BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK
(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

INSTITUTE VISION

To become a Globally Recognized Academic Institution in consonance with the social, economic, and ecological environment, striving continuously for excellence in education, research and technological service to the national needs.

INSTITUTE MISSION

- To educate students at Undergraduate, Post Graduate, Doctoral and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.
- To provide excellent research and development facilities to take up Ph.D. programmes and research projects.
- To develop effective teaching and learning skills and state-of-the-art research potential of the faculty.
- To build national capabilities in technology, education, and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

DEPARTMENT VISION

To become an internationally recognized center of excellence in academics, research, and technological services in the area of Electrical and Electronics Engineering and related interdisciplinary fields.

DEPARTMENT MISSION

- Imparting strong fundamental concepts to students and motivating them to find innovative solutions to engineering problems independently.
- Developing engineers with managerial attributes capable of applying latest technology with responsibility.
- Creation of congenial atmosphere and excellent research facilities for undertaking quality research by faculty and students.
- To strive for more internationally recognized publication of research papers, books and to obtain patents and copyrights.
- To provide excellent technological services to industry.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. To develop capability to understand the fundamentals of Science and Electrical & Electronics Engineering for analyzing engineering problems with futuristic approach.
2. To foster a confident and competent graduate capable of solving real life practical engineering problems fulfilling the obligation towards society.
3. To inculcate an attitude for identifying and undertaking developmental work both in industry as well as in academic environment with emphasis on continuous learning enabling to excel in competitive participations at global level.
4. To nurture and nourish effective communication and interpersonal skills to work in a team with a sense of ethics and moral responsibility for achieving goal**.**

PROGRAMME OUTCOMES (POs)

1. Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
3. Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
4. Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
10. Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments

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

PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. Pragmatic professional exposure in the domain of Power Engineering, Power Electronics, Measurement, and Control through systematically designed courses, laboratory contents, projects, and commensurate electives.

2. Development of analytical and designed skills for electrical & electronic systems as well as multidisciplinary areas of engineering utilizing appropriate conventional and modern tools.

3. Holistic amalgamation of managerial skills and research aptitude to strengthen industry-academia collaboration.

Mapping of Pos and PSOs with PEOs

	PEO1	PEO2	PEO3	PEO4
PO1	**3**	**1**	**1**	**1**
PO2	**3**	**3**	**1**	**1**
PO3	**3**	**3**	**1**	**1**
PO4	**3**	**1**	**3**	**1**
PO5	**3**	**1**	**3**	**1**
PO6	**1**	**3**	**1**	**1**
PO7	**1**	**3**	**1**	**3**
PO8	**1**	**1**	**1**	**3**
PO9	**1**	**3**	**1**	**3**
PO10	**1**	**3**	**1**	**3**
PO11	**1**	**1**	**3**	**3**
PSO1	**3**	**1**	**1**	**1**
PSO2	**3**	**3**	**3**	**1**
PSO3	**1**	**3**	**2**	**3**

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

Program Course Structure

Birla Institute of Technology, Mesra, Ranchi

Course Structure for B.Tech. (Electrical and Electronics Engineering)
Based on NEP-2020, CBCS and OBE, Effective from 2024-2025

Sr. No.	Semester of Study (Recommended)	Category of Course	Course Code	Subjects	Mode of Delivery & Credits *L-Lecture; T-Tutorial; P-Practical*			Total Credits
					L (*Periods/ Week*)	**T** (*Periods/ Week*)	**P** (*Periods/ Week*)	
	FIRST	**THEORY**						
I.1		FS	MA24101	Mathematics - I	3	1	0	4
I.2			CH24101	Chemistry	3	1	0	4
I.3		GE	EC24101	Basic Electronics	2	1	0	3
I.4			ME24101	Basics of Mechanical Engineering	2	1	0	3
I.5		FS	CE24101	Environmental Sciences	2	0	0	2
		LABORATORIES						
I.6		FS	CH24102	Chemistry Lab	0	0	2	1
I.7		GE	EC24102	Basic Electronics Lab	0	0	2	1
I.8			ME24102	Engineering Graphics	0	0	4	2
I.9			PE24102	Workshop Practice	0	0	2	1
I.10		MC	MC24 101/ 102 /103/ 104/105	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA) /Entrepreneurship	0	0	2	1
TOTAL (Theory + Labs)								**22**
	SECOND	THEORY						
II.1		FS	MA24103	Mathematics - II	3	1	0	4
II.2			PH24101	Physics	3	1	0	4
			BE24101	Biological Sciences for Engineers	2	0	0	2
II.4		GE	CS24101	Programming for Problem Solving	3	1	0	4
II.5			EE24101	Basics of Electrical Engineering	2	1	0	3
		LABORATORIES						
II.6		FS	PH24102	Physics Lab	0	0	2	1
II.7		GE	CS24102	Programming for problem Solving Lab.	0	0	2	1
II.8			EE24102	Electrical Engineering Lab.	0	0	2	1
I.9		HSS	HS24131	Communication Skill - I	0	0	3	1.5
I.10		MC	MC24 106 /107/108/109/110	Choice of: NCC/NSS/ PT & Games/ Creative Arts (CA) /Entrepreneurship	0	0	2	1
TOTAL (Theory + Labs)								**22.5**

