010.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	1				2	1		1	2		
2	3	3	3	2	1				2	1		1		3	
3	3	3	3	2	1				2	1		1		3	
4	3	3	3	2	1				2	1		1		3	
5	3	3	3	2	1				2	1		1	2		
6	3	3	3	2	1				2	1		1	2		
Avg.	**3**	**3**	**3**	**2**	**1**				**2**	**1**		**1**	**2**	**3**	

1-low, 2-medium,3-high

PROFESSIONAL ELECTIVE COURSES: II. . POWER AND ENERGY

	POWER AND ENERGY MANAGEMENT	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Global energy scenario - Role of energy managers in industries - Energy forecasting - Limitations of energy resources - Renewable energy resources - Load management - Demand Side Management (DSM) - Energy conservation in realistic distribution system Energy monitoring - Auditing - Targeting - Energy pricing - Energy security.

MODULE II ENERGYAUDIT **9**

Energy auditing-Data to be collected in auditing-Needs, methodology and types of audit Waste heat recovery-Sources of waste heat-High temperature heat recovery-Medium temperature heat recovery-Waste heat recovery applications.

MODULE III ENERGYANALYSIS **9**

Real Factory Systems: Process system optimization - Electrical system optimization - Cogeneration - Heating, ventilation and air conditioning systems. Real Transportation Systems: Energy conservation in transportation - New technologies - Progress in clean diesel technology. Real buildings systems: Consumption-Cost vs lifecycle cost-Building design-HVAC systems-Water supply systems-Lighting systems.

MODULE IV PLANNING AND MONITORING **9**

Energy Action Planning: Energy management system - Management commitment and Energy conservation policy-Energy performance assessment Data collection and management-Analysis of data, baseline and benchmarking - Estimation of energy savings potential - Action planning and Training planning.

Monitoring and Targeting - Elements - Data and information, various techniques - Energy consumption, Production and Cumulative sum of differences (CUSUM).

MODULE V OPPORTUNITIES **9**

Supply Side: Methods to minimize supply-Demand gap, Renovation and Modernization of power plants-Reactive power management Energy conservation in boilers, compressors, water heaters and coolers, HVAC and FACTS. Demand side: Energy conservation in Lighting, Motors, Pumps and Fan systems – Energy efficient motors.

COURSEOUTCOMES

After successful completion of this course, the students will be able to,

CO1: Identify the demand supply gap of energy in current scenario.

CO2: Carry out auditing of energy equipment and to prepare energy flow diagrams and energy audit report.

CO3: Analyze the energy economic analysis methods and tools used.

CO4: Evaluate the techno economic feasibility of the energy conservation technique adopted.

CO5: Identify and evaluate the common energy conservation opportunities in different energy intensive industrial equipments.

CO6: Emphasize the energy management on various electrical equipments

TOTAL:45 PERIODS

TEXTBOOKS:

1. Amlan Chakrabarti, "Energy Engineering and Management", PHI Learning, New Delhi 2018.
2. General Aspects of Energy Management and Energy Audit", BEE Guide book, 2015.

REFERENCES:

1. Frank Krieth and D Yogi Goswami, "Energy Management and Conservation Handbook", CRC Press, 2017.
2. Y P Abbi and Shashank Jain, "Handbook on Energy Audit and Environment Management", TERI, 2009.
3. Craig B. Smith, Kelly E. Parmenter ,"Energy Management Principles: Applications, Benefits, Savings", Pergamon Press, New York, 2015
4. D. P. Sen Gupta, K. R. Padiyar, Indranil Sen, M.A, "Recent Advances in Control and Management of Energy Systems", Interline Publishers, Bangalore, 1993
5. Rao S. and B. B. Parulekar," Energy Technology", Khanna Publishers, 2005.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3		3				2		2	3			
2	1	1	2		2				2		2	3			
3	1	2	3		2				2		2	3			
4	1	2	3		2		3		3		2	3			
5	2	3	3		1				2		2	3			
6	1	1	1	3	1	3	3		3		3	3		2	
Avg.	**1.5**	**2**	**2.5**	**3**	**1.8**	**3**	**3**		**2.3**		**2.2**	**3**		**2**	

1-low, 2-medium,3-high

	ENERGY STORAGE TECHNOLOGY	L	T	P	C
		3	0	0	3

MODULE I ENERGY STORAGE: GLOBAL SCENARIO, NEED & INTRODUCTION 8

Energy production and consumption in various sectors, Projected energy consumption for the next century - Environmental issues: Ozone layer depletion and Global warming. Need for energy storage - Types of energy storage (Physical & Electrical systems) - Comparison of different energy storage technology- Energy and power balance in a storage unit - Mathematical model of storage - Econometric model of storage.

MODULE II ELECTROCHEMICAL ENERGY STORAGE SYSTEMS 10

Batteries: Basic concepts - Battery performance - Safety issues. Types of Batteries: Principle of operation-Primary, Secondary Batteries, Lithium, Solid - state and Molten solvent batteries; Lead acid batteries - Nickel Cadmium Batteries - Sodium ion batteries - Modern Batteries - Battery management system – generic model of a battery.

MODULE III MAGNETIC AND ELECTRIC ENERGY STORAGE SYSTEMS 9

Superconducting Magnet Energy Storage (SMES) systems - Capacitor and Batteries: comparison and application. Super Capacitor: Electrochemical Double Layer Capacitor (EDLC) - Principle of working, Structure, Performance, Application and Supercapacitor Stacking - Energy and Power Densities of Electrochemical Supercapacitors- Role of activated carbon and Carbon nano – tubes.

MODULE IV THERMAL ENERGY STORAGE 9

Fundamental concepts - Types - Phase Change Materials (PCMs) and its properties- - Selection criteria of PCMs. Solar Thermal Latent Heat TES systems - Energy conservation through LHTES systems - LHTES systems in refrigeration and air - conditioning systems. -compressed air energy storage systems (CAES).

MODULE V OTHER ENERGY STORAGE TECHNOLOGIES AND APPLICATIONS 9

Fuel cells: Principle - Difference between batteries and fuel cells - Types of Fuel cells. Flywheel energy storage -hydrogen storage- conversion from hydrogen into electricity- Pumped storage system - Applications: Power plant applications, Green house heating, Heating applications in Industry, Food Preservation, Energy storage plug in hybrid Electric vehicles.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Recall the necessity and contrast different energy storage techniques.

CO2: Recognize the safety and performance concerns with batteries.

CO3: Categorize the types of batteries and infer their usage for different applications.

CO4: Explain the differences between magnetic and electric energy storage methods and their applicability in different scenarios.

CO5: Identify the various kinds of thermal energy storage systems and describe their principles.

CO6: Examine energy storage methods for power plants and heating applications.

TOTAL:45 PERIODS

TEXTBOOKS:

1. A Alfred Rufer, “Energy Storage Systems and Components” CRC Press, 2018.

2. Glaize, C, "Lithium Batteries and other Electrochemical Storage Systems", Wiley Publications, 2013.

REFERENCES:

1.Yasar Demirel, “Energy Production, Conversion, Storage, Conservation, and Coupling”, Edition, Springer, 1st edition, 2012.

2. Aiping Yu, Victor Chabot, and Jiujun Zhang,” Electrochemical Supercapacitors for Energy Storage and Delivery”, CRC Press, 2013.

3. Kordesch K and Simader G, "Fuel Cell and Their Applications", Wiley - Verlag publisher, Germany 1996.

4. James Larminie and Andrew Dicks, "Fuel Cell Systems Explained", Wiley Publications, 2003.

5. A.G. Ter-Gazarian,” Energy Storage for Power Systems” 2nd Edition, The Institution of Engineering and Technology,2011

6. Ru - shiliu, Leizhang and Xueliang sun, "Electrochemical Technologies for Energy Storage and Conversion", Wiley publications, 2012

7. Ibrahim Dincer and Mark A. Rosen, "Thermal Energy Storage Systems and Applications", John Wiley & Sons, 2nd Edition, 2010.

8. Robert A. Huggins “Energy storage”,Springer US, 1st Edition,2010

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3													
2	3	3													
3	3	3													
4	3	3													
5	3	3													
6	3	3			3										
Avg.	3	3			3										

1-low, 2-medium,3-high

	ELECTRICAL SAFETY	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION AND HAZARDS OF ELECTRICITY 9

Electrical Safety introduction : Hazard Analysis: Primary and secondary hazards - Arc, blast, shocks - Causes and effects - Summary of causes- Protection and precaution - Injury and death protective strategies - IE Rules 1956 - Basic rules for new installations: power system, Domestic and Industry (Qualitative treatment only).

MODULE II ELECTRICAL SAFETY EQUIPMENT 9

General inspection and testing procedure for electrical safety equipment - Electrical safety equipment for external protection: Flash and thermal protection - Head and eye protection - Insulation protection. Electrical safety equipment for internal protection: Over voltage, Short circuit, Earth Fault, Leakage current, High/ Low frequency - Single Line diagram of industrial power system with safety control - Electrician's Safety kit and materials.

MODULE III SAFETY PROCEDURES 9

Introduction - Six step safety method - Job briefings - Energized or De - energized - Safe switching of power systems - General energy control programs - Lockout - Tagout - Voltage measurement techniques - Placement of safety grounds - Flash hazard calculations and approach distances - Calculating the required level of arc protection (flash hazard calculations) - Barriers and warning signs - Tools and test equipment - Field marking of potential hazards - Shock avoidance techniques - One minute safety audit.

MODULE IV GROUNDING AND ELECTRICAL MAINTENANCE 9

Need for electrical equipment grounding - System grounding - Equipment grounding - Types of Earthing- Earth testing for electrical equipment in Power house and Industry - Eight step maintenance program - Maintenance requirements for specific equipment and location - IEC and UL standard.

MODULE V VOLTAGE SAFETY SYNOPSIS AND MEDICAL SAFETY MANAGEMENT 9

Safety equipment and safety procedures for low voltage and high voltage system - Electrical safety around electronic circuits- Electrical safety for medical equipment like over current safety, Isolation, EMI and harmonics - Battery maintenance procedure-Stationary battery safety - Accident prevention - First aid - Rescue techniques.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Identify and analyze the precautions and protection of electrical hazards.

CO2: Select and use the suitable personal protective equipment according to the working environment.

CO3: Interpret the safety procedures for the specific work place.

CO4: Analyze and apply the various grounding techniques.

CO5: Infer the electrical safety against low voltage and high voltage systems

CO6: Interpret the electrical safety for medical equipments.

TOTAL:45 PERIODS

TEXTBOOKS:

1. John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel and Al Winfield, " Electrical Safety Handbook", 4th edition, Mc Grew Hill, 2012.

REFERENCES:

1. Mohamed A El - Sharkawi, "Electric safety: Practice and Standards", CRC press, New York, 2013.

2. Martha J. Boss and Gayle Nicoll, "Electrical Safety: systems, sustainability and stewardship", CRC press, New York, 2014.

3. Ray A. Jones and Jane g. Jones, "The Electrical Safety Program Guide", National fire protection

association, Quincy, 2011.
4. Electrical Safety booklets issued by Government bodies.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3													
2	3	3													
3	3	3													
4	3	3													
5	3	3													
6	3	3													
Avg.	3	3													

1-low, 2-medium,3-high

	ENERGY EFFICIENT LIGHTING SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION: BASICS OF LIGHTING 10

Lighting Physics - Optical Radiation - Concept of Color - Biological Factors : Human eye and brain response - Different entities of illuminating systems. Properties of Lighting – Basic Terms in Lighting System - Luminance measurement - Laws of Illumination - Polar Curves - Rousseau's construction – Concept of Photometry – Introduction of lighting software's. Natural and Artificial lighting - Good and Bad Lighting - Challenges in Lighting – Good Practices in Lighting - Types of Lighting.

MODULE II LIGHTING SYSTEM 9

Lamps: Incandescent Lamps: Halogen lamps - Discharge Lamps: MV and SV Lamps, Fluorescent Lamps: FTL, CFL – Arc lamps – Special Lamps: LED: Surface Mounted Devices (SMD-LEDs), Chip on Board (COB-LEDs) – Neon lamps - Lasers - Comparison of Lamps - Life Cycle Cost (LCC) Analysis – Efficacy.

MODULE III LIGHTING EQUIPMENTS AND STANDARDS 9

Luminaries, Wiring, Control gears, Switching boards, Reflectors and Control circuits – Heating, Harmonics and EMI Suppression techniques from lighting equipment – Switching and Dimming control algorithm - Recommendation of Illumination Levels for Various Tasks / Activities / Locations - Role of 3D printing technology for designing luminaries – International Standards and code of lighting system.

MODULE IV LIGHTING APPLICATIONS 8

Interior lighting: Industrial, Residential, Indoor stadium and Hospitals. Exterior lighting: Flood, Street, Aviation and Transport lighting - Sign and display Board Lighting - Lighting in Agriculture - Lighting in Automobiles.

MODULE V SMART LIGHTING SYSTEMS 9

Intelligent lighting system - Smart LED lighting systems - LED Smart Projector system – Solar Street Lighting Systems - Role of IoT in lighting system – Concept of Light Fidelity (Li-Fi) - Significance of UV-C lighting in medical - Concept of Artificial Moon for street lighting.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Understand the properties of light, importance of lighting in various fields, types of light sources and methods of lighting.

CO2: Perform the calculation of luminance parameters in various applications.

CO3: Identify the criteria for selection of lighting equipment's and control systems in various applications.

CO4: Impart design and technology for Interior lighting and Exterior lighting applications.

CO5: Review the various technologies used in Smart lighting systems.

CO6: Role of Intelligent lighting system in real time applications

TOTAL:45 PERIODS

TEXTBOOKS:

1. Joseph B. Murdoch, "Illumination Engineering from Edison's Lamp to the Laser", Visions Communications, Washington DC, USA, 2nd Edition, 1994.

2. Jack L. Lindsey, "Applied Illumination Engineering", Prentice Hall of India, New Delhi, 3rd Edition, 2008.

3. Leon Gaster, John Stewart Dow, "Modern Illuminants and Illuminating Engineering", Nabu Press, Washington DC, 1st Edition, 2010.

4. Philip Gordon., "Principles and Practices of Lighting Design: The Art of Lighting Composition", Blue Matrix Productions, 2011.

REFERENCES:

1. Lighting Engineering: Practical Hand Book, INDALUX 2002.
2. IES Lighting Handbook, 10th Edition, 2011.
3. NPTEL Course: Illumination Engineering.
4. Philips Lighting Academy: https://www.lighting.philips.co.in/education/lighting academy-india.
5. Signify Lighting University: https://www.signify.com/global/lighting academy/university-program.
6. Application paper reference from GE, Osram, Havells, Philips.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3													
2	3	3													
3	3	3											2		
4	3	3													
5	3	3													
6	3	3												2	
Avg.	3	3											2	2	

1-low, 2-medium,3-high

	POWER SYSTEM DESIGN	L	T	P	C
		3	0	0	3

MODULE I DESIGN OF POWER SYSTEM **9**

Introduction-selection of sizes and location of generating stations-selection and specifications of transmission lines -sizes and location of substations, interconnection.

MODULE II POWER SYSTEM EARTHING **9**

Objectives-definition- tolerable limits of body currents, soil resistivity, earth resistance, tolerable step, actual step and touch voltage-design of earthing grid-concrete encased electrode- tower footing resistance- measurement of earth resistance (R)-measurement of soil resistivity-impulse behaviour of earthing system.

MODULE III INSULATION CO-ORDINATION **9**

Introduction, definitions- determination of line insulation-B.I.L and insulation levels of sub-station equipment- lightning arrester selection-power system overvoltage- tentative selection of arrestor voltage ratings- selection of arrestor discharge currents-arrestor discharge voltage-establishment of impulse voltage level of equipment-protective margin-establishment of separation limits-location of lightning arrestor.

MODULE IV POWER SYSTEM PLANNING AND IMPROVEMENT **9**

Introduction, methods of power system planning and improvement-power system improvement scheme, determination of the voltage regulation and losses in a power system-shifting of distribution transformer centre- financial aspects of the power system improvement scheme-Forecasting load and energy requirements-generation planning-transmission system planning-distribution system planning reliability of electrical power systems-methods of measuring power system reliability.

MODULE V DESIGN OF DISTRIBUTION SYSTEMS **9**

Development of a distribution plan- transmission and distribution systems- types of distribution systems arrangements- primary distribution design- secondary distribution design- distribution substations-calculation of distributor sizes: voltage drops, voltage regulation, Lamp flicker.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Predicting the sizes and location of generating stations, substations.

CO2: Illustrating of power system earthing and measurement of earthing resistance.

CO3: Analyzing of insulation co-ordination.

CO4: Interpretation of generation planning, transmission planning and distribution planning.

CO5: Modeling of primary and secondary distribution network.

CO6: Design cost effective low loss distribution system.

TOTAL:45 PERIODS

TEXTBOOKS:

1. Electrical Power System Design - M. V.Deshpande, TMH publication,2001.

2. SubstationDesignandequipment-P.S.Satnam&P.V.Gupta,DhanpatRaiandCo. 2018.

REFERENCES:

1. Electrical Power System Analysis and Design B.R.Gupta,S.CHANDPublications,6th Ed.2011.

2. M.L.Sony, P.V.Gupta, V.SBhatnagarand A.Chakraborti,"A Text Book on Power Systems Engineering",DhanpatRaiand Co.,Delhi,1997-98.

3. Electrical PowerSystemPlanning-A.S.Pabla,TMHpublication 1998.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	1	3	3				3		3				
2	3	2		3	3				3		3				
3	3	2	3	3	3				3		3				
4	3	2	3	3	3				3		3				
5	3	2		3	3				3		3		3	2	
6	3	2		3	3				3		3	3		3	
Avg.	**3**	**3**	**2.3**	**3**	**3**				**3**		**3**	**3**			

1-low, 2-medium,3-high

	HIGH VOLTAGE TRANSMISSION SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I ELECTRICAL POWER TRANSMISSION AT HIGH VOLTAGES INTRODUCTION 8

Introduction to EHVAC and HVDC transmission - Comparison between HVAC and HVDC overhead and underground transmission scheme - Standard transmission voltages - Factors concerning choice of HVAC - Block diagram of HVAC and HVDC transmissions schemes. Introduction to thyristor valves and valve tests .

MODULE II EHV LINE CONDUCTORS 8

Properties of bundled conductors - Inductance and Capacitance of EHV lines - Surface voltage gradient on single, double and more than three conductor bundles - Corona effects - Power loss - Increase in radius of conductor - Charge voltage diagram - Qualitative study of corona pulses, their generation and properties -Gas insulated EHV Lines.

MODULE III EHVAC SYSTEMS 9

Properties of EHVAC transmission at power frequency - Generalized constants - Power circle diagram and its use - Voltage Control Using Synchronous Condensers, Cascade Connection of Components— Shunt and Series Compensation, Capacitor Compensated Lines, Static Reactive Compensating Systems (Static VAR), High Phase Order Transmission.

MODULE IV HVDC SYSTEMS 10

Review of rectification and inversion process - Constant Current and Constant Excitation angle Modes of operations - Analysis of DC transmission systems - Harmonics on AC and DC sides and Filters for their suppression - Multiterminal DC transmission systems - Parallel operation of AC and DC transmission systems - Modern developments in HVDC transmission.

MODULE V EHV CABLES 10

Introduction to EHV cable transmission - Electrical characteristics of EHV cables - Properties of cable insulation materials-Design of cable insulation –tests on cable characteristics EHV insulators – superconducting cables system –case study on world's first demonstration test to low cost superconducting cable in Tokyo, Japan.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Intelligently choose HVDC/HVAC transmission systems in practice and identify various thyristor valves in high voltage system.

CO2: Interpret the analysis on corona effects & become familiar with the losses associated with the transmission lines and suggest the appropriate conductors to meet out the losses.

CO3: Inculcate the knowledge of various components for compensation.

CO4: Plan an appropriate electric power transmission system between two destinations to satisfy the pre - defined load requirement without compromising the technical performance.

CO5: Explore the characteristics of cables and distinguish cable insulators for various high voltage applications.

CO6: Learn the concept of superconducting cables and its current application.

TOTAL:45 PERIODS

TEXTBOOKS:

1. Begamudre, Rakosh Das, "Extra high voltage AC transmission engineering", 4th Edition, new academic science, 2013.

2. S.Rao, "EHVAC and HVDC Transmission and Distribution Engineering (Theory, Practice and Solved Problems)", Khanna Publishers, 3rd Edition, 2004.

3. Hao Zhou et al.,"Ultra-high Voltage AC/DC Power Transmission" Springer-Verlag Berlin

Heidelberg,1st edition, 2018

REFERENCES:

1. K.R. Padiyar, “HVDC Power Transmission Systems”, New Age International Publications, 3rd Edition, 2017.

2 Jos Arrillaga , “High Voltage Direct Current Transmission”, 2nd Edition, Institution of Engineering and Technology, 2008.

3. T.J.E.Miller, "Reactive Power Control in Electric Systems", John Wiley and Sons, New York, 2010.

4. M. G. Dwek, “EHV Transmission” Elsevier Sc., 1991.

FURTHER READING:

1. NPTEL - High Voltage DC Transmission
2. Online Materials -
httpshttps://www.basf.com/jp/en/media/newsreleases/jp/2020/10/BASF_Cable_System.html

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2										2	
2	3	3	2	2	2										
3	3	2	2	1											
4	2		2			1									
5	2	3	2			1									
6	1	1	2	2											
Avg.	**2.3**	**2.4**	**2.2**	**1.8**	**2**	**1**								2	

1-low, 2-medium,3-high

	DEREGULATED POWER SYSTEM	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Deregulation - Reconfiguring Power systems - Unbundling of electric utilities - Background to deregulation and the current situation around the world - Benefits from a competitive electricity market after effects of deregulation-Role of the independent system operator.

MODULE II DEREGULATED POWER SECTOR **9**

Separation of ownership and operation - Deregulated models - Operational planning activities of ISO:ISOinPoolmarkets-ISOinBilateralmarkets-OperationalplanningactivitiesofaGENCO GENCOinPoolandBilateralmarkets-marketparticipationissues-competitivebidding Power wheeling-Transmission open access-Pricing of power transactions.

MODULE III SECURITY IN DEREGULATED POWER SYSTEMS **9**

Securitymanagementinderegulatedenvironmentandcongestionmanagementinderegulation Ancillary services management - General description of some ancillary services - Ancillary services management in various countries Reactive power management in some deregulate de electricity markets.

MODULE IV TRANSMISSION CONGESTION MANAGEMENT **9**

Definition of congestion-Reasons for transfer capability limitation Importance of congestion management in deregulated environment –Effects of congestion Desired features of congestion management schemes Classification of congestion management methods.

MODULE V PRICING OF TRANSMISSION NETWORK USAGE AND LOSS ALLOCATION **9**

Power wheeling-Issues involved-Principle soft transmission pricing Classification of transmission pricing methods - Rolled-in transmission pricing methods: Postage stamp method, Incremental postage stamp method, Contract path method, MW-Mile method Distance based - Power flow based - Power flow tracing - Marginal transmission pricing paradigm - Composite pricing paradigm-Introductiontolossallocation-Classificationoflossallocationmethods.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Describe the role and essential of restructuring the power system.

CO2: Identify the role sand responsibilities of different entities in power market.

CO3: Ascertain the security ancillary service management in deregulated power system.

CO4: Describe ancillary service management in deregulated power system.

CO5: Recognize and interpret the importance of congestion management in deregulated environment.

CO6: Comprehend the various pricing methods in deregulated power system.

TOTAL:45 PERIODS

TEXTBOOKS:

1. Venkatesh P, Manikandan BV, CharlesRaja S and Srinivasan ,"A Electrical Power Systems Analysis, Security and deregulation ",PHI Publications, 2nd Edition2017.

2.Tripathi M M, Restructured Power System and Electricity Market Fore casting Create space Independent Publications, First Edition 2015.

REFERENCES:

1.Pinni Srinivasa Varma and Sankarvelamury, “Power System Deregulation Lap Lambert Academic Publishing”, First Edition 2017.

2.KankarBhattacharya,JaapE.Daadler,MathH.JBollen,"Operation of restructured power systems",KluwerAcademicPub.,2001.

3. Kundur P “Power System Stability and Control”, Tata McGraw Hill Third Edition2012.

4. Mohammad Shahidehpour, M.Alomoush, "Restructured Electrical Power Systems: Operation:Trading,and Volatility",CRCPress,2001.
5. Daniel Kirschen and GoranS trbac, "Fundamentals of Power System economics" JohnWiley &Sons Ltd, 2018.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2											
2	3	3	2	2	2										
3	3	2	2	1											
4	2		2			1									
5	2	3	2			1									
6	1	1	2	2											
Avg.	**2.3**	**2.4**	**2.2**	**1.8**	**2**	**1**									

1-low, 2-medium,3-high

	UTILIZATION OF SOLAR ENERGY	L	T	P	C
		3	0	0	3

MODULE I SOLAR THERMAL ENERGY SYSTEM 9

Solar collectors: Liquid flat plate collectors, Concentrating collectors, advantages and disadvantages and comparison - Thermal energy storage: Sensible heat storage and latent heat storage - solar pond – Solar heating of buildings: Principle and system components – Solar cooling of buildings: Principle and system components – Solar pond: Principle of operation, applications of solar ponds – Basic concepts of energy efficient buildings.

MODULE II SOLAR PHOTOVOLTAIC ENERGY SYSTEM 10

Design aspects of solar PV installation: Technical and general requirements of solar PV module , Main components of solar PV system: Solar panel, Batteries (types, parameters and factors affecting battery performance, Charge controllers, Converter requirements) - installation practices of solar panel –sizing of wires - Electrical safety standards and requirements - Data monitoring system: Remote monitoring – On-site monitoring.

MODULE III SOLAR THERMAL APPLICATIONS 10

Principle of operation: Solar furnace, Solar Distillation, Solar Water Heating, Solar Air Heating and solar pumping system – Industrial process heat: Types and choice of solar collectors, examples for industrial applications – Solar green house concepts.

MODULE IV SOLAR PV APPLICATIONS 9

Home Lighting Systems – Street lighting systems - Battery Charging Stations – PV powered water pumping system – PV powered refrigeration system – Military uses – Solar lanterns - Solar energy utilization in space – MNRE schemes for grid connected and off-grid applications.

MODULE V ECONOMIC ANALYSIS AND E-WASTE HANDLING 7

Initial cost – Annual cost – Annual savings – Cumulative savings – Life cycle savings – Payback period – Present worth factor – operation and maintenance cost – Economic Analysis Methods. E-waste - Indian Scenario - Health and environmental hazards - Recycling concepts of E-waste – E waste generation and handling of solar power plants .

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Infer the solar thermal energy system for thermal energy collection and storage and its' use in the buildings.

CO2: Design the solar PV system for the given applications and to explain the data monitoring system.

CO3: Interpret and analyze the applications of solar thermal energy system.

CO4: Interpret and analyze the applications of solar PV system.

CO5: Identify the factors involved in economic analysis.

CO6: Infer the concept of E-waste management.

TOTAL:45 PERIODS

TEXTBOOKS:

1. S.P. Sukhtme & J.K. Nayak, "Solar Energy: Principles of thermal collection and storage", McGraw-Hill Education (India), 3rd edition, 2015.

2. G.D. Rai," Solar energy utilization", Khanna Publishers, New Delhi, 2017 .

3. H P Garg & J. Prakash, "Solar Energy – Fundamentals and applications", Mcgrew Hill Education, New Delhi, 2016

REFERENCES:

1. Chetan Singh Solanki, “Solar Photovoltaics, Fundamentals, Technologies and Applications”, PHI learning, New Delhi 3rd Edition, 2015.

2. Hand book on installation and maintenance of solar panel – Government of India.

3. Ministry of Electronics and Information Technology (MeitY) – Relevant downloads.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3													
2	3	3	3											3	
3	3	3											2		
4	3	3											2		
5	3	3													
6	3	3													
Avg.	**3**	**3**	**3**										**2**	3	

1-low, 2-medium,3-high

PROFESSIONAL ELECTIVE COURSES: III. ELECTRONIC DESIGN

	REAL TIME EMBEDDED SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Real life Examples for Embedded Systems - Real Time Embedded Systems - Developing Embedded Systems - Linkers and Linking process - Executable and Linking format - Mapping to Target embedded system - Embedded System Initialization - Target system tools - Boot Scenarios - System software initialization - On - chip debugging.

MODULE II RTOS **9**

Structure of a real time system - Characterization of real time systems and tasks - Hard and Soft timing constraints -Foreground , Background Systems - Critical Sections - Resources - Tasks - Context Switching - Kernel - Round robin - Task priorities - EDF - RM scheduling - Deadlock – Inter task communication - Interrupts - Memory requirements - Real time Kernels summary.

MODULE III SOFTWARE PERFORMANCE OPTIMIZATION **9**

Program Optimization - Program Level Performance Analysis: Elements of program performance - Measurement driven performance analysis Program Level Energy and Power Analysis - Analysis and Optimization of Program Size.

MODULE IV RELIABILITY AND FAULT TOLERANCE **9**

Metrics for Reliability - Faults, Failures, Bugs - Testing techniques - Fault tolerance - CPU testing - Memory testing - System integration tools.

MODULE V DESIGN EXAMPLES **9**

Data compressor - Alarm clock - Cell phone - Compact disc - DVD - Digital still camera - Audio player - Video accelerator.

COURSEOUTCOMES

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

CO1: Illustrate embedded and real time system development process.

CO2: Conceive real time scheduling algorithms and Cite real life examples for real time systems.

CO3: Perform program level optimization for low power consumption and build a reliable real time system.

CO4: Summarize real time kernel concepts and Use appropriate testing techniques to develop fault tolerant embedded system.