GRAND TOTAL FOR FIRST YEAR							**44.5**
Vocational Courses for Exit after 1st Year							
Vocational Course I: EE24151Basics of Electrical Appliance and Electrical Wiring				3	1	0	**4**
Vocational Course II: EE24152Laboratory on Electrical System Installation, Maintenance and Troubleshooting				0	0	3	**2**
	THIRD	THEORY					
III.1		PC	EE24201	Electrical Measurement and Instrumentation	3	0	0	3
III.2			EE24203	Analog and Digital Circuits	3	0	0	3
III.3			EE24205	Engineering Electromagnetics	3	1	0	4
III.4			EE24207	Introduction to System Theory	2	1	0	3
III.5			EE24209	Circuit Theory	3	1	0	4
III.6		HSS	MT24131	UHV-II: Understanding Harmony	3	0	0	3
		LABORATORIES						
III.7		PC	EE24202	Electrical Measurement and Instrumentation Lab.	0	0	2	1
III.8		PC	EE24204	Analog and Digital Circuits Laboratory	0	0	2	1
III.9		MC	MC24 201/202/ 203/204 / 205	Choice of: NCC/NSS/ PT & Games/ Creative Arts (CA) / Entrepreneurship	0	0	2	1
	TOTAL (Theory + Labs)							**23**
	FOURTH	THEORY					
IV.1		PC	EE24251	DC Machines and Transformer	3	1	0	4
IV.2			EE24253	Digital Signal Processing	3	1	0	4
IV.3			EE24255	Microprocessor and Embedded System	3	0	0	3
IV.4			EE24257	Electrical Energy Generation and Control	3	0	0	3
IV.5		OE	XX24XXX / MO24201	Open Elective - I / MOOC - I	3	0	0	3
IV.6		GS	MA24201	Numerical Methods	2	0	0	2
IV.7		MC	HS24211	Indian Knowledge System	2	0	0	0
		LABORATORIES						
IV.8		PC	EE24252	Electrical Machine Lab. – I	0	0	3	1.5
IV.9		PC	EE24254	Digital Signal Processing Laboratory	0	0	2	1
IV. 10		PC	EE24256	Microprocessor and Embedded System Lab.	0	0	3	1
IV. 11		GS	MA24202	Numerical Methods Laboratory	0	0	2	1
IV.12		MC	MC24 206/ 207/208 / 209/ 210	Choice of: NCC/NSS/ PT & Games/ Creative Arts (CA) / Entrepreneurship	0	0	2	1
TOTAL (Theory + Labs)								**24.5**
GRAND TOTAL FOR SECOND YEAR								**47.5**

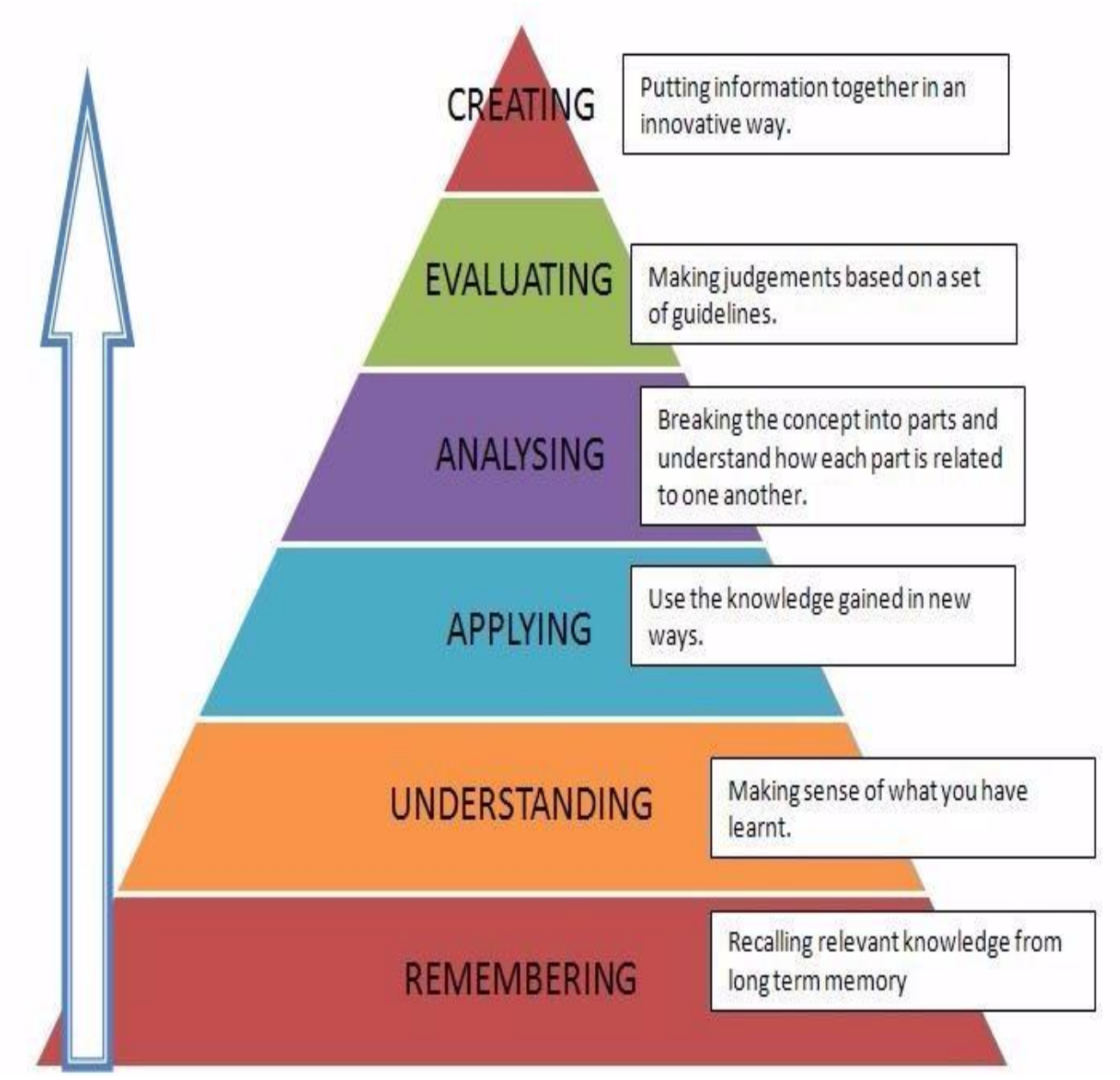
Vocational Course III: EE24275Electrical Power Equipment and Protection					3	1	0	**4**
Vocational Course IV: EE24276 Laboratory on Electrical Power Equipment and Protection					0	0	3	**2**
	FIFTH	THEORY						
V.1		PC	EE24301	AC Rotating Machines	3	0	0	3
V.2		PC	EE24303	Control Theory	3	1	0	4
V.3		PC	EE24305	Power Electronics	3	1	0	4
V.4		PC	EE24307	Electric Power Transmission and Distribution	3	0	0	3
V.5		PE	EE24XXX	Program Elective-I	3	0	0	3
		OE	XX24XXX /MO24301	Open Elective - II / MOOC - II	3	0	0	3
		LABORATORIES						
V.7		PC	EE24302	Electrical Machine Lab.	0	0	2	1
V.8		PC	EE24304	Control System Laboratory	0	0	2	1
V.9		PC	EE24300	Project - I				2
TOTAL (Theory + Labs)								**24**
	SIXTH	THEORY						
VI.1		PC	EE24351	Power System Analysis	3	0	0	3
VI.2		PC	EE24353	Electric Drives	3	0	0	3
VI.3		PE	EE24XXX	Program Elective – II	3	0	0	3
VI.4		PE	EE24XXX	Program Elective-III	3	0	0	3
VI.5		OE	XX24XXX / MO24303	Open Elective - III / MOOC - III	3	0	0	3
VI. 6		HSS	MT24204	Constitution of India	2	0	0	0
		LABORATORIES						
VI.7		PC	EE24306	Power Electronics Laboratory	0	0	2	1.5
VI.8		PC	EE24356	Electrical Workshop	0	0	2	1
VI.9		PE	EE24XXX	Program Elective-III Lab	0	0	3	1.5
VI.X		PC	EE24350	Project - II				2
VI.XI		HSS	HS24133	Communication Skill - II	0	0	3	1.5
TOTAL (Theory + Labs)								**22.5**
GRAND TOTAL FOR THIRD YEAR								**46.5**
	SEVENTH	THEORY						
VII.1		PC	EE24401	Switchgear and Protection	3	1	0	4
VII.2		PE	EE24XXX	Program Elective-IV	3	0	0	3
VII.3		PE	EE24XXX	Program Elective-V	3	0	0	3
VII.4		OE	XX24XXX / MO24401	Open Elective - IV / MOOC - IV	3	0	0	3
		LABORATORIES						
VII.5		PC	EE24402	Power System Laboratory	0	0	2	1
VII. 6		PE	EE24XXX	Program Elective – V Lab.	0	0	3	1.5
VII.7		MC	MC24400	Summer Training (Minimum Four Weeks / 160 Hrs)				4
VII.8		PC	EE24400	Project - III				3
TOTAL (Theory + Labs)								**22.5**