CO5: To study the difference between traditional and real time databases problems.

CO6: Understand of hardware components commonly used in embedded systems, including microcontrollers, sensors, actuators, and communication interfaces like UART, SPI, and I2C.

TOTAL: 45 PERIODS

TEXTBOOKS:

1.Marilyn Wolf, "Computers as Components: Principles of Embedded Computer Systems Design", Morgan Kaufman Publishers, 2019.

2.C.M.Krishna and Kang G.Shin, "Real Time Systems", Tata McGraw Hill, 2019.

REFERENCES:

1. Philip A.Laplante, "Real Time Systems Design and Analysis: An Engineers Handbook", Prentice Hall of India, 3rd Edition, New Delhi, 2018.
2. Jean J.Labrosse, "MicroC/OS - II - The Real - Time Kernel", CMP Books, 2nd Edition, 2018.
3. Qing Li , "Real time Concepts for Embedded Systems ", CRC Press, 2016.
4. David E. Simon, "An Embedded Software Primer" Pearson Education, 2016.
5. Rajib Mall, “Real–Time Systems: Theory and Practice”, First Edition, Pearson Education, 2012.
6. Jane Liu, “Real–Time Systems”, First Edition, Prentice Hall, 2012.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3													
2	3	3													
3	3	3													
4	3	3													
5	3	3													
6	3	3													
AVg.	3	3													

1-low, 2-medium,3-high

	VLSI DESIGN	L	T	P	C
		3	0	0	3

MODULE I MOS AND CMOS CIRCUITS **9**

nMOS, pMOS and CMOS Fabrication process - Electrical properties of MOS and BiCMOS circuits - nMOS inverter - pull-up to pull-down ratio - BiCMOS inverter - latch-up in CMOS circuits - stick diagrams- design rules and layout.

MODULE II SUB SYSTEM DESIGN **9**

Sheet resistance - capacitive loads - inverter delays - propagation delays - wiring capacitances. Switch - logic - gate logic - combinational logic - structured design - clocked sequential circuits - bus drivers - power dissipation for CMOS and BiCMOS circuits - current limitations.

MODULE III MEMORY DESIGN **9**

VLSI testing -need for testing, manufacturing test principles, design strategies for test, chip level and system level test techniques.

MODULE IV VLSI SYSTEM TESTING **9**

Comparison between overhead line and underground cable for transmission - Types of cables - Types of insulating materials - Insulation resistance - Potential gradient - Grading of cables - Capacitance of single and three core cables - Faults and fault location by loop test - Sheath effect - Cable installation - Current rating of cables -Operating problems with underground cables.

MODULE V TESTING TECHNIQUES **9**

Basics of Testing: Fault models, Combinational logic and fault simulation, Test generation for Combinational Circuits. Current sensing based testing. Classification of sequential ATPG methods. Fault collapsing and simulation.

COURSEOUTCOMES

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

CO1: Describe the construction and working of MOS transistors.

CO2: Analyze the performance of VLSI subsystems.

CO3: Differentiate the logic implementation of commercial FPGAs.

CO4: Illustrate the working of MOS memory cell design.

CO5 Demonstrate the need for chip level and system level VLSI testing.

CO6: Compare the testing techniques for chip level and board level circuits.

TOTAL:45 PERIODS

TEXTBOOKS:

1. John F.Wakerly, "Digital Design Principles and Practices", 5th Edition, Pearson Education, 2018.
2. Dauglas A. Pucknell, Kamran Eshraghian, "Basic VLSI Design", 2006.

REFERENCES:

1. Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design", McGraw-Hill Higher Education, 2013.
2. J Wayne Wolf, "Modern VLSI Design : System On-Chip Design", Pearson Education Asia Pvt. Ltd.,2008.
3. W.W.Wen,"VLSI Test Principles and Architectures Design for Testability",Morgan Kaufmann Publishers. 2006.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3												
2	3	3	3												
3	3	3	3												
4	3	3	3												
5	3	3	3												
6	3	3	3												
AVg.	3	3	3												

1-low, 2-medium,3-high

	FPGA BASED SYSTEM DESIGN	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Digital Design and FPGA - Role of FPGA - FPGA Types - FPGA Vs Custom VLSI - Goals and Techniques- Design Challenges-Design abstraction - Methodologies.

MODULE II FPGA FABRICS **9**

FPGA Architectures - SRAM Based FPGA - Logic Elements - Interconnection Networks - Antifuses -Logic Blocks - Chip I/O - Logic Elements - Interconnect - Circuit Design - Architecture of FPGA Fabrics -Logic Element Parameters - Interconnect Architecture-Pin out.

MODULE III DATA PATH CONTROLLER **9**

Behavioral Design - Data path controller Architecture - Scheduling and allocation - Power - Pipelining - Design methodologies - Processes - Standards - Verification Design Example: Digital Signal Processor.

MODULE IV ELECTRONIC SYSTEM TESTING **9**

Introduction-Integrated Circuit Testing-Printed Circuit Board Testing-Boundary Scan Testing Software Testing.

MODULE V SYSTEM LEVEL DESIGN **9**

Introduction-Electronic System Level Design-Case Study-DC Motor Control-Digital Filter Design-Translation Automation.

COURSEOUTCOMES

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

CO1: Distinguish FPGA and custom VLSI.
CO2: Illustrate the key features of FPGA fabrics.
CO3: Explain the internal architecture of FPGA.
CO4: Design data path controller using standard FPGA design techniques.
CO5: Outline the testing techniques for Electronic systems.
CO6: Perform system level design for real time application.

TOTAL:45 PERIODS

TEXTBOOKS:

1. Stephen Brown , "Fundamentals of digital logic with verilog design", McGraw Hill Education, 2017.
2. Stephen M.Trimbeger,"Field-Programmable Gate Array Technology", Springer, 2012.

REFERENCES:

1. Ian Grout, "Digital Systems Design with FPGAs and CPLDs", Elsevier, 2008.
2. Joseph Cavanagh," Digital Design and Verilog HDL Fundamentals", CRC Press, 2017.
3. Charles Roth, Lizy K. John, ByeongKil Lee, "Digital Systems Design Using Verilog", Global Engineering, 2014.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	1	2		1			1		1			
2	3	3	2	2	2		1			1		1			
3	3	3	2	1	3		1			1		2			
4	3	2	1	1	2		1			1		1			
5	3	2	1	2	1					1		3			
6	3	2	1	1	1		1			1		1		3	
AVg.	**3**	**2.5**	**1.5**	**1.3**	**1.8**		**1**			**1**		**1.5**		**3**	

1-low, 2-medium,3-high

	ROBOTICS AND CONTROL	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Introduction to robotics: Evolution of Robotics - Laws of Robotics - Classification - Robot Anatomy – DOF Specification - Resolution - Repeatability and Precision movement. Introduction to robotic drives: Hydraulic, Electric and Pneumatic drives - Linear and Rotary actuators - End - Effectors.

MODULE II ROBOTIC ARM MODELING **9**

Forward and Inverse Kinematics: Rotations and translation of vectors - Transformations and Homogenous transformations - Denavit - Hartenberg representation - Velocity kinematics - Manipulator Jacobian. Dynamics: Euler - Lagrange Equations - Equation of motion. (Algorithmic approaches only).

MODULE III ROBOTIC CONTROL **9**

Trajectory planning - Control of robot manipulator: PID control scheme - Variable structure control - Resolved motion control - Computed torque control with effect of external disturbance - Force control of robotic manipulators - Sliding mode and Adaptive control.

MODULE IV ROBOTIC SENSORS **9**

Robotic Design: System specification - Selection of Motor and Drive mechanism - Controller Design - Vision system consideration and Method of programming. Industrial Applications: Future scope of robotics - Safety in robotics - Robot intelligence and Task planning - Application of artificial intelligence and Expert systems in robotics.

MODULE V ROBOTIC DESIGN AND APPLICATIONS **9**

Introduction - State space representation using physical variables – Phase variables and canonical variables – Derivation of transfer function from state model – Solving the time invariant state equation – State transition Matrix – Its properties and computation. Introduction to controllability and observability.

COURSEOUTCOMES

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

CO1: Recognize, identify and select the major components of a robot for system specifications.
CO2: Model the kinematics and dynamics of manipulators.
CO3: Model the kinematics and dynamics of manipulators.
CO4: Choose a specific robot controller for various applications.
CO5: Employ sensors for real time robotic application to include artificial intelligence in expert systems.
CO6: Select robot components, model kinematics, choose controller, integrate AI sensors.

TOTAL:45 PERIODS

TEXTBOOKS:

1. Deb. S. R, "Robotics Technology and Flexible Machine Design", Tata McGraw Hill 1. Publisher, paperback 2010.
2. Fu K.S, Gonzalez RC and Lee CSG., "Robotics Control, Sensing vision and Intelligence", 2. McGraw Hill Publisher, 1987.

REFERENCES:

1. Antoni Grau, Zhuping Wang," Industrial Robotics: New Paradigms", BoD 1. - Books on Demand, 2020.
2. Mikell. P. Groover, Michell Weis, Roger. N. Nagel and Nicolous G. Odrey, "Industrial 2. Robotics

Technology, Programming and Applications", McGraw Hill publisher,2005.
3. Richard D Klafter,Thomas A.Chmielewski and Michael Negin, "Robotic Engineering: An 3. Integrated approach", Prentice Hall of India, New Delhi, 2005.
4. Krishna Kant, "Computerized based 4. Industrial Control" PHI, 2nd edition, 2012.
5. Carol Fairchild, Dr. Thomas L. Harman, "ROS Robotics By Example 5. - Second Edition: Learning to control wheeled, limbed, and flying robots using ROS Kinetic Kame", 2nd Revised, 2019.

FURTHER READING: NPTEL:

1. https://nptel.ac.in/courses/112105249.

2. https://nptel.ac.in/courses/107106090

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	3	3	1	-	-	2	1	-	-	
2	3	3	3	3	3	3	-	1	1	-	2	1	2	3	
3	3	3	3	3	-	3	-	1	1	-	2	1	-	-	
4	3	-	-	3	-	1	1	-	2	-	3	2	2	-	
5	3	3	-	2	-	3	1	1	2	1	3	1	3	-	
6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
AVg.	3.0	3.0	3.0	2.8	3.0	2.7	2.0	1.4	1.8	2.0	2.5	1.5	2.5	3.0	

1-low, 2-medium,3-high

	DIGITAL CONSUMER TECHNOLOGY	L	T	P	C
		3	0	0	3

MODULE I DIGITAL GENERATION AND CONSUMER DEVICES 9

Generation - Digitization of consumer products - Home networking - Era of digital consumer devices - Market Forecast - Market drivers - Success factors and challenges - Digital home. Perspective on global marketing - Process of consumer behavior - Connecting consumer research and consumer behavior.

MODULE II DIGITAL AUDIO AND VIDEO SYSTEMS 9

Microphones and Loud speakers - Construction, working principles and applications; Principles of digital audio systems - Internet audio formats and players - Components of MP3 - Components of digital TV - SDTV and HDTV technologies - Digital home theater systems.

MODULE III DIGITAL DISPLAY DEVICES AND DIGITAL IMAGING 9

LED Video - LCDs - Plasma Display Panels - Field Emission Displays - Digital light Processor – Comparison of different digital displays - Digital camcorders - Digital display interface standards.

MODULE IV INTERNET AND PC DEVICES 9

Printers - Scanners - Smart Card readers - Benefits of using ebooks and challenges - Mobile phones and smart phone - DVD types and working, applications and challenges.

MODULE V EMERGING CONSUMER DEVICES 9

Net TV - Pen Computing and Digital notepad - Lighting control - Home control and security – Energy management systems - Home theatre and Entertainment - Vehicle Security - Home networking – PLC and Xilinx solutions. Geo - Spatial maps - Smart transportations.

COURSEOUTCOMES

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

CO1: Describe the concepts of audio, video and digital display devices.

CO2: Outline the working of digital display devices.

CO3: Categorize the digital devices for internet and PC and analyze their applications.

CO4: Identify applications of the domestic digital devices.

CO5: Assess the usage of emerging consumer devices for industrial applications.

CO6: Illustrate the working principles of digital consumer devices.

TOTAL:45 PERIODS

TEXTBOOKS:

1. Bali S.P, "Consumer Electronics", Pearson Education, India, 2010.
2. Amit Dhir, "The Digital Consumer Technology - Hand book", Elsevier Publications, 2004.

REFERENCES:

1. Gupta R.G, "Audio Video systems", Tata Mc Graw Hill Publisher, 2010.
2. R.R Gulati, "Color Television - Principles & Practice" , Wiley Eastern Limited, New Delhi, 2003.
3. Thomas M. Coughlin, "Digital Storage In Consumer Electronics", Elsevier Publications, 2008.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3		2	1	2	1	1	1		1		1			
2	3		2	2	2	2	1	2		1		2			
3	3		2	1	3	3	1	1		1		3			
4	3		1	1	2	1	1	1		1		1			
5	3		1	2	1	1		1		1		1			
6	3		1	1	1	1	1	2		1		1			
AVg.	**3**		**1.5**	**1.3**	**1.8**	**1.3**	**1**	**1.3**		**1**		**1.5**			

1-low, 2-medium,3-high

	ELECTRONIC PRODUCT DESIGN	L	T	P	C
		3	0	0	3

MODULE I PRODUCT DESIGN AND DEVELOPMENT 9

Overview of product ion development stages - Assessment of reliability - Ergonomic and aesthetic design Techno commercial feasibility of a product - Quality assurance - Packing and storage - Estimating power supply requirement - HCMOS power dissipation - Power supply protection devices - Enclosure sizing and supply requirements - Selection of materials for enclosure - Noise reduction - Grounding, Shielding and Guarding Techniques - Thermal reduction.

MODULE II PRINTED CIRCUITED BOARD DESIGN PCB 9

Layout considerations - Issues related to PCB design - Parasitic elements in PCB due to vias - Parasitic elements in PCB due to traces - Multilayer PCB - Soldering Techniques - Automation in PCB design and manufacturing - High speed and EMI/ EMC considerations in PCB design - Packaging for semiconductor devices and IC's - Reliability issues in IC's - Introduction to SMD.

MODULE III HARDWARE DESIGN AND TESTING METHODS 9

Logic Analyzer - Digital Oscilloscope - Spectrum analyzer - Signal integrity issues - Mixed signal oscilloscope- Monte - Carlo Analysis - Evaluation of virtual instrumentation - Electronic gears.

MODULE IV SOFTWARE DESIGN AND TESTING METHODS 9

Software design – Use of simulators –Use of emulators – Use of compilers – Algorithmic state machines Finite state machines.

MODULE V PRODUCT TESTING 9

Environmental testing - Temperature testing - Humidity testing - Vibration test - Bump test - EMI/EMC Compliance testing - EMI/ EMC Test setup - Conducted emission test using time domain principle - Radiated emission test.

COURSEOUTCOMES

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

CO1: Integrate engineering principles with real applications from a systems perspective.

CO2: Fabricate printed circuit boards intended for projects in industries.