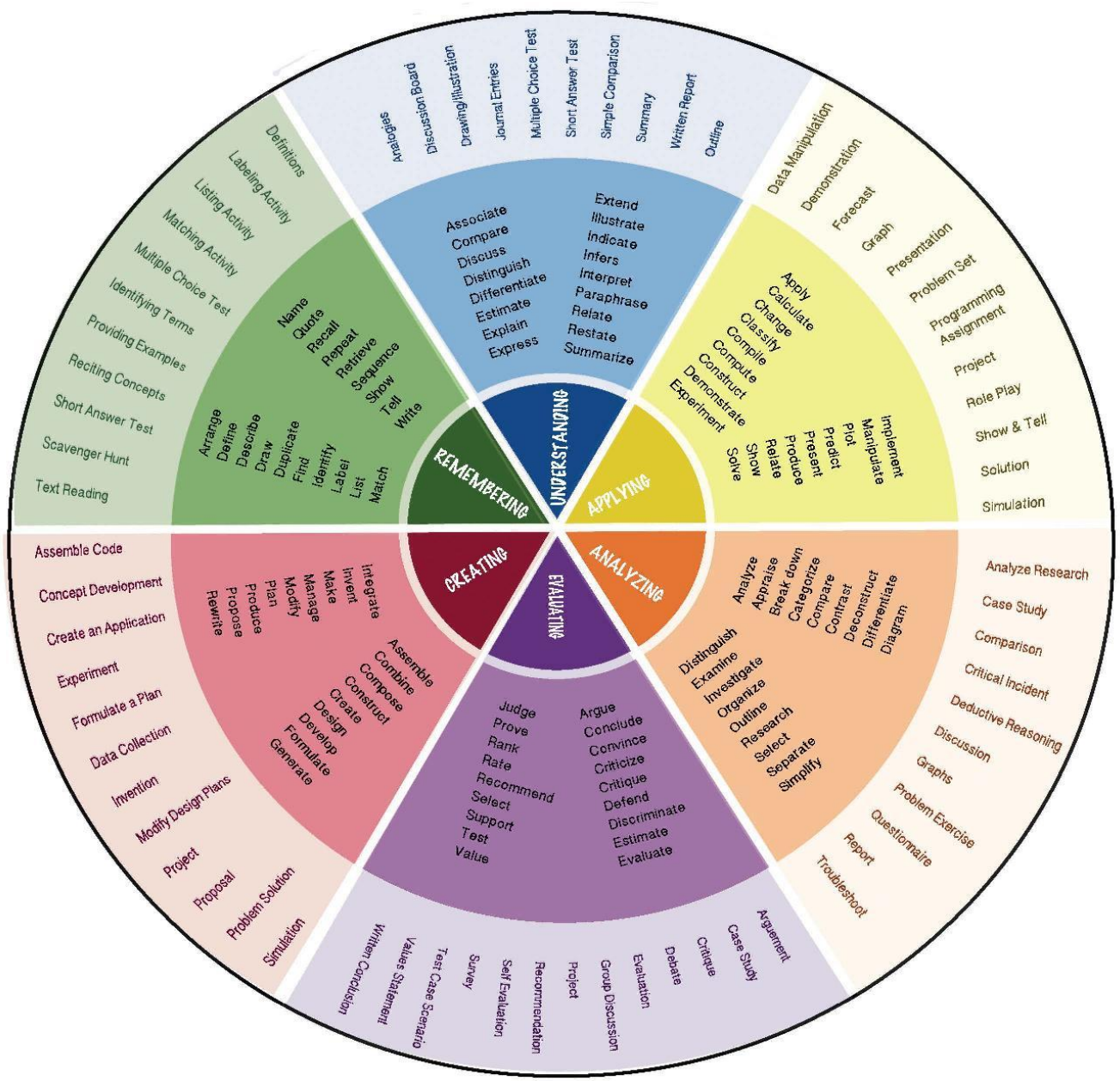
VIII.1	EIGHTH	PC	EE24450/ EE24490	Project-IV / Industry Internship				6
VIII.2			EE24498	Comprehensive Viva				1
	TOTAL (Theory + Labs)							**7**
GRAND TOTAL FOR FOURTH YEAR								**29.5**
GRAND TOTAL FOR B.TECH.								**168**

BLOOM'S TAXONOMY FOR CURRICULUM DESIGN AND ASSESSMENT:

Preamble

The design of curriculum and assessment is based on Bloom's Taxonomy. A comprehensive guideline for using Bloom's Taxonomy is given below for reference.





Bloom's Taxonomy is used to formulate questions. It facilitates the formulation of action verbs in connection with the various tiers of thinking to achieve a balance between basic retrieval and more complex abilities. Questions at the Remember level, e.g., may use verbs to define or list, questions at the Understand level may use verbs to explain or summarize, at the Apply level use or demonstrate, at the Analyze level differentiate or compare, at the Evaluate level justify or critique, and then at the Create level design or formulate.

COURSE INFORMATION SHEET

Course Code: MA24101

Course Title: Mathematics-I

Pre-requisite(s): -

Co- requisite(s): --

Credits: 4 L: 3 T: 1 P: 0

Class schedule per week: 4

Class: B.Tech.

Semester / Level: I/1

Branch: All

Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	infinite sequences and series
2.	theory of matrices including elementary transformations, rank and its application in consistency of system of linear equations, eigenvalues, eigenvectors etc.
3.	multivariable functions, partial differentiation, properties and applications of partial derivatives.
4.	integrals of multivariable functions viz. double and triple integrals with their applications
5.	properties like gradient, divergence, curl associated with derivatives of vector point functions and integrals of vector point functions

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	decide the behavior of sequences and series using appropriate tests.
CO2	handle problems related to the theory of matrices including elementary transformations, rank and its application in consistency of system of linear equations, eigenvalues, eigenvectors etc.
CO3	get an understanding of partial derivatives and their applications in finding maxima - minima problems.
CO4	apply the principles of integrals (multivariable functions viz. double and triple integrals) to solve a variety of practical problems in engineering and sciences.
CO5	get an understanding of gradient, divergence, curl associated with derivatives of vector point functions and integrals of vector point functions and demonstrate a depth of understanding in advanced mathematical topics, enhance and develop the ability of using the language of mathematics in engineering.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
MODULE – I: Sequences and Series Sequences, Convergence of Sequence. Series, Convergence of Series, Tests for Convergence: Comparison tests, Cauchy's Integral test, Ratio test, Cauchy's root test, Raabe's test, Gauss test, Alternating series, Leibnitz test, Absolute and Conditional Convergence.	**9**
MODULE – II: Matrices Rank of a Matrix, elementary transformations. Vectors, Linear Independence and Dependence of Vectors. Consistency of system of linear equations. Eigenvalues, Eigenvectors, Cayley - Hamilton theorem.	**9**
III: Advance Differential Calculus Function of several variables, Partial derivatives, Euler's theorem for homogeneous functions, Total derivatives, Chain rules, Jacobians and its properties, Taylor series for function of two variables, Maxima – Minima.	**9**
MODULE – IV: Advance Integral Calculus Double integrals, double integrals in polar coordinates, Change of order of integration, Triple Integrals, cylindrical and spherical coordinate systems, transformation of coordinates, Applications of double and triple integrals in areas and volumes.	**9**
MODULE – V: Vector Calculus Scalar and vector point functions, gradient, directional derivative, divergence, curl. Line Integral, Work done, Conservative field, Green's theorem in a plane, Surface and volume integrals, Gauss – divergence theorem, Stoke 's theorem.	**9**

TEXTBOOKS:

1. M. D. Weir, J. Hass and F. R. Giordano: Thomas' Calculus, 11th edition, Pearson Educations, 2008E.
2. H. Anton, I. Brivens and S. Davis, Calculus, 10th Edition, John Wiley and sons, Singapore Pte. Ltd., 2013.
3. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint,2010.

REFERENCE BOOKS:

1. M. J. Strauss, G. L. Bradley And K. J. Smith, Calculus, 3rd Ed, Dorling. Kindersley (India) Pvt. Ltd. (P Ed), Delhi, 2007.
2. David C. Lay, Linear Algebra and its Applications (3rd Edition), Pearson Ed. Asia, Indian Reprint, 2007.
3. Robert Wrede & Murray R. Spiegel, Advanced Calculus, 3rd Ed., Schaum's outline series, McGraw-Hill Companies, Inc.,2010.
4. D. G. Zill and W.S. Wright, Advanced Engineering Mathematics, Fourth Edition, 2011.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) --

POS MET THROUGH GAPS IN THE SYLLABUS --

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN ---

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN --

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Laboratory experiments/teaching aids
CD5	Industrial/guest lectures
CD6	Industrial visits/in-plant training
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	0	0	0	0	1	2			
CO2	3	3	2	2	2	0	0	0	0	1	2			
CO3	3	3	2	2	1	0	0	0	0	1	2			
CO4	3	3	3	3	2	1	0	0	0	1	2			
CO5	3	3	2	3	2	1	1	1	1	2	2			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: CH24101

Course Title: Chemistry

Pre-requisite(s): Intermediate level Chemistry

Co- requisite(s):

Credits: 4 L: 3 T: 1 P: 0

Class schedule per week: 4

Class: B.Tech.

Semester / Level: I

Branch: All

Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students:

1	To create concept of chemical bonding in coordination chemistry
2	To understand the basics of stereochemistry, aromaticity and reaction mechanism of organic molecules
3	To understand the reaction dynamics and to know different types of catalysis
4	To apprehend the basic principles and the application of vibrational, electronic and NMR spectroscopy
5	To develop knowledge on the physical state and electrochemistry of molecules

COURSE OUTCOMES (COs) (3 COs to 6 COs depending upon the course)

After the completion of this course, students will be able to:

CO1	Able to explain the bonding in a coordination complex
CO2	Able to explain the 3D structure, aromaticity and stereochemistry of organic molecules
CO3	Able to predict the rate, molecularity and mechanism of a simple as well as catalytic reaction
CO4	Able to explain the UV-vis, IR and NMR spectra of unknown molecules
CO5	Able to interpret the phase diagram of simple one and two component heterogeneous systems in equilibrium and the electrochemical behavior of the molecules

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I: Bonding in Coordination Complex Introduction to Chemical Bonding, Werner's Theory, Bonding in coordination complexes, Crystal Field Theory, Octahedral, Tetrahedral and Square planar complexes, CFSE, Jahn Teller theorem, Spectral, electronic and magnetic properties of coordination complexes.	**8**
Module – II: Organic Structure and Reactivity Aromaticity, Geometrical isomerism: cis–trans, E/Z, and syn-anti isomerism; Optical isomerism & Chirality; Wedge, Fischer, Newmann and Sawhorse projection formulae and interconversions; D/L, R/S nomenclature system; Conformational studies of n-butane. Addition, Elimination, Substitution and Rearrangement reaction.	**8**
Module – III: Kinetics and Catalysis Kinetics of Chain, Parallel/Competing/Side, Consecutive reactions; Fast reactions; Outline of Catalysis, Acid-base catalysis, Enzyme catalysis (Michaelis-Menten equation), Important catalysts in industrial processes: Hydrogenation using Wilkinsons catalyst, Phase transfer catalyst**.**	8
Module – IV: Spectroscopic Techniques Absorption Spectroscopy, Lambert-Beers law, Principles and applications of UV-Visible spectroscopy, Principles and applications of Vibrational spectroscopy; Introduction of NMR spectroscopy.	8
Module – V: Phase and Chemical equilibrium Phase rule: terms involved, Phase diagram of one component (Water) & two component (Pb/Ag) system & their applications; Gibbs Free energy, Van't Hoff equation and Chemical Equilibrium; Nernst Equation, Standard electrode potential, EMF measurement and its application, Batteries and Fuel Cells.	8

TEXTBOOKS:

1. Huheey, J. E., Inorganic Chemistry: Principles of Structure and Reactivity, 4 th edition, Pearson.
2. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Seventh Edition, Pearson
3. Atkins, P. W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.

REFERENCE BOOKS:

1. Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
2. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier (2009).
3. William Kemp, Organic Spectroscopy, 3 rd Ed., 2008 Macmillan.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

Limited exposure to computational tools, industrial case studies, and skill-based training needed for industry readiness.

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
CO1	3	2	1	1	0	0	0	0	1	0	2			
CO2	3	3	2	1	0	0	0	0	1	0	2			
CO3	3	3	3	2	1	1	0	0	1	0	3			
CO4	3	2	1	3	3	0	0	0	2	0	2			
CO5	3	3	2	2	1	2	0	0	1	0	3			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: EC24101

Course Title: Basic Electronics

Pre-requisite(s): N/A

Co- requisite(s): N/A

Credits: L:2 T:1 P: 0 C:3

Class schedule per week: 03

Class: B. Tech.

Semester / Level:0I/01

Branch: ALL B.TECH.