CO3: Infer different hardware design and testing methods.

CO4: Interpret different software design and testing methods.

CO5: Equip with the different product testing methods.

CO6: Articulate Emission test on PCB.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. R.G.Kaduskar and V.B.Baru,"Electronic Product Design" Wiley India, 2nd Edition, New Delhi, 2014.
2. James Angus and Anthony Ward, “Electronic Product Design",CRC Press,1996.
3. Bert Haskell,"Portable Electronic Product Design and Development", Mc.GrawHill, 2004.

REFERENCES:

1. Anand M.S,"Electronic Instruments and Instrumentation Technology”, Prentice Hall of India,2004.
2. JohnRBarnes,"RobustElectronicDesignReferenceBook",VolumesIandII,KluwerAcademicPublishers,NewYork,2004.
3. OttH.W,"NoiseReductionTechniquesinElectronicSystem",JohnWiley&Sons,NewYork,1988.
4. Bruce R Archam beault,"PCB Design for Real-World EMI Control", Kluwer Academic Publishers, NewYork, 2002.
5. MouradSamihaandZorianYervant,"PrinciplesofTestingElectronicSystems",JohnWiley&Sons,

NewYork,2000.
6. Walter C.Bosshart, "Printed Circuit Boards: Design and Technology", Tata McGraw Hill, New Delhi,2005.
7. Stillwell,Richard,"ElectronicProductDesignforAutomatedManufacturing",UnitedStates,CRC Press,2018.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3													
2	3	3													
3	3	3													
4	3	3			3										
5	3	3													
6	3	3													
AVg.	3	3			3										

1-low, 2-medium,3-high

	MEDICAL ELECTRONICS	L	T	P	C
		3	0	0	3

MODULE I BIO-POTENTIAL MEASUREMENTS 9

Basic components of a biomedical system - Cell Resting and action potentials - Physiological measurements Electrodes: Limb electrodes, floating electrodes, pre-gelled disposable electrodes, Micro, needle and surface electrodes- Electrode electrolyte interface and equivalent circuit- Amplifiers: Preamplifiers, differential amplifiers, chopper amplifiers, Isolation amplifier - Different types of biotelemetry systems and patient monitoring, Use of Standard HL7.

MODULE II CARDIAC SYSTEM 9

ECG sources - Normal and Abnormal waveforms - Lead systems and recording systems - Cardiac pacemaker - External pacemaker - Implantable pacemaker - Different types of pacemakers - Fibrillation - Defibrillator - AC defibrillator - DC defibrillator - Arrhythmia monitor.

MODULE III NEUROLOGICAL SYSTEM AND SKELETAL SYSTEM 9

EEG - Wave characteristics -Frequency bands - Spontaneous and evoked response - 10-20% Lead system Recording - Analysis of EMG waveforms - muscle latent velocity - Muscle and nerve stimulation - Fatigue characteristics.

MODULE IV RESPIRATORY MEASUREMENT AND VENTILATOR 9

Spirometer - Heart-Lung Machine - Oxygenators - Pnemograph - Artificial Respirator - IPR type - Functioning: Ventilators, Dialysis : Acute and Renal failure -Dialysis types and - Types of Machine - Blood Gas Analyser - pO2, pCO2, measurements. Finger-tip oximeter, ESR, GSR, measurements.

MODULE V THERAPHATIC AND MONITORING INSTRUMENTS 9

Electromagnetic and Ultrasonic blood flow meter - Equipment of physiotherapy - Transcutaneous Electric Nerve Stimulator (TENS) - Ultrasonic therapy - Extra corporeal shockwave lithotripsy - Diathermy - Audiometers - Medical Imaging: MRI and CT scan (Principle and Quantitative approach only) - Electrical safety Management and Maintenance: shock hazards, leakage current- safety of Medical Equipment.

COURSEOUTCOMES

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

CO1: Differentiate and analyse the biomedical signal sources.

CO2: Elucidate cardiovascular system and related measurements.

CO3: Explain the brain, respiratory and nervous systems and related measurements.

CO4: Measure non-invasive diagnostic parameters.

CO5: Recommend problem solving and service procedures for safety use of medical instruments as per medical standards.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 3rd Edition, 2014.
2. Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi, 2010.

REFERENCES:

1.John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2011.

2.Joseph J.carr and John M. Brown, "Introduction to Biomedical Equipment Technology", John Wiley and sons, New York, 2001.

3.Prof.Venkataram S.K, "Biomedical Electronics and Instrumentation", Galgotia Publications Pvt. Ltd., 2003.

4.Webb, Andrew G, “Principles of Biomedical Instrumentation. India", Cambridge University Press, 2018.

CO-PO& PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3													
2	3	3													
3	3	3													
4	3	3													
5	3	3													
6	3	3													
AVg.	3	3													

1-low, 2-medium,3-high

	MULTIMEDIA SYSTEM	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION AND TEXT COMPRESSION 9

Special features of Multimedia - Graphics and Image Data Representations - Fundamental Concepts in Video and Digital Audio - Storage requirements for Multimedia Applications - Need for Compression - Taxonomy of compression techniques – Overview of information theory - Static Huffman coding - Dynamic Huffman coding - Lempel - Ziv coding - Lempel - Ziv Welsh coding.

MODULE II AUDIO COMPRESSION 9

Audio compression techniques - Frequency domain and filtering - Basic sub band coding - Application to speech coding - G.722 - Application of audio coding: MPEG audio - Silence compression - Speech compression techniques - Vocoders - Linear predictive coder.

MODULE III IMAGE COMPRESSION 9

Approaches to image compression - Graphics interchange format - Tagged image file format, Digitized documents – Digitized pictures - JPEG - Quad trees - DCT coding - Wavelet methods - Filter banks - EZW coding - SPIHT coding - JPEG 2000 standards.

MODULE IV VIDEO COMPRESSION 9

Video signal representation - Video compression techniques - MPEG1, 2, 4 - Motion estimation - H.261, H.263 - Overview of wavelet based compression - PLV performance real time compression.

MODULE V VoIP TECHNOLOGY 9

Basics of IP transport - VoIP challenges - H.323/ SIP Network Architecture, Protocols, Call establishment and release - VoIP and SS7 - Quality of Service - CODEC Methods - VoIP applicability.

COURSEOUTCOMES

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

CO1: Identify the taxonomy of compression techniques and describe information theory.

CO2: Interpret audio and video compression techniques.

CO3: Ascertain the different approaches to image and text compression.

CO4: Conceive the video compression techniques and outline the wavelet based Compression.

CO5: Analyze challenges of implementing Internet Protocol for multimedia transmissions.

CO6: Identify an appropriate components to implement multimedia system for the given requirement.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Fred Halsall and James F. Kurose, "Multimedia communication Applications, Networks, Protocols and standards", Pearson Education Limited, 2004.
2. Prabhat K Andleigh and Kiran Thakrar, “Multimedia Systems and Design”, Prentice Hall of India, Reprint 2007.

REFERENCES:

1.Khaleed, "Introduction to Data Compression", Morgan Kauffman publication, 4th Edition, 2012.

2.Tay Vaughan, "Multimedia: making it work", TMH, 7th Edition, 2007.

3.Marcus Goncalves, "Voice over IP Networks", McGraw Hill Publisher, 1999.

4.Jerry D. Gibson, "Multimedia Communications: Directions and Innovations", Morgan Kaufmann Publication, 2nd Edition, 2001.

5.David Solomon, "Data Compression the complete reference", Springer publisher, 4th Edition, 2007.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	3	2	1			1	2	1		1			
2	3	2	3	2	1			1	2	1		1			
3	3	2	3	2	1			1	2	1		1			
4	3	2	3	2	1			1	2	1		1			
5	3	2	3	2	1			1	2	1		1			
6	3	2	3	2	1			1	2	1		1			
AVg.	**3**	**2**	**3**	**2**	**1**			**1**	**2**	**1**		**1**			

1-low, 2-medium,3-high

	MEMS and NEMS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO MEMS AND NEMS 9

Overview of Nano and Micro electromechanical Systems, Introduction to Design of MEMS and NEMS, Applications of Micro and Nano electromechanical systems, Micro electromechanical systems, devices and structures Definitions, Materials for MEMS: Silicon, Silicon Compounds, Polymers, Metals.

MODULE II MEMS FABRICATION TECHNOLOGIES 9

Overview of Nano and Micro electromechanical Systems, Introduction to Design of MEMS and NEMS, Applications of Micro and Nano electromechanical systems, Micro electromechanical systems, devices and structures Definitions, Materials for MEMS: Silicon, Silicon Compounds, Polymers, Metals.

MODULE III MICRO SENSORS AND ACTUATORS 9

MEMS Sensors: Design of Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors-engineering mechanics behind these Micro sensors. Case study: Piezo-resistive pressure sensor. Micro-Actuators - Design of Actuators: Actuation using piezoelectric crystals, Actuation using Electrostatic forces (Parallel plate, Torsion bar, Comb drive actuators), Micromechanical Motors and pumps. Case study: Comb drive actuators.

MODULE IV NEMS TECHNOLOGY 9

Atomic scale precision engineering- Nano Fabrication techniques - NEMS in measurement, sensing, actuation and systems design. Introduction to Quantum Mechanics.

MODULE V MEMS AND NEMS APPLICATION 9

Applications of vibratory gyroscope MEMS sensors in vehicles, RF MEMS components in communications, space and defense applications. Case studies: Micro-switches BioMEMS Micro motors – Smart sensors. Recent trends in MEMS and NEMS.

COURSEOUTCOMES

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

CO1: Select an appropriate material for the fabrication of micro electromechanical devices.

CO2: Model the working mechanisms of MEMS and NEMS.

CO3: Demonstrate knowledge delivery on micromachining and micro fabrication.

CO4: Apply the fabrication mechanism for MEMS sensor and actuators.

CO5: Apply the fabrication mechanism for NEMS sensors and actuators.

CO6: Select one or more suitable MEMS/NEMS sensors and actuators for a given application.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Chang Liu, “Foundations of MEMS”, Pearson International Edition, 2011, 2nd Edition.
2. Lyshevski, S.E. “Nano- and Micro-Electromechanical Systems: Fundamentals of Nano-and Micro engineering “(2nd ed.). CRC Press, 2005.

REFERENCES:

1.Tai Ran Hsu,”MEMS and Microsystems Design and Manufacture”, Tata McGraw Hill, 2002.

2.Sergey Edward Lyshevski, “MEMS and NEMS: Systems, Devices, and Structures” CRC Press, 2002.

3.A.M. Dirac," Principles of Quantum Mechanics", Oxford University Press, Oxford, 1978.

4.Marc Madou, “Fundamentals of Micro fabrication”, CRC press 1997.

5.Stephen D. Senturia,” Micro system Design”, Kluwer Academic Publishers, 2001.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	1				2	1		1			
2	3	3	3	3	1				2	1		1			
3	3	3	3	3	1				2	1		1			
4	3	3	3	3	1				2	1		1			
5	3	3	3	3	1				2	1		1			
6	3	3	3	3	1				2	1		1			
AVg.	**3**	**3**	**3**	**3**	**1**				**2**	**1**		**1**			

1-low, 2-medium,3-high

	WEARABLE SENSORS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Wearable Devices development -advent of wearable computing -wearable sensors in various sectors: Industry sectors' overview – sports, healthcare, Fashion and entertainment, military, environment monitoring, mining industry, public sector and safety

Wearable haptics: World of wearable's - Attributes of wearable's - Intelligent clothing: The meta wearable - Challenges and opportunities - Future of wearable's - Need for wearable haptic devices - Categories of wearable haptic and tactile display.

MODULE II WEARABLE DEVICES FOR HEALTH CARE **9**

Introduction to remote health monitoring and their challenges- Design, fabrication & geometry of Electrode- Wearable Bioelectric impedance devices for Galvanic skin response; Wearable ECG device, wearable EEG device, Wearable EMG devices: EMG/ SEMG Signals, EMG Measurement – wearable surface electrodes, SEMG Signal Conditioning- Wearable Blood Pressure (BP) Measurement: Cuff-Based Sphygmomanometer, Cuffless Blood Pressure Monitor- Wearable sensors for Body Temperature: Intermittent and Continuous temperature monitoring, Detection principles – thermistor, infrared radiation, thermopile.

MODULE III WEARABLE SENSORS **9**

Introduction - Challenges in chemical and biochemical sensing –Types Invasive, Non-invasive Wearable inertial sensors- Flex sensor, pulse oximeter, glucose sensor, Inertial sensor, dehydration sensor, pH sensor, heart rate sensor, gas sensor, haptic glove, fitness tracker-Applications for wearable motion sensors -Practical considerations for wearable inertial sensor - Conductive textile electrodes, Knitted Piezoresistive Fabric (KPF) sensors.

MODULE IV TEXTILE SENSOR TECHNOLOGY **9**

Introduction to Textile electrode- smart fibers to textile sensors - Interlaced network-Textile sensors for physiological state monitoring - Biomechanical sensing - Noninvasive sweat monitoring by textile sensors- FBG sensor in Intelligent Clothing and Biomechanics - textile sensor technology for athletes.

MODULE V APPLICATIONS OF WEARABLE'S **9**

Wearable's for the Monitoring of Physical and Physiological Changes in Daily Life- Wearing Sensors Inside and Outside of the Human Body for the Early Detection of Diseases- Wearable and Non-Invasive Assistive Technologies- Application of Optical Heart Rate Monitoring -Wearable's with Global Positioning System (GPS) integration for tracking and navigation- Applications of wearable's for military personnel & its design difficulties -Photoplethysmography (PPG).

COURSEOUTCOMES

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

CO1: Gain basic idea of development areas of wearable's and its impact on various sectors.

CO2: Explore their features in terms of benefits, limitations, and challenges of using wearable devices.

CO3: Design & recognize various electrodes in monitoring devices for healthcare applications.

CO4: Discuss biochemical and gas sensors as wearable devices in medical & other allied industries.

CO5: Realize Electronic textiles in wearable technology and acquire the knowledge in textile sensors.

CO6: Comprehend the design & development of various wearable's for physiological changes and other detections in human body.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Jacob Fraden, “HandBook of Modern Sensors: physics, Designs and Applications”, 2015, 3rd edition, Springer, New York.
2. Edward Sazonov, Michael R. Newman, “Wearable Sensors: Fundamentals, Implementation and Applications”, 2014, 1st Edition, Academic Press, Cambridge.

REFERENCES:

1.Kate Hartman, “Make: Wearable Electronics: Design, prototype, and wear your own interactive garments”, 2014, 1st Edition, Marker Media, Netherlands.

2.John G Webster, “Measurement, Instrumentation and sensor Handbook”, 2017, 2nd edition, CRC Press, Florida.

3.Michael J. McGrath, Cliodhna Ní Scanaill, “Sensor Technologies Healthcare, Wellness, and Environmental Applications” 2013, Apress, springer.

4.Subhas C. Mukhopadhyay” Wearable Electronics Sensors For Safe and Healthy Living”,2015, Springer International Publishing.