Course Objectives

This course enables the students:

1.	To understand PN Junction, diodes and their applications.
2.	To comprehend BJT and the bias configurations.
3.	To understand operating principles of FETs
4.	To understand op amp and its applications.
5.	To apprehend number system, Logic Gates and Boolean algebra.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Understand the characteristics of electronic devices like PN-diode, BJT, JFET and MOSFET
CO2	Classify and analyze the various circuit configurations of BJTs and MOSFETs.
CO3	Analyze the characteristics of operational amplifier.
CO4	Design electronic circuits using diodes, transistors, op-amp and logic gates for analogand digital applications.
CO5	Solve day-to-day life problems using electronic circuits.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Diodes and Applications:** Introduction to semiconductor materials, PN junctiondiode, barrier potential, depletion layer width, junction capacitance,diode current equation, I-Vplot, diode-resistance, temperature dependence,breakdown mechanisms, Zener diode – operation and applications, Diode as a Rectifier: Half Wave and Full Wave Rectifiers with and without C-Filters.	**8**
Module – II **Bipolar Junction Transistors (BJT):** Basic operation of PNP and NPN Transistors, Input and Output Characteristics of CB, CE and CC Configurations.Transistor biasing: operating point, Fixed bias, emitter bias, voltage divider bias, stability factor, small signal analysis (h-parametermodel) of CE configuration.	**8**
Module – III **Field Effect Transistors:** JFET: Principle of operation,transfer characteristics, MOSFET: Operation of N-MOS, P-MOS, enhancement and depletion type, transfer characteristics, CS biasing of JFET and MOSFET.	**8**
Module – IV **Operational Amplifiers:** Introduction of Operational Amplifier, Characteristics of Operational Amplifier, Differential Amplifier, CMRR, Slew Rate, input and output offset voltages, Inverting and non-inverting amplifiers, Summing Amplifier, Difference amplifier, Differentiator and Integrator.	**8**
Module – V **Boolean Algebra and Logic Gates:** Boolean Algebra, Boolean operators, Truth table of different digital logic gates (AND, OR, NOT, NAND, NOR, EXOR, EX-NOR),application of diode for design of logic gates, realization of logic gates using universal gates, adder, subtractor.	**8**

Textbooks:

1. Millman J., Halkias C.C. “Integrated Electronics: Analog and Digital Circuits and Systems”, Tata McGraw-Hill.
2. Boylstead R.L., Nashelsky L., “Electronic Devices and Circuit Theory”, Pearson Education, Inc, 11/e.
3. Mano M.M., Michael D. Ciletti, “Digital Design”, Pearson Education, Inc, 5/e, 2011.

Reference books:

1. Millman J., Halkias C.C., Parikh Chetan, "Integrated Electronics: Analog and Digital Circuits and Systems", Tata McGraw-Hill, 2/e.
2. Millman J., Halkias C.C., Satyabrata Jit, "Millman's Electronic Devices and Circuits", Tata McGraw-Hill, 3/e.
3. Albert Paul, Malvino, David J. Bates, "Electronic principles", McGraw-Hill, 8/e, 2015.

Gaps in the syllabus (to meet Industry/Profession requirements): NA

POs met through Gaps in the Syllabus: 3, 11, 12

Topics beyond syllabus/Advanced topics/Design: NA

POs met through Topics beyond syllabus/Advanced topics/Design: 2, 3, 11, 12

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Student Feedback on Faculty
2. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
CO1	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO2	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO3	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO4	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO5	3	3	1	2	3	1	2	2	3	2	2	3	3	1

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

Mapping Between COs and Course Delivery (CD) methods

CD	Course Delivery Methods	Course Outcome	CD Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2, CD3, CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: ME24101

Course Title: Basics of Mechanical Engineering

Pre-requisite(s): NIL

Co- requisite(s): NIL

Credits: 3 **(**L: 2 T:1 P: 0)

Class schedule per week: 3

Class: B. Tech

Semester / Level: SECOND

Branch: Mechanical Engineering

Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Introduce system of forces, and write equation of equilibrium.
2.	Analyse motion of particle and rigid body subjected to force.
3.	Grasp the importance of internal and external combustion engines.
4.	Apprehend the fundamentals of friction.
5.	Understand the different sources of energy.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Explain the basics of Mechanical Engineering.
CO2	Apply various laws of mechanics on static and dynamic elements and bodies.
CO3	Analyse various problems of mechanics related to static and dynamic bodies.
CO4	Evaluate the real life problem related to mechanics and energy for its probable solution.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **System of Forces and Structure Mechanics;** Addition of Forces, Moment of a Force, Couple, Varignon's theorem, Free Body Diagram, Equilibrium in Two and Three Dimensions, Equivalent Forces and Moment. Types of Plane Trusses, Analysis of Plane Trusses by: Method of Joints and Method of Sections. Hooke's Law of elasticity, Stress and Strain, Relation between elastic constants.	**8**
Module – II **Kinematics & Kinetics of rigid bodies:** Types of rigid body motion– translation, rotation about fixed axis, equations defining the rotation of a rigid body about a fixed axis, plane motion, absolute and relative velocity in plane motion, instantaneous center of rotation. Equation of motion and D'Alembert's principle.	**8**
Module – III **Friction :** Interfacial Friction (a) Laws of dry friction, static & kinetic co-efficient of friction, Analysis of static, kinetic and rolling friction. (b) Analysis of frictional forces in inclined planes, wedges, screw jacks and belt drives.	**8**
Module – IV **Boilers and Internal Combustion Engine;** Classification of Boilers, Fire tube and Water Tube boilers. Boiler Mountings and Accessories. Boiler efficiency. Classification of I C Engines. Basic components and terminology of IC engines, working principle of four stroke and two stroke - petrol and diesel engine.	**6**
Module – V **Non-Conventional Energy Sources** Renewable and Non-renewable Energy Resources, Advantages and Disadvantages of Renewable Resources, Renewable Energy Forms and Conversion- Solar Energy, Wind Energy, Hydro Energy.	**5**

TEXTBOOKS:

1. Engineering Mechanics, Irving H. Shames, P H I. ltd, 2011.
2. Boiler operator, Wayne Smith, LSA Publishers, 2013.
3. Internal Combustion Engines, M. L. Sharma and R. P. Mathur, Dhanpat Rai Publications, 2014.

   Fundamentals of Renewable Energy Processes, Aldo Vieira Da Rosa, Elsevier publication, 2012.

REFERENCE BOOKS:

1. Engineering Mechanics : statics, James L. Meriam, L. G. Kraige, Wiley, 7th Edition, 2011.
2. Engineering Mechanics, S. Rajasekaran & G. Sankarasubramaniam, Vikash publishing house, 2018.
3. An Introduction to Steam Boilers, David Allan Low, Copper Press Publisher, 2012.
4. Internal Combustion Engines – V Ganesan, McGraw hill, 2017.
5. Non Conventional Energy Resources, B. H. Khan, McGraw Hill Education Publisher, 2017.

6. Principles of Mechanical Engineering, R. P. Sharma & Chilkesh Ranjan, Global Academic Publishers, 2016.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) : NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
Mid Semester Examination	25
Quiz	10
Assignment	10
Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	√	√	√	√
Semester End Examination	√	√	√	√

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

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

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 6
CO4	CD1, CD2, CD 6

COURSE INFORMATION SHEET

Course Code: CE24101

Course Title: Environmental Science

Pre-requisite(s): NA

Co- requisite(s): NA

Credits: 3 L:3 T:0 P:0

Class schedule per week: 2

Class: B.Tech.

Semester / Level: 1st Semester/1

Branch: ALL

Name of Teacher:

COURSE OBJECTIVES

This course enables the students to:

1.	To develop basic knowledge of ecological principles and their applications in environment.
2.	To identify the structure and composition of the spheres of the earth, the only planet sustaining life.
3.	To analyse, how the environment is getting contaminated and probable control mechanisms for them.
4.	To generate awareness and become a sensitive citizen towards the changing environment.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Able to explain the structure and function of ecosystems and their importance in the holistic environment.
CO2	Able to identify the sources, causes, impacts and control of air pollution
CO3	Able to distinguish the various types of water pollution happening in the environment and understand about their effects and potential control mechanisms.
CO4	Able to judge the importance of soil, causes of contamination and need of solid waste management.
CO5	Able to know the impacts of noise pollution and its management.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I: Ecosystem and Environment Concepts of Ecology and Environmental Science, ecosystem: structure, function and services, Biogeochemical cycles, energy and nutrient flow, ecosystem management. Concept of Biodiversity.	6
Module – II: Air Pollution Structure and composition of unpolluted atmosphere, classification of air pollution sources, types of air pollutants, effects of air pollution, monitoring of air pollution, Air pollution control and management.	6
Module – III: Water Pollution Water Resource; Water Pollution: types and Sources of Pollutants; effects of water pollution; Water quality monitoring, Water quality index, water and wastewater treatment: primary, secondary and tertiary.	6
Module – IV: Soil Pollution and Solid Waste Management Soil profile, soil properties, soil pollution, and Municipal solid waste management. MSW – Functional elements of MSW.	6
Module – V: Noise Pollution Noise pollution: introduction, sources, outdoor and indoor noise propagation, Effects of noise on health, criteria noise standards and limit values, Noise measurement techniques, prevention and control of noise pollution.	6

TEXTBOOKS:

1. A, K. De. (3rd Ed). 2008. Environmental Chemistry. New Age Publications India Ltd.
2. R. Rajagopalan. 2016. Environmental Studies: From Crisis to Future by, 3rd edition, Oxford University Press.
3. Eugene P. Odum. 1971. Fundamentals of Ecology (3rd ed.) -. WB Sunders Company, Philadelphia.
4. C. N. Sawyer, P. L. McCarty and G. F. Parkin. 2002. Chemistry for Environmental Engineering and Science. John Henry Press.
5. S.C. Santra. 2011. Environmental Science. New Central Book Agency.

REFERENCE BOOKS:

1. D.W. Conell. Basic Concepts of Environmental Chemistry, CRC Press.
2. Peavy, H.S, Rowe, D.R, Tchobanoglous, G. Environmental Engineering, Mc-Graw – Hill International.
3. G.M. Masters & Wendell Ela. 1991. Introduction to Environmental Engineering and Science, PHI Publishers.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS):

NA

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internet

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
CO1	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**			
CO2	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**			
CO3	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**			
CO4	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**			
CO5	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2
CO2	CD1, CD2
CO3	CD1, CD2
CO4	CD1, CD2
CO5	CD1, CD2

COURSE INFORMATION SHEET

Course Code: CH24102

Course Title: Chemistry Lab

Pre-requisite(s): Intermediate level Chemistry

Co- requisite(s):

Credits: 1 L: 0 T: 0 P: 2

Class schedule per week: 2

Class: B.Tech.