5.Jon. S. Wilson, “Sensor Technology HandBook”, 2011, 1st edition, Elsevier, Netherland.

6.Katsuyuki Sakuma “Flexible, Wearable, and Stretchable Electronics” 2020,CRC Press.

FURTHER READING: NPTEL:

1. Sensor Technologies: Physics, Fabrication, and Circuits

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2		1										
2	3			1	1	2	3					1			
3	2	3	3	2	3			3							
4	3	3	2	3	3	2	2	2							
5	3		2	2	3						1				
6	3	2	3	3	3	2	3	3			3				
AVg.	**2.8**	**2.5**	**2.4**	**2.2**	**2.3**	**2**	**2.6**	**2.6**			**2**	**1**			

1-low, 2-medium,3-high

PROFESSIONAL ELECTIVE COURSES: IV. COMPUTER AND COMMUNICATION

	COMPUTER ARCHITECTURE AND PARALLEL PROCESSING	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **7**

Classes of computers - Defining Computer Architecture - Trends in Technology - Trends in Power and Energy in Integrated Circuits - Trends in Cost - Dependability - Measuring - Reporting and Summarizing Performance - Quantitative Principles of Computer Design.

MODULE II DESIGN OF CPU **9**

CPU organization - General register organization - Stack organization - Instruction formats - Addressing modes - Data transfer and manipulation - Program control - Hardwired and micro programmed control. Design and implementation of basic micro sequencer - Designing mapping logic - Design of ALU - Look up Rom - Wallace trees - CISC and RISC characteristics.

MODULE III MEMORY AND I/O ORGANIZATION **9**

Memory Hierarchy - Main memory - Cache memory - Virtual memory concepts - IO interface - Modes of data transfer - Programmed IO and Interrupt driven data transfer - Direct memory access - Asynchronous data transfer - IO processor and IO channels.

MODULE IV MULTIPROCESSOR ARCHITECTURE **10**

Organization of multiprocessor system - Interconnection networks - Multiprocessor scheduling strategies - Shared memory architecture - Symmetric shared memory and distributed shared memory - Cache coherence - Snooping and directory based cache coherence - Synchronization - Parallel memory organization.

MODULE V PARALLEL PROCESSING ARCHITECTURE **10**

Principles of pipelining - Implementation - Pipeline hazards and resolution - Performance issues - Instruction level parallelism and thread level parallelism - Instruction prefetch and branch handling - Vector processor - Effectiveness of vectorization - Array processor - Parallel algorithms - Bubble sort - matrix multiplication - Superscalar processor.

COURSEOUTCOMES

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

CO1: Describe the basic computer organization and to design a micro sequencer based control unit.

CO2: Explain and infer the various memory organizations.

CO3: Compare and analyze the various IO organizations.

CO4: Categorize the multiprocessor architecture and relate the performance.

CO5: Describe the concepts of parallel processing architecture.

CO6: Design and analyze algorithms suitable for parallel processing, considering factors like load balancing, synchronization, and scalability.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. M. Morris Mano, "Computer System Architecture", Pearson Education, 3rd Edition, 2017.
2. John L Hennessy and David APatterson, " Computer Architecture:A quantitative approach", Morgan Kaufmann publishers, 5th Edition, 2018.
3. David. A. Patterson, John L. Hennessy, “Computer Architecture: A Quantitative approach”, Fifth Edition, Elsevier, 2018.

REFERENCES:

1. Kai Hwang and Faye A. Briggs, "Computer Architecture and Parallel Processing", Tata McGrew Hill, 2018.
2. Carl Hamacher, Zvonko Vranesic, Safwatzaky, "Computer Organization", McGraw Hill, 6th Edition, 2016.
3. John D Carpinelli, "Computer system Organization and Architecture", Pearson Education,India. 2016.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3													
2	3	3													
3	3	3													
4	3	3													
5	3	3													
6	3	3	3												
AVg.	**3**	**3**	**3**												

1-low, 2-medium,3-high

	MULTI CORE ARCHITECTURE	L	T	P	C
		3	0	0	3

MODULE I SUPERSCALAR PROCESSORS 9

Fundamentals of Superscalar Processor Design - Introduction to Multicore Architecture - Chip Multiprocessing - Homogeneous Vs heterogeneous design - SMP - Multicore Vs Multithreading.

MODULE II MEMORY ORGANIZATION 9

Shared memory architectures - Synchronization - Memory organization - Cache Memory - Cache Coherency Protocols - Design of Levels of Caches.

MODULE III PARALLEL PROGRAMMING 9

Fundamental concepts - Designing for threads - scheduling - Threading and parallel programming constructs - Synchronization - Critical sections - Deadlock - Threading APIs.

MODULE IV POWER PC ARCHITECTURE 9

RISC design - PowerPC ISA - PowerPC Memory Management - Power Multi core architecture design – Power 6 Architecture.

MODULE V PROGRAMMING SUPPORT FOR MULTI - CORE/MANY - CORE PROCESSORS 9

Cell Broad band engine architecture - PPE (Power Processor Element) - SPE (Synergistic processing element) - Cell Software Development Kit - Programming for Multicore architecture..

COURSEOUTCOMES

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

CO1: Describe the basic computer organization and to design a micro sequencer based control unit.

CO2: Explain the thread - level parallelism.

CO3: To be able to understand various programming constructs in multi-core architecture.

CO4: Comprehend various memory architectures.

CO5: Develop various multicore programming models for given specifications.

CO6: Understand the techniques for managing concurrency and ensuring thread safety in Multicore systems.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Hennessey & Paterson, "Computer Architecture A Quantitative Approach", Harcourt Asia, Morgan Kaufmann publication,USA, 2018.
2. Kai Hwang, "Advanced Computer Architecture: Parallelism, Scalability and Programmability", McGraw - Hill Publications, 2014.

REFERENCES:

1. Michael J Quinn, “Parallel programming in C with MPI and OpenMP”, Tata McGraw Hill, 2015.
2. Joseph JaJa, "Introduction to Parallel Algorithms", Addison - Wesley publisher, 2012.
3. IBM Journals for Power 5, Power 6 and Cell Broadband engine architecture.2015.
4. Richard Y. Kain, "Advanced Computer Architecture: A System Design Approach", PHI, 2012.
5. Rohit Chandra, Ramesh Menon, Leo Dagum, and David Kohr, "Parallel Programming in Open MP", Morgan Kaufmann Publication, 2016.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3													
2	3	3													
3	3	3													
4	3	3													
5	3	3													
6	3	3													
AVg.	**3**	**3**													

1-low, 2-medium,3-high

	DATA COMMUNICATION NETWORKS	L	T	P	C
		3	0	0	3

MODULE I BASIC CONCEPTS **9**

Introduction - Line configuration topology - Transmission mode - Categories of networks - Internetworks - OSI Model and Functions of the Layers.

MODULE II SIGNALS AND TRANSMISSION **9**

Various types of signals - Analog to Digital and Digital to Analog conversion - Interfacing - Co - Axial Cables - Fibre Optics - Wireless - Multiplexing - Error detection and correction.

MODULE III DATA LINK CONTROL AND PROTOCOLS **9**

Flow control - Error control - Asynchronous protocols - Synchronous protocols - Character and Bit oriented protocols - TCP / IP Protocol - Point to Point protocol - X.25 Protocol.

MODULE IV NETWORK AND SERVICES **9**

Local Area Network - Ethernet - Token ring - Token bus - Fibre Distributed Data Interface - Metropolitan Area Networks - IEEE 802.16 - Switching - Integrated Services Digital Network - Asynchronous Transfer.

MODULE V NETWORKING AND INTERNETWORKING DEVICES AND APPLICATIONS **9**

Repeaters - Bridges - Routers - Gateways - Routing algorithm - Distance vector and link state Routing - Client - Server model - Domain Name System - Simple Mail Transfer Protocol - Simple Network Management Protocol - Hypertext Transfer Protocol - World Wide Web.

COURSEOUTCOMES

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

CO1: Explain the need for the OSI model and the functions performed by each layer of the OSI model.

CO2: Realize the basic network concepts and their transmission mode.

CO3: Evaluate the signal conversions and understand the transmission of signals through different cables.

CO4: Describe the different networking and internetworking devices and their applications.

CO5: Explain the process of communication from source to destination through various layers of the Communication protocol.

CO6: Grasp the foundational concepts of data communication networks, including the OSI model, TCP/IP protocol suite, and network devices.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. William A.Shay, "Understanding Data Communications and Networks", Brooks /Cole Publishing Company, 2008.
2. Behrouz. A. Forouzan, "Data Communications and Networking", 5th Edition, Tata McGraw Hill Publisher, 2017.
3. Curt White, "Fundamentals of Networking and Data Communications", South-Western College Publishing, 2013.
4. William Stallings, "Data and Computer Communications", 10th Edition, Prentice Hall of India, New Delhi, 2014.
5. A.S. Tanenbaum, "Computer Networks", Prentice Hall of India, 6th Edition, New Delhi, 2020.

REFERENCES:

1. S.Keshav,"An Engineering Approach to Computer Networking", Addision Wesley, 2010.

2. Srikant and Lei Ying, "Communication Networks: An Optimization, Control and Stochastic Networks Perspective", Cambridge University Press, UK,2014
3. Larry L. Peterson and Bruce S. Davie, "Computer Networks: A Systems Approach", 5th Edition, Elsevier, 2012.
4. Dimitri Bertzekas and Robert Gallager,"Data Networks", Prentice Hall of India", 2nd Edition, 2004.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3													
2	3	3													
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4	3	3													
5	3	3													
6	3	3													
AVg.	3	3													

1-low, 2-medium,3-high

	FOG COMPUTING	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Introduction to Fog Computing / Network - Definitions - Characteristics - Four layer fog computing architecture in smart cities.

MODULE II SEVEN LAYER FC **9**

Physical Devices & Device Controllers- Connectivity - Edge (Fog) Computing - Data Accumulation - DataAbstraction –Application- Collaboration & Processes - Interaction between each level.

MODULE III IoT for FC **9**

IoT/IoE applications on the fog infrastructure - Cloud and IoT estimation - Comparison with Cloud Computing (CC) - Benefits of using Fog Computing.

MODULE IV CHALLENGES & SOFTWARE PLATFORMS **9**

Overview and Comparison of Microsoft Azure - Amazon Web Services - Google Cloud Platform - Security and Reliability - Storage - Monitoring and Automation - Introduction to Open-source softwares: Eucalyptus - OpenNebula - OpenStack - Apache CloudStack.

MODULE V APPLICATIONS **9**

Healthcare and Activity Tracking - Smart utility services - Augmented reality - Caching and Preprocessing - Cognitive systems and Gaming.

COURSEOUTCOMES

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

CO1: Apply knowledge in systems, protocols and mechanisms which supports fog computing.

CO2: Explain major security and privacy problems in the fog computing scenarios and how they are addressed with the security mechanisms.

CO3: Describe the high level architecture of fog computing models.

CO4: To understand the cloud providers and software platforms.

CO5 Design and implement a computing applications novel fog.

CO6: Explore various applications and use cases of fog computing across different domains such as IoT, smart cities, healthcare, and industrial automation.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Amir Vahid Dastjerdi, Harshit Gupta, Rodrigo N. Calheiros, Soumya K. Ghosh, and Rajkumar Buyya, "Fog Computing: Principles, Architectures and Applications", Morgan Kaufmann Publications, Burlington, Massachusetts, USA.28 Jan 2016.
2. Amir Vahid Dastjerdi and Rajkumar Buyya, University of Melbourne "Fog Computing: Helping the Internet of Things Realize its Potential" on IEEE Computer Society,2016

REFERENCES:

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

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3													
2	3	3													
3	3	3													
4	3	3													
5	3	3													
6	3	3													
AVg.	3	3													

1-low, 2-medium,3-high

	INTERNET OF THINGS	L	T	P	C
		3	0	0	3

MODULE I M2M To IoT **9**

Introduction - Architecture of IoT - Challenges of IoT - M2M to IoT - IoT global context - Differing Characteristics - Deployment and Operational - IoT reference Model and architecture, Different communication protocol for secured Cloud services.

MODULE II IoT FUNDAMENTALS **9**

Devices and gateways used in networks - Local and wide area networking - Data management - Business processes in IoT - Everything as a Service (XaaS),SaaS, PaaS - IoT Analytics –Public Cloud, Private Cloud and Hybrid Cloud- Input, output Devices and Sensors.

MODULE III DESIGN PRINCIPLES **9**

Technical Design constraints - Hardware Design constraints ESP8266, Aurdino, Raspberry pi - Data base types representation and visualization in different online cloud platforms - Interaction and remote control. Micro service and Macro service, Introduction to Python and Library files and its applications.

MODULE IV DESIGN CONSTRAINTS **9**

Overview and Comparison of Microsoft Azure - Amazon Web Services - Google Cloud Platform - Security and Reliability - Storage - Monitoring and Automation - Introduction to Open-source softwares: Eucalyptus - OpenNebula - OpenStack - Apache CloudStack.

MODULE V INDUSTRIAL AUTOMATION AND HOME AUTOMATION **9**

Case study: Cisco IoT System, Network connectivity, IOx and Fog Applications, Data analytics, Security, VPN, Cyber and Physical Management – Skimming Attack, Brute Force attack, spoofing attack - Automation – Applications.

COURSEOUTCOMES

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

CO1: Distinguish the Evolution of IoT.

CO2: Identify the architecture, emerging industrial infrastructure and challenges involved in deployment of IoT.

CO3: Interpret the use of devices, gateways and hardware design constraints in IoT.

CO4: Describe the design principles to realize enterprise integrated Web of Things.

CO5: Demonstrate the technical design constraints involved in IoT based industrial automation.

CO6: Apply the application of IoT in Industrial and Commercial Building Automation.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos and David Boyle, "From Machine -to - Machine to the Internet of Things: Introduction to a New Age of Intelligence", Academic Press, 1st Edition, 2014.
2. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands - on - Approach)", VPT, 1st Edition, 2014.

REFERENCES:

1. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", A - press Publications, 1st Edition, 2013.
2. J.P. Vasseur, A. Dunkels, "Interconnecting Smart Objects with IP: The Next Internet", Morgan Kaufmann, 2010.
3. Shriram K. Vasudevan, Abhiishek S Nagarajan, RMD Sundaram “internet of Things” Wiley Publications, 2nd Edition2020

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3													
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4	3	3													
5	3	3													
6	3	3													
AVg.	**3**	**3**													

1-low, 2-medium,3-high

	DATA ANALYTICS	L	T	P	C
		3	0	0	3

MODULE I TECHNOLOGY FOUNDATION FOR BIG DATA 9

Fundamentals of Big Data – Classification and characteristics of Big Data – Types of Data Analysis – Introduction to Open source frameworks - Hadoop Environment – Mapper – Reducer – Combiner – Partitioner – Searching – Sorting – Compression - Hive - Introduction to features of Mongo DB, Cassandra, Spark, Kafka.

MODULE II MATHEMATICAL FOUNDATIONS 9

Population and Sample - Measures of Central Tendency - Measures of Deviation – Measures of Shape - Correlation Analysis – Bayes Theorem - Probability Density functions and distributions – Hypothesis Testing – Dimensionality Reduction – Principal Component Analysis - Analysis of Variance (ANOVA).

MODULE III DATA ANALYSIS IN MACHINE LEARNING 9

Overview of Machine learning concepts – Bias/variance, overfitting and train/test splits - Types of Machine learning – Supervised, Unsupervised, Semi-supervised- Classification and Regression algorithms-Naïve Bayes, K-Nearest Neighbors, logistic regression, support vector machines (SVM), decision trees - Metrics - Linear Regression-model assumptions - Regularization (lasso, ridge, elastic net) - Analysis of Time Series - Bagging and Boosting (to balance bias and variance) and random forest - Neural Networks-Learning And Generalization, Overview of Deep Learning - Unsupervised learning: K Means and Hierarchical clustering - Reinforcement learning.

MODULE IV PROGRAMMING TOOLS FOR DATA SCIENCE 9

Visualizing Data: Bar Charts, Line Charts, Scatterplots - Working with data: Reading Files, Scraping the Web, Using APIs (Example: Using the Twitter APIs), Cleaning and Munging, Manipulating Data, Rescaling, Dimensionality Reduction - Basics of Python (file handling, case folding, spell check, split, strip, Regex, find, replace, etc.) - Toolkits using Python: Matplotlib, NumPy, Scikit-learn, NLTK.

MODULE V APPLICATIONS OF DATA NALYTICS 9

Solar and Wind Forecasting algorithms – Naïve Bayes algorithms for Protective Relay - Connected homes - Smart thermostats - Wearable's: Fitness bands - Real - time analytics and Industrial automation - Connected cities - Smart meters - Connected cars - Fleet management.

COURSEOUTCOMES

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

CO1: Work with big data platform and its analysis techniques.

CO2: Use Probability and Statistics in Data Analysis.

CO3: Analyze the data for machine learning algorithms.

CO4: Implement using Python.

CO5: Identify and perform appropriate data analysis in real life applications.

Co6: Identify the programming tools for the real time applications

TOTAL: 45 PERIODS

TEXTBOOKS:

1. U.Dinesh Kumar, " Business Analytics- The Science of Data – Driven Decision Making",Wiley, 2018.

REFERENCES:

1. Goldman Sachs,"Big Data Analytics and the Internet of Things", Datameer, 2015.
2. Robert Stackowiak, Art Licht, Venu Mantha and Louis Nagode,"Big Data and The Internet of Things: Enterprise Information Architecture for A New Age", A press, 2015.
3. Michael Wessler, OCP & CISSP, "Big Data for Dummies", John Wiley & Sons, Inc, 2013.
4. Grolemund and Garrett, "Hands - On Programming with R", O'Reilly Media, 2014.
5. Ebook: Dr. Mark Gardener "Beginning R: The Statistical Programming Language", ISBN: 978 - 1 - 118 - 16430 - 3, 2012.
6. Judith Hurwitz, Alan Nugent, and Dr. Fern Halper, "Big Data for Dummies", John Wiley & Sons, Inc, 2013.
7. Seema Acharya, Subhashini Chellappan, " Big Data and Analytics", Wiley,2018.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3													
2	3	3													
3	3	3													
4	3	3													
5	3	3													
6	3	3													
AVg.	**3**	**3**													

1-low, 2-medium,3-high

	VIRTUAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

MODULE I REVIEW OF DIGITAL INSTRUMENTATION 9

Representation of PC based DAQ System - Sampling theorem - Linearization and Quantization of amplitude and time - Analog I/O - Digital I/O - Counter/timer - DAQ software architecture - Networked data acquisition.

MODULE II FUNDAMENTALS OF VIRTUAL INSTRUMENTATION 9

Concept of virtual instrumentation-PC based data acquisition-Typical onboard DAQ card Resolution and Sampling frequency-Multiplexing of analog inputs-Single-ended and differential inputs-Different strategies for sampling of multi-channel analog inputs. Concept of universal DAQ card – Use of timer, Counter and analog outputs of the universal DAQ card.

MODULE III CLUSTER OF INSTRUMENTS IN VI SYSTEM 9

PC Interfacing - RS232, RS422, RS485 and USB standards - IEEE 488 standard-ISO-OSI model for serial bus-Introduction to bus protocols of MOD Industrial Ethernet-CAN.

MODULE IV GRAPHICAL PROGRAMMING ENVIRONMENT IN VI 9

Concepts of graphical programming-Lab-view software-Concept of VI's and sub VI-Display types-Digital and Analog Chart- Oscilloscope types - Loops - Case and sequence structures - Types of data - Arrays - Formulae nodes - Local and global variables - String and File I/O.

MODULE V ANALYSIS TOOLS AND SIMPLE APPLICATIONS IN VI 9

Fourier transform - Power spectrum - Correlation - Windowing and filtering tools - Simple temperature indicator - ON/OFF controller - PID controller - CRO and DSO emulation - Simulation of a simple second order system -Signal generation.

COURSEOUTCOMES

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

CO1: Summarize the fundamental concepts of Digital and Virtual Instrumentation.
CO2: Compare the interfacing of RS232, RS 422, RS 485 and USB standards with PC.
CO3: Recall the concepts of various bus protocol implementations in virtual instrumentation.
CO4: Choose the data acquisition components for the given application.
CO5: Develop and emulate the real-time hardware applications virtually using Lab VIEW Software.
CO6: Apply digital instrumentation, interface standards, bus protocols, and LabVIEW emulation.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Robert H. Bishop, "Learning with Lab - view", Prentice Hall, 1st Edition, 2014.
2. Jovitha Jerome, "Virtual Instrumentation using LabVIEW", PHI Learning Pvt. Ltd., 2017.

REFERENCES:

1. KevinJames, "PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control", Newnes publications, 2000.
2. Gary W.Johnson, Richard Jennings, "Lab-view Graphical Programming", McGraw Hill Professional Publishing, 4th Edition, 2011.
3. Sanjay Gupta and Joseph John, "Virtual Instrumentation using LabVIEW", Tata McGraw - Hill Inc,2010.
4. Dr. Balachander K., Suresh Kumaar G, “Professional Work Book on Virtual Instrumentation Using LabVIEW”, Lambert Academic Publishing, 2022.

FURTHER READING: NPTEL

1. https://nptel.ac.in/courses/108105064
2. https://mycourses.aalto.fi/course/view.php?id=32114

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3													
2	3	3													
3	3	3													
4	3	3													
5	3	3													
6	3	3													
AVg.	3	3													

1-low, 2-medium,3-high

	CYBER PHYSICAL SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO CYBER-PHYSICAL SYSTEMS 7

Cyber-Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS, Industry 4.0, Auto-SAR, IIoT implications, Building Automation, Medical CPS.

MODULE II CPS - PLATFORM COMPONENTS 9

CPS Hardware platforms - Processors, Sensors, Actuators, CPS Network – Wireless Hart, CAN, Automotive Ethernet, CPS Software stack – RTOS, Scheduling Real Time controltasks.

MODULE III PRINCIPLES OF AUTOMATED CONTROL DESIGN 9

Dynamical Systems and Stability Controller Design Techniques, Stability Analysis: CLFs, MLFs, stability under slow switching, Performance under Packet drop and Noise, State flow.

MODULE IV CPS IMPLEMENTATION 9

From features to software components, Mapping software components to ECUs, CPSPerformance Analysis - effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion.

MODULE V SAFETY ASSURANCE OF CYBER-PHYSICAL SYSTEMS 11

Advanced Automata based modeling and analysis, Basic introduction and examples, Timed and Hybrid Automata, Definition of trajectories, Formal Analysis: Flow pipe construction, reach ability analysis, CPS SW Verification, Frama-C, CBMC Secure Deployment of CPS.

COURSEOUTCOMES

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

CO1: Interpret the core principles behind CPS.

CO2: Select appropriate networking protocols for CPS.

CO3: Identify the components required to build CPS.

CO4: Identify safety specifications and critical properties.

CO5: Inference the abstractions in CPS design.

CO6: Inference the pre- and post-conditions and invariants for CPS models.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Raj Rajkumar, Dionisio De Niz , and Mark Klein, “Cyber-Physical Systems”, Addison-Wesley Professional.
2. Rajeev Alur, “Principles of Cyber-Physical Systems”, MIT Press, 2015.
3. Lee E A and Seshia S A, “Embedded Systems: A Cyber-Physical Systems Approach”, MIT Press (2017).

REFERENCES:

1. André Platzer, Logical Analysis of Hybrid Systems: Proving Theorems for Complex Dynamics., Springer, 2010, ISBN 978-3-642-14508-7.
2. Jean J. Labrosse, “Embedded Systems Building Blocks: Complete and Ready-To-UseModules in C”, The publisher, Paul Temme, 2011.

3. P. Tabuada, Verification and control of hybrid systems: a symbolic approach, Springer-Verlag 2009.
4. A.J. van der Schaft, J.M. Schumacher, An Introduction to hybrid dynamical systems, Lecture Notes in Control and Information Sciences, Vol. 251, Springer-Verlag,London, 2000.
5. Borrell F, Bemporad A and Morari M, Predictive control for Linear and Hybrid Systems, Cambridge University Press (2017).

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	2	1			1	2	1		1			
2	3	2	3	2	1			1	2	1		1			
3	3	2	3	2	1			1	2	1		1			
4	3	2	3	2	1			1	2	1		1			
5	3	2	3	2	1			1	2	1		1			
6	3	2	3	2	1			1	2	1		1			
AVg.	**3**	**2**	**3**	**2**	**1**			**1**	**2**	**1**		**1**			

1-low, 2-medium,3-high

	INTELLIGENT TECHNIQUES FOR ELECTRICAL ENGINEERING	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO AI & EXPERT SYSTEMS 9

Introduction to Artificial Intelligence and Computational Intelligence -Expert Systems - Fundamental Concepts, Architecture - Knowledge Base - Inference Engine Components and Mechanisms - Expert Systems Application - Expert System for Control in Power Systems.

MODULE II NEURAL NETWORKS 9

Biological neurons - NN terminology, Activation functions, Fundamental models; Architectures - Feed forward & Feedback NN, Types of NN based on learning methods, Applications of NNs- Identification, Control - Case Study - Neural Network Applications for Power System Monitoringand Control.

MODULE III FUZZY SYSTEMS 9

Introduction - Fuzzy versus Crisp, Fuzzy sets, Fuzzy relations, Fuzzy Systems: Fuzzy logic- universe of discourse, membership function, Quantifiers, Inference, Fuzzy Rule based system, Defuzzification methods, Fuzzy Controller, Constructing Fuzzy Model, Application of Fuzzy Logic in Control System.

MODULE IV DECISION TREES & MULTIAGENT SYSTEMS 9

Introduction - Decision Trees - Construction - Pruning - Oblique Decision Trees – Applications of Decision Trees in Power Systems - Introduction to Multi agent Systems, Multi agent Technology Overview - Applications of Multiagent Systems in Power Engineering.

MODULE V HEURISTIC OPTIMIZATION TECHNIQUES 9

Introduction to Genetic Algorithm; GA steps - Selection, Crossover and Mutation; Application of GA to optimal control problems - Particle Swarm Optimization, Ant Colony Algorithm, Unsupervised Learning and Hybrid Methods.

COURSEOUTCOMES

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

CO1: Interpret the basics of intelligent techniques and the role of artificial intelligence inindustrial controllers.

CO2: Explain the fundamental modeling of a controller using fuzzy, expert systems and neuralsystems.

CO3: Apply the fundamental of fuzzy logic and reasoning to handle uncertainty and solve thecontrol engineering problems.

CO4: Implementing genetic algorithms to basic optimal control problems.

CO5: Outline the basic concepts of a heuristic algorithm to solve engineering problems.

CO6: Interpret the role of intelligent control in electrical engineering applications.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Simon Haykin, "Neural Networks & Learning Machines", Pearson Education, 3rd Edition,2016.
2. John Yen Timothy J. Ross, "Fuzzy Logic with Engineering Applications", John Wiley & Sons, 4th Edition, 2016.
3. Omid Bozorg - Haddad, Mohammad Solgi, "Meta-Heuristic & Evolutionary Algorithmsfor Engineering Optimization", John Wiley & Sons, 2017.

REFERENCES:

1. Dan W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", Pearson,2015.
2. George J. Klir and Bo Yuan, "Fuzzy sets and Fuzzy Logic", Prentice Hall, Pearson, 2015.
3. B. Yegnanarayana, "Artificial Neural Networks", PHI Learning Pvt. Ltd., 2009.
4. Xin-She Yang, "Nature-Inspired Optimization Algorithms", 1st Edition, Elsevier, 2014.
5. Ben Coppin, "Artificial Intelligence Illuminated", Jones & Bartlett Learning, 2004.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3													
2	3	3													
3	3	3													
4	3	3													
5	3	3													
6	3	3													
AVg.	3	3													

1-low, 2-medium,3-high

	INDUSTRIAL AUTOMATION	L	T	P	C
		3	0	0	3

MODULE I BUILDING BLOCKS OF AUTOMATION SYSTEM 9

Automation strategies - Production economics- Costs in manufacturing - Break Even analysis. Smart Sensors, Transducers and Motion Actuators - PID Controller - Digital PID Controller- Multi microprocessor Systems - Local Area Networks - Analog and Digital I/O Modules - Supervisory Control and Data Acquisition Systems - Remote Terminal Unit - Intelligent Electronic devices (IEDs)-Industrial Process Models.

MODULE II PROGRAMMABLE CONTROLLERS 9

Introduction - Relay logic - PLCs - Hardware design - Programming of PLCs - PLCs Internal operation and signal processing - Programming of PLC Systems. Application: Robotics, Factory automation - PLC in process control - PLC maintenance – Internal and External PLC faults - Programme error - Watch dogs - Hardware safety circuits - Troubleshooting.

MODULE III DISTRIBUTED CONTROL AND INDUSTRIAL COMMUNICATION SYSTEMS 9

Introduction - DDC Structure - DDC Software - Fundamental requirements of Process Control System Architecture - Distributed Control Systems - Configuration - Popular Distributed Control Systems. Data communication link, Reliability, Digital signal formats, Error detection, Correction and Recovery circuit, Message and Packet switching, RS485, Industrial Ethernet, Concept of Field bus, Study of MODBUS-protocol-HART.

MODULE IV INTRODUCTION TO INDUSTRY 4.0 9

Introduction - The Various Industrial Revolutions -Defining Industry 4.0 -Main Characteristics of Industry 4.0 - The Value Chain - Industry 4.0 Design Principles - Building Blocks of Industry 4.0 - Smart Manufacturing-Digitalization and the Networked Economy - Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0- Smart Factories- Real-World Smart Factories: GEs Brilliant Factory - Siemens Amberg Electronics Plant (EWA) -The Journey so far: Developments in India, USA, Europe, China and other countries.

MODULE V INDUSTRIAL CONTROL APPLICATIONS 9

Industrial Control Applications - Cement Plant - Thermal Power Plant - Water Treatment Plant- Irrigation Canal Management - Steel plant - Petroleum Refineries - Pharmaceutical Industries - Automobile Industries - KAIZEN, SIX SIGMA - IoT in industrial control applications.

COURSEOUTCOMES

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

CO1: Design and develop a suitable controller for automated system involving different disciplines to achieve more reliable and flexible system.

CO2: : Demonstrate hardware design, understand its internal operation

CO3: Comprehend and define business strategies and plan toward the Fourth Industrial Revolution

CO4: Discuss the fundamental requirements of process control systems and describe the architecture of various distributed control systems.

CO5: Choose suitable automation hardware for the given industrial application.

CO6: Develop PLC programmingfor factory automation, process control and fault detection.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Mikell. P. Groover, "Automation Production Systems and Computer IntegratedManufacturing", Pearson India Eduction Series Pvt. Limited, 4th Edition, New Delhi, 2016.
2. Krishna Kant, "Computer - Based Industrial Control ", Prentice Hall of India Pvt. Ltd., NewDelhi, 2010.

REFERENCES:

1. Alp Ustundag, Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation,Springer International Publishing AG; 1st ed. 2018.
2. Curtis D.Johnson, "Process Control Instrumentation Technology", Pearson India EducationServices Pvt. Ltd., 8th Edition, 2015.
3. David W. Pessen, "Industrial Automation: Circuit Design and Components", Wiley India Pvt. Ltd., New Delhi, 2011.
4. Ian G. Warnock, "Programmable Controllers operation and Application", Prentice Hall International,UK, 2008.
5. K.L. Sharma,"Overview of Industrial Process Automation", Elsevier, 2011.
6. Tan KokKiong and AndiSudjana Putra, "Drives & Control for Industrial Automation",Springer, 2010.
7. W.Bolton, "Programmable Logic Controllers", Elsevier, Fifth Edition, 2011.
8. Frank D.Petruzella, "Programmable Logic Controllers", McGraw Hill, 2nd Edition, 5thEdition, 2019.

CO-PO&PSO MAPPING

CO	PO												PSO		
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1	3	3	3	2									2	2	
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3	3	3	3	2									3	3	
4	3	3											2		
5	3	3											2	2	
6	3	3												2	
AVg.	**3**	**3**	**3**	**2**									**2.4**	**2.3**	

1-low, 2-medium,3-high

	DEEP LEARNING	L	T	P	C
		3	0	0	3

MODULE I MATHEMATICAL FOUNDATIONS **9**

Linear Algebra : Vectors, Matrices and Tensors – Linear Dependance and Span – Norms – Eigen Decomposition – Singular Value decomposition – Principal Component Analysis Probability and Information Theory : Population and Sample - Measures of Central Tendency - Measures of Deviation – Measures of Shape - Correlation Analysis- Probability Distributions – Baye's Rule – Linear regression – Logistic Regression.

MODULE II MACHINE LEARNING BASICS **9**

Learning Algorithms – Capacity, overfitting and Underfitting – Hyperparameters and Validation Sets – Estimators , Bias and Variance – Supervised and Unsupervised Learning Algorithms.

MODULE III DEEP NETWORKS **9**

Deep feedforward networks – Gradient Based Learning – Back Propagation – Regularization –Dataset Augmentation – Multitask Learning – Early stopping – Difficulty of training deep neural networks, Greedy layerwise training - Bagging – Optimization strategies.

MODULE IV CONVOLUTIONAL AND RECURRENT NETWORKS **9**

Convolution Neural Networks: Convolution – Pooling – Variants – Structured output – Datatypes - Unsupervised features

Recurrent Neural Networks: Back propagation through time- Long Short Term Memory- Gated Recurrent Units - Bidirectional LSTMs - Bidirectional RNNs.

MODULE V RECENT TRENDS AND APPLICATIONS **9**

Recent trends: Variational Autoencoders - Generative Adversarial Networks - Multi-task DeepLearning – Multi-view Deep Learning - Vision Transformers - Swin Transformers.

Applications: Vision, NLP, Speechaccelerator.

COURSEOUTCOMES

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

CO1: Use Mathematical foundations in deep learning.

CO2: Develop algorithms and train them.

CO3: Analyze machine learning algorithms.

CO4: Implement using python.

CO5: Identify and perform appropriate networks in real life applications.

CO6: Analyze the recent trends

TOTAL: 45 PERIODS

TEXTBOOKS:

1.Ian Goodfellow and Yoshua Bengio and Aaron Courville ,"Deep Learning" , MIT Press,2016.

2.Josh Patterson, " Deep Learning: A Practitioner's Approach, O'Reilly Media:, 2017.

REFERENCES:

1. François Chollet, "Deep Learning with Python", Manning Publications, 2021.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3													
2	3	3													
3	3	3													
4	3	3													
5	3	3												3	
6	3	3													
AVg.	**3**	**3**												**3**	

1-low, 2-medium,3-high

	PRINCIPLES OF OPERATING SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I OPERATING SYSTEM OVERVIEW 9

Introduction to OS – Operating System Operations – Virtualization – Operating System Services – User and Operating System Interface – System Calls – Operating System Structures – Process Concept – Process Scheduling – Context Switch – Operations on Processes – Interprocess Communication – IPC in Shared-Memory Systems – IPC in Message-Passing Systems – Examples of IPC Systems.

MODULE II PROCESS SYNCHRONIZATION AND SCHEDULING 9

Multicore Programming – Multithreading Models – Thread Libraries – Threading Issues – The Critical-Section Problem – Peterson's Solution – Hardware Support for Synchronization – Mutex Locks – Semaphores – Monitors – Liveness – Basic Concepts of CPU Scheduling– Scheduling Criteria – Scheduling Algorithms: FCFS, SJF, RR, Priority, Multilevel Queue, Multilevel Feedback Queue – Thread Scheduling –Real-Time CPU Scheduling.

MODULE III STORAGE MANAGEMENT 9

Contiguous Memory Allocation – Paging – Structure of the Page Table – Swapping – Demand Paging – Copy-on-Write – Page Replacement – Allocation of Frames – Thrashing – Memory Mapped Files – Allocating Kernel Memory.

MODULE IV FILE SYSTEMS AND I/O SYSTEMS 9

File Concept – Access Methods – Directory Structure – Protection – File-System Structure –File-System Operations – Directory Implementation – Allocation Methods – Free-Space Management – Recovery.

MODULE V I/O SYSTEMS 9

I/O Hardware – Application I/O Interface – Kernel I/O Subsystem – Transforming I/O Requests to Hardware Operations – STREAMS – I/O Performance – DISK Scheduling: FCFS, SSTF, SCAN, C-SCAN, LOOK – Disk Management: Disk formatting, Boot block, Bad Blocks.

COURSEOUTCOMES

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

CO1: Articulate the main concepts, strengths and limitations of operating systems.
CO2: Infer the concept of process synchronization and scheduling
CO3: Analyze the structure and basic architectural components of OS.
CO4: Design and implement memory management schemes.
CO5: Understand various file management systems.
CO6: Analyse various aspects of I/O management.

TOTAL: 45 PERIODS

REFERENCES:

1. Peter B. Galvin, Greg Gagne, Abraham Silberschatz "Operating System Concepts", 9th edition, John Wiley & Sons, Inc., 2018.
2. Andrew S. Tanenbaum Modern Operating Systems ," Operating Systems", Prentice Hall of India 5th Edition, 2016.
3. William Stallings, "Opearting Systems", Pearson Education India, 2019.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3													
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6	3	3													
AVg.	3	3													

1-low, 2-medium,3-high

	ANALOG AND DIGITAL COMMUNICATION	L	T	P	C
		3	0	0	3

MODULE I ANALOG MODULATION TECHNIQUES 9

Principles of Amplitude Modulation Systems - DSB, SSB and VSB modulations- Angle Modulation- Representation of FM and PM signals- Spectral characteristics of angle modulated signals-Noise in Analog Modulation - Review of probability and random process-Gaussian and white noise characteristics-Noise in amplitude modulation systems-Noise in Frequency modulation systems- Pre-emphasis and Deemphasis- Threshold effect in angle modulation.

MODULE II PULSE MODULATION 9

Sampling process- Pulse modulation (PAM, PCM, PWM, PPM) - Differential pulse code modulation- Delta modulation.

MODULE III SIGNAL DETECTION THEORY 9

Elements of Detection Theory- ISI, Optimum detection of signals in noise – Coherent communication with waveforms- Probability of Error evaluations - Baseband Pulse Transmission- Inter symbol Interference and Nyquist criterion- Pass band transmission.

MODULE IV DIGITAL MODULATION 9

Digital Modulation schemes : Phase Shift Keying, Frequency Shift Keying- Quadrature Amplitude Modulation - Continuous Phase Modulation and Minimum Shift Keying- Digital Modulation trade-offs.

MODULE V EQUALIZATION TECHNIQUES 9

Optimum demodulation of digital signals over band-limited channels- Maximum likelihood sequence detection (Viterbi receiver) - Equalization Techniques - Synchronization and Carrier Recovery for Digital modulation.

COURSEOUTCOMES

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

CO1: Distinguish different analog modulation schemes for their efficiency and bandwidth.

CO2: Predict the behaviour of a communication system in presence of noise.

CO3: Evaluate pulsed modulation system and analyze their system performance.

CO4: Illustrate various optimal detection schemes.

CO5: Distinguish different analog modulation schemes for their efficiency and bandwidth.

CO6: Distinguish different digital modulation schemes and can compute estimate the bit error performance.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Simon Haykin, “Digital communication Systems”, John Wiley and sons, 2014.
2. John G. Proakis and Masoud Salehi “Digital Communication”, Fifth Edition, Mc GrawHill Publication, 2014 .

REFERENCES:

1. Lathi B P and Zhi Ding, “Modern Digital and Analog communication Systems", OxfordUniversity Press, 2011.
2. Grami, Ali,"Introduction to Digital Communications. Netherlands, Elsevier Science",2015.
3. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, ‘Communication Networks forSmart Grids’, Springer, 2014.
4. B.Carlson, Introduction to Communication Systems, McGraw-Hill, 4th edition 2009.

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
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5	3	3													
6	3	3													
AVg.	3	3													

1-low, 2-medium,3-high

	INTELLIGENT VEHICLES	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Concept of intelligence- need and necessity of intelligent vehicles- driver assistance systems- driver monitoring systems- road scene interpretation- automated vehicles- applications and challenges.

MODULE II EMBEDDED DECISION COMPONENTS **9**

Embodied decision architectures - Behavior planning - Motion prediction and risk assessment - Motion search space - Motion planning - End-to-end architectures - Interplay between decision and control.

MODULE III INFRASTRUCTURE-ORIENTED DECISION-MAKING **9**

Sensors Proprioceptive/Exteroceptive and passive/active sensors- performance measures of sensors- sensors for autonomous vehicles like global positioning system (GPS)- Doppler effect- based sensors- vision based sensors- uncertainty in sensing- filtering.

MODULE IV OBSTACLE DETECTION **9**

Object detection - Anomalous Activity Detection Using Deep Learning Techniques in Autonomous Vehicles – YOLO Programming –Vulnerability and Security.

MODULE V INTRODUCTION TO PATH PLANNING AND NAVIGATION **9**

Data compressor - Alarm clock - Cell phone - Compact disc - DVD - Digital still camera - Audio player - Video accelerator.

Hands-on

1. LIDAR based programs
2. Traffic Analysis using Python
3. Object detection using YOLO
4. Basic programs using ROS
5. Path Planning Algorithms
6. Autonomous Algorithms

COURSEOUTCOMES

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

CO1: Assess the need of autonomous vehicles and intelligent transportation systems.

CO2: Decide on challenging problems of navigation and planning.

CO3: Select the suitable infrastructure for navigation.

CO4: Compare, contrast, and differentiate object detection algorithms.

CO5: Analyze the path planning for autonomous vehicles.

CO6: develop programs for real life applications

TOTAL: 45 PERIODS

TEXTBOOKS / REFERENCES:

1. Ali Emadi, Advanced Electric Drive Vehicles (Energy, Power Electronics, and Machines) 1st Edition, CRC Press, 2014.
2. Romil Rawat, A. Mary Sowjanya, Syed Imran Patel, Varshali Jaiswal, Imran Khan, Allam Balaram , Autonomous Vehicles Volume 1: Using Machine Intelligence, Scrivener Publishing LLC, 2022.
3. Jorge Villagra, Felipe Jimenez, Decision-Making Techniques for Autonomous Vehicles,Elsevier, 2023.
4. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Mehrdad Ehsani, Yimin Gao,Stefano Longo, CRC Press, 2018.
5. Lentin Joseph, “Robot Operating Systems (ROS) for Absolute Beginners, Apress, 2022.

6. Humanoid Robotics: A Reference, Vadakkepat P., GoswamiA., Springer, 2019.
7. Kala R , “On Road Intelligent Vehicles”, Elsevier, 2017.
8. R. Siegwart, I. R. Nourbakhsh, “Introduction to Autonomous Mobile Robots”, The MITPress, 2011.
9. S.G. Tzafestas “Introduction to Mobile Robot Control”, Elsevier, 2013.

CO-PO&PSO MAPPING

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6	3	3	3	3										3	
AVg.	**3**	**3**	**3**	**3**										**3**	

1-low, 2-medium,3-high

OPEN ELECTIVE COURSES

	ENERGY AUDITING	L	T	P	C
		3	0	0	3

MODULE I ENERGY AUDIT **9**

Global energy scenario - Heat and Electrical energy - Role of energy managers in industries - Energy auditing -Types of energy audit- Data to be collected in auditing - Needs, methodology and types of energy audits - Simple payback period - Net present value of saving- Energy audit report.

ELECTRICAL ENERGY CONSERVATION

MODULE II ELECTRICAL ENERGY CONSERVATION **9**

Basic Industrial electrical distribution- energy saving and energy efficiency with Transformers, reactive power correction and cable loss reduction- Energy saving in lighting systems -Specific Energy Consumption (SEC) - Load management - Demand Side Management (DSM).

MODULE III HEAT ENERGY CONSERVATION **9**

Energy Audit - Losses in Boiler - Waste heat recovery - Sources of waste heat - High temperature heat recovery - Medium temperature heat recovery - Waste heat recovery applications- Cogeneration- Heating, ventilation and air conditioning systems (HVAC) :Types - energy conservation in cooling towers and Spray ponds.

MODULE IV BUILDING, TRANSPORT AND UTILITY ENERGY CONSERVATION **9**

Real buildings systems: Consumption - Cost versus lifecycle cost - Building design - Water supply systems Real Transportation Systems: Energy conservation in transportation - New technologies - Progress in clean diesel technology. Energy conservation in pumps, and fan and blowers - Energy efficient motors.

MODULE V ENERGY AUDIT PLANNING AND MONITORING **9**

Energy Action Planning: Energy management system - Management commitment and Energy conservation policy - Energy performance assessment - Data collection and management - Analysis of data, baseline and benchmarking - Estimation of energy savings potential - Action planning and Training planning.

Monitoring and Targeting: Defining monitoring & targeting, Elements of monitoring & targeting - Data and information, various techniques - Energy consumption, Production and Cumulative sum of differences (CUSUM).CAD.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Exhibit Conceptual knowledge of the technology, economics and regulation related issues associated with energy conservation and energy auditing.

CO2: Compute the thermal efficiency of various thermal utilities and use the energy audit methods learnt to identify the areas deserving tighter control to save energy expenditure.

CO3: The cost- benefit of various investment alternatives for meeting the energy needs of productive processes through energy conservation study.

CO4: Illustrate the energy saving techniques to reduce power consumption of the non- productive loads.

CO5: Advocacy of strategic and policy recommendations on energy conservation and energy auditing

CO6: Apply the simple audit procedure

TOTAL:45 PERIODS

TEXTBOOKS:

1. D. P. Sen Gupta, K. R. Padiyar, IndranilSen, M.A, "Recent Advances in Control and Management of Energy Systems", Interline Publishers, Bangalore, 1993.
2. AmlanChakrabarti, "Energy Engineering and Management", PHI Learning, New Delhi 2012.
3. YP.Abbi and Shashank Jain, "Handbook on Energy Audit and Environment Management", TERI, 2006.
4. Frank Krieth and D Yogi Goswami, "Energy Management and Conservation Handbook", CRC Press, 2007.
5. C.B. Smith, "Energy Management Principles", Pergamon Press, New York, 1981.

REFERENCES:

1. "General Aspects of Energy Management and Energy Audit-Unit- 1,2,3,4", BEE Guide book, 2010.
2. Hamies, "Energy Auditing and Conservation: Methods, Measurements, Management & case study", Hemisphere, Washington, 1980.
3. Diamant R.M, "Total Energy", Pergamon Press, Oxford Press, 1970.
4. Albert Thumann, "Fundamentals of Energy Engineering", Prentice Hall, May 1984
5. Larry C Whit et.al, "Industrial Energy Management & Utilization", 1st Edition, Springer, 1988

CO-PO&PSOMAPPING

CO	PO												PSO		
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4	3	3													
5	3	3													
6	3	3													
Avg.	3	3													

1-low, 2-medium,3-high

	SOLAR AND WIND ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I SOLAR RADIATION AND SOLAR CELL FUNDAMENTALS 9

Basic characteristics of sunlight - solar spectrum - insolation specifics- irradiance and irradiation pyranometer - solar energy statistics- Solar PV cell - I-V characteristics -P-V characteristics- fill factor. Modeling of solar cell- maximum power point tracking.

MODULE II SPV SYSTEM PERFORMANCE AND APPLICATIONS 9

PV module - blocking diode and by -pass diodes- composite characteristics of PV module - PV array - solar cell array design concepts - Peak power operation-System components. PV- powered fan-PV fan with battery backup - PV-powered pumping system - PV powered lighting systems - grid - connected PV systems.

MODULE III WIND ENERGY FUNDAMENTALS AND COMPONENTS 9

Wind source-wind statistics-energy in the wind- Basic principle of wind energy conversion - nature of wind - power in the wind -turbine power characteristics- parts of wind turbines- braking systems-tower- Maximum power operation.

MODULE IVWIND TURBINE TYPES AND CONTROL 9

Classification of WECS - Generating Systems - DC generator, Synchronous generator, Induction - generator, Doubly fed Induction generator, Direct -driven generator- generator control - load control.

MODULE V SYSETM INTEGRATION 9

Energy storage-Power electronic converters for interfacing wind electric generators - power quality issues- Hybrid system: wind - diesel systems, wind-solar systems.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Summarize the solar radiation, measurements and characteristics of solar PV cell.

CO2: Develop the model of a PV system and its applications.

CO3: Illustrate the basic types, mechanical characteristics and model of wind turbine.

CO4: Analyse the electrical characteristics and operation of various wind-driven electrical generators.

CO5: Utilize various power electronic converters used for hybrid system.

CO6: Infer solar and wind integration principles with the electrical utility.

TOTAL:45 PERIODS

TEXTBOOKS:

1. S N Bhadra, S Banerjee and D Kastha, "Wind Electrical Systems", Oxford University Press, 1st Edition, 2005.
2. Chetan Singh Solanki, "Solar Photovoltaic's: Fundamentals,Technologies and Applications" PHI Learning Publications, 3rd Edition, 2015.

REFERENCES:

1. Roger A. Messenger and Jerry Ventre, "Photovoltaic systems engineering", Taylor and Francis Group Publications, 2020.
2. M.Godoy Simoes and Felix A. Farret, "Alternative Energy Systems: Design and Analysis with Induction Generators", CRC press, 2nd Edition, 2008.
3. Ion Boldea, "The electric generators hand book - Variable speed generators", CRC press, 2015.

CO-PO&PSOMAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2													
2		3													
3		3													
4	2														
5		2													
6	3	2													
Avg.	**2.6**	**2.4**													

1-low, 2-medium,3-high

	ELECTRICAL SAFETY PROCEDURES AND MANAGEMENT	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION AND HAZARDS OF ELECTRICITY 9

Electrical Safety introduction : Hazard Analysis: Primary and secondary hazards - Arc, blast, shocks - Causes and effects - Summary of causes- Protection and precaution - Injury and death protective strategies - IE Rules 1956 - Basic rules for new installations: power system, Domestic and Industry (Qualitative treatment only).

MODULE II ELECTRICAL SAFETY EQUIPMENT 9

General inspection and testing procedure for electrical safety equipment - Electrical safety equipment for external protection: Flash and thermal protection - Head and eye protection - Insulation protection. Electrical safety equipment for internal protection: Over voltage, Short circuit, Earth Fault, Leakage current, High/ Low frequency - Single Line diagram of industrial power system with safety control - Electrician's Safety kit and materials.

MODULE III SAFETY PROCEDURES 9

Introduction - Six step safety method - Job briefings - Energized or De - energized - Safe switching of power systems - General energy control programs - Lockout - Tagout - Voltage measurement techniques - Placement of safety grounds - Flash hazard calculations and approach distances - Calculating the required level of arc protection (flash hazard calculations) - Barriers and warning signs - Tools and test equipment - Field marking of potential hazards - Shock avoidance techniques - One minute safety audit.

MODULE IV GROUNDING AND ELECTRICAL MAINTENANCE 9

Need for electrical equipment grounding - System grounding - Equipment grounding - Types of Earthing - Earth testing for electrical equipment in Power house and Industry - Eight step maintenance program - Maintenance requirements for specific equipment and location - IEC and UL standard.

MODULE V VOLTAGE SAFETY SYNOPSIS AND MEDICAL SAFETY MANAGEMENT 9

Safety equipment and safety procedures for low voltage and high voltage system - Electrical safety around electronic circuits- Electrical safety for medical equipment like over current safety, Isolation, EMI and harmonics - Battery maintenance procedure- Stationary battery safety - Accident prevention - Accident investigation - First aid - Rescue techniques - Electrical safety program structure and development - Safety meetings - Safety audits.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Identify and analyze the precautions and protection of electrical hazards.

CO2: Select and use the suitable personal protective equipment according to the working environment

CO3: Interpret the safety procedures for the specific work place.

CO4: Analyze and apply the various grounding techniques.

CO5: Infer the electrical safety against low voltage and high voltage and to manage the medical equipments.

TOTAL:45 PERIODS

TEXTBOOKS:

1. John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel and Al Winfield, "Electrical Safety Handbook", 4th edition, Mc Grew Hill, 2012.

REFERENCES:

1. Mohamed A El - Sharkawi, "Electric safety: Practice and Standards", CRC press, New York, 2013.
2. Martha J. Boss and Gayle Nicoll, "Electrical Safety: systems, sustainability and stewardship", CRC press, New York, 2014.
3. Ray A. Jones and Jane g. Jones, "The Electrical Safety Program Guide", National fire protection association, Quincy, 2011.
4. Electrical Safety booklets issued by Government bodies.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2													
2		3													
3		3													
4	2														
5		2													
6	3	2													
Avg.	2.6	2.4													

1-low, 2-medium,3-high

	ENERGY EFFICIENT ILLUMINATION SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION: BASICS OF LIGHTING 7

Lighting Physics - Optical Radiation - Concept of Color - Biological Factors: Human eye and brain response - Different entities of illuminating systems. Properties of Lighting - Natural and Artificial lighting - Good and Bad Lighting - Challenges in Lighting - Good Practices in Lighting - Types of Lighting.

MODULE II LIGHTING CALCULATIONS AND LIGHT SOURCES 12

Basic Terms in Lighting System - Luminance measurement - Laws of Illumination - Polar Curves - Rousseau's construction - Concept of Photometry - Introduction of lighting software .

Lamps: Incandescent Lamps: Halogen lamps - Discharge Lamps: MV and SV Lamps, Fluorescent Lamps: FTL, CFL - Arc lamps

- Special Lamps: LED: Surface Mounted Devices (SMD-LEDs), Chip on Board (COB-LEDs) - Neon lamps - Lasers - Comparison of Lamps - Life Cycle Cost (LCC) Analysis - Efficacy.

MODULE III LIGHTING EQUIPMENTS AND STANDARDS 9

Luminaries, Wiring, Control gears, Switching boards, Reflectors and Control circuits - Heating, Harmonics and EMI Suppression techniques from lighting equipment - Switching and Dimming control algorithm - Recommendation of Illumination Levels for Various Tasks / Activities / Locations - Role of 3D printing technology for designing luminaries - International Standards and codes of lighting system.

MODULE IV LIGHTING APPLICATIONS 8

Interior lighting: Industrial, Residential, Indoor stadium and Hospitals. Exterior lighting: Flood, Street, Aviation and Transport lighting - Sign and display Board Lighting - Lighting in Agriculture - Lighting in Automobiles.

MODULE V SMART LIGHTING SYSTEMS

Intelligent lighting system - Smart LED lighting systems - LED Smart Projector system - Solar Street Lighting Systems - Role of IoT in lighting system - Concept of Light Fidelity (Li-Fi) - Significance of UV-C lighting in medical - Concept of Artificial Moon for street lighting.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Understand the properties of light, importance of lighting in various fields, types of light sources and methods of lighting.

CO2: Perform the calculation of luminance parameters in various applications.

CO3: Identify the criteria for selection of lighting equipment's and control systems in various applications.

CO4: Impart design and technology for Interior lighting and Exterior lighting applications.

CO5: Review the various technologies used in Smart lighting systems.

CO6: Develop the suitable lighting system for the given applications.

TOTAL:45 PERIODS

TEXTBOOKS:

1. Joseph B. Murdoch, "Illumination Engineering from Edison's Lamp to the Laser", Visions Communications, Washington DC, USA, 2nd Edition, 1994 .

2. Jack L. Lindsey, "Applied Illumination Engineering", Prentice Hall of India, New Delhi, 3rd Edition, 2008 .

3. Leon Gaster, John Stewart Dow, "Modern Illuminants and Illuminating Engineering", Nabu Press,

Washington DC, 1st Edition, 2010 .

4. Philip Gordon., "Principles and Practices of Lighting Design: The Art of Lighting Composition", Blue Matrix Productions, 2011.

REFERENCES:

1. Lighting Engineering: Practical Hand Book, INDALUX 2002.
2. IES Lighting Handbook, 10th Edition, 2011.
3. NPTEL Course: Illumination Engineering.
4. Lighting - Research paper reference from Philips - Lighting Academy and Signify Lighting University.

CO-PO&PSOMAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2													
2		3													
3		3													
4	2														
5		2													
6	3	2												3	
Avg.	**2.6**	**2.4**													

1-low, 2-medium,3-high

	ELECTRIC VEHICLE TECHNOLOGY	L	T	P	C
		3	0	0	3

MODULE I ELECTRIC VEHICLES **9**

An Overview of Conventional, Battery, Hybrid and Fuel Cell Electric Systems - Conventional IC Engine Vehicle - BEVs - HEVs - Series HEV - Parallel HEV - Series-Parallel HEV - FCEV - EV subsystems - Vehicle Dynamics: Vehicle Load Forces - Basic Power, Energy, and Speed Relationships - Aerodynamic Drag - Aerodynamic Drag and Fuel Consumption - Rolling Resistance- Gradability.

MODULE II ELECTRIC PROPULSION **9**

Electric Motors in EVs - Configuration and control of DC motor drives - Induction motor drives- Permanent Magnet motor drives

Switched reluctance motor drives - Transmission configuration, Components - gears, differential, clutch, brakes - regenerative braking - types - Motor sizing.- Matching the electric machine and the internal - combustion engine (ICE), Sizing the propulsion motor, sizing the power - electronics, selecting the energy storage technology, Communications- supporting subsystems.

MODULE III BATTERIES **9**

Introduction to Batteries - Energy Storage Requirements in Electric Vehicles: Batteries Types: Lead-Acid Battery - Nickel-Metal Hydride - Lithium-Ion - Battery Operation - Battery Parameters and Comparisons - Battery Packs - Battery Sizing - Battery based energy storage and its analysis - Fuel Cells - Fuel Cell based energy storage and its analysis - Super capacitors- Hybridization of different energy storage devices.

MODULE IV BATTERY CHARGING **9**

Charging methods for battery- Fast charging - Battery Charging, Protection, and Management System - Termination methods - Charging from grid - Isolated and Non-isolated DC - DC Converters - Bidirectional DC-DC converter - High-frequency transformer based isolatedcharger topology - Transformer less topologies .

MODULE V E-MOBILITY **9**

Energy Management Strategies - Automotive networking and communication, EV and EV charging standards, V2G, G2V, V2B, V2H - E-mobility business - Electrification challenges - Connected Mobility and Autonomous Mobility- Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Apprehend the fundamentals and importance of electric vehicles and its components.

CO2: Select the suitable drive scheme based on the motor and topology for the given specification and applications.

CO3: Design and categorize the battery system for electric vehicles and hybrid electric vehicles.

CO4: Recognize the suitable battery charging scheme for different environments and applications.

CO5: Describe the significance of E-mobility and its various business opportunities.

CO6: Analyze the case studies**.**

TOTAL:45 PERIODS

TEXTBOOKS:

1. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, 2nd Edition CRC Press, 2018.
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 3rd Edition, CRC Press, 2021.

REFERENCES:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, 2nd edition, Wiley, 2012.
2. Soylu "Electric Vehicles - The Benefits and Barriers", InTech Publishers, Croatia, 2011.
3. J.M. Miller, "Propulsion Systems for Hybrid Vehicles", Institution of Electrical Engineers (IEE), 2nd edition, London, UK, 2010.
4. R. Stone and J.K. Bell, "Automotive Engineering Fundamentals", SAE International, Warrendale, PA, 2004.
5. Viswanathan B. and Scibioh Aulice M, "Fuel cells: Principles and Applications", University Press, 2008.

CO-PO&PSOMAPPING

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6	3	2													
Avg.	2.6	2.4													

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