Semester / Level: I

Branch: All

Name of Teacher:

COURSE OBJECTIVES

This course enables the students to:

1.	To gain an understanding of the synthesis of organic and inorganic compounds.
2.	To interpret and analyze spectroscopic data effectively.
3.	To develop a strong concept of potentiometric and pH-metric titrations of acids and bases.
4.	To understand and calculate the rate constant of chemical reactions.
5.	To acquire knowledge of determining melting points and estimating eutectic and transition temperatures.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Able to perform the synthesis of organic and inorganic compounds.
CO2	Able to interpret and analyze spectroscopic data.
CO3	Able to carry out potentiometric and pH-metric titrations of acids and bases.
CO4	Able to determine the rate constant of chemical reactions.
CO5	Able to measure melting points and estimate eutectic and transition temperatures.

SYLLABUS (List of experiments)

1. Gravimetric estimation of Nickel using Dimethylglyoxime.

2. Determination of total Hardness of a given water Sample (Complexometric Titration).

3. Verification of Beer's Law using Fe^{3+} solution by spectrophotometer/colorimeter, and determination of the concentration of an unknown Fe^{3+} solution.

4. Preparation of Diazoamino Benzene and reporting of its melting point and yield.

5. Construction of a melting point–mass percent composition diagram for a two-component mixture and determination of its eutectic temperature.

6. Study of the kinetics of acid-catalyzed hydrolysis of ethyl acetate and evaluation of the rate constant.

7. Determination of the strength of a strong acid using potentiometric titration with a strong base.

8. Determination of the transition temperature of a given salt hydrate.

9. Separation of binary organic mixture by acid-base extraction and analysis using given FTIR and NMR spectrum.

10.Construction of a pH-titration curve for a strong acid versus a strong base

REFERENCE MATERIALS:

1. https://bitmesra.ac.in/edudepartment/content/1/140/553 (link of Lab Manual)
2. **Experimental Physical Chemistry** – B. Viswanathan, P. S. Raghavan, Narosa Publishing House (1997).
3. **Vogel's Textbook of Practical Organic Chemistry**
4. **Experiments in General Chemistry** – C. N. R. Rao, U. C. Agarwal.
5. **Experimental Organic Chemistry, Vol. 1 & 2** – P. R. Singh, D. S. Gupta, K. S. Bajpai, Tata McGraw-Hill

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars (discussion of experimental results and error analysis).
CD5	Group discussions/problem-solving sessions (to analyze experimental data and calculations).
CD6	Industrial/guest lectures (applications of chemical analysis techniques in industry).
CD7	Industrial visits (exposure to real chemical laboratories and processes).

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	2	3	1	1	2	2			
CO2	3	2	2	3	3	2	1	1	3	2	3			
CO3	3	3	1	3	3	1	2	1	2	2	2			
CO4	3	3	1	3	2	1	1	1	1	2	3			
CO5	3	2	1	2	2	2	1	1	1	1	3			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: EC24102

Course Title: Basic Electronics Lab

Pre-requisite(s): N/A

Co- requisite(s): N/A

Credits: L: 0 T: 0 P: 2 C:1

Class schedule per week: 02

Class: B. Tech.

Semester / Level: I/01

Branch: ALL B.TECH.

Course Objectives

This course enables the students:

1.	To measure magnitude, time-period, frequency, phase of signals using CRO
2.	To know PN junction characteristics and its applications
3.	To understand the working of transistor amplifier
4.	To understand the working of operational amplifier and circuits
5.	To realize logic gates and implement simple Boolean expression

Course Outcomes

After the completion of this course, students will be able to:

CO1	Familiarize with electronics components like diode, transistors, ICs
CO2	Make use of measuring instruments and function generators
CO3	Verify characteristics of diodes, transistors and op-amp
CO4	Design electronic circuits using diodes, transistors, op-amp for analog applications
CO5	Design electronic circuits using logic gates for digital applications

List of Experiments

Experiment No.	Name of the Experiments
	(A) HARDWARE BASED EXPERIMENTS
1.	**MEASURMENTS USING CRO** AIM-1: To understand the Measurement of voltage, time-period and frequency of different signals on CRO. AIM-2: To measure the frequency and phase of two different signals using Lissajous pattern.
2.	**HALF-WAVE AND FULL WAVE RECTIFIER CIRCUITS** AIM-1: To understand the basic operation principle of Half-wave rectifier circuit and measurement of rectification efficiency and ripple factor with and without C-Filter. AIM-2:To understand the basic operation principle of Full-wave rectifier circuit and measurement of rectification efficiency and ripple factor with and without C-Filter.
3.	**COMMON EMITTER (CE) TRANSISTOR AMPLIFIER** AIM-1: To understand the basic operation principle of CE transistor amplifier circuit and finding its frequency response. AIM-2: To determine the gain bandwidth product of CE transistor amplifier from its frequency response.
4.	**INVERTING OPERATIONAL AMPLIFIER (OP-AMP)** AIM: To design the inverting operational amplifier using IC741 OP-AMP and find its Gain and Frequency Response.
5.	**DIFFERENTIAL AMPLIFIER** AIM-1: To design common mode and differential mode circuit using IC741 OP-AMP AIM-2:To obtain common mode gain and differential mode gain and calculate CMRR.
6.	**REALIZATION OF LOGIC GATES** AIM-1: To understand basic Boolean logic functions (NOT, AND, OR). AIM-2: To realize the basic logic gates (AND, OR, NOT) using NAND Gate (IC-7400).
	(B) SOFTWARE BASED EXPERIMENTS
1.	**PN JUNCTION CHARACTERISTICS** AIM-1: To determine the forward bias V-I characteristics of PN junction diode and finding itsforward cut-in voltage. AIM-2: To determine the reverse bias V-I characteristics of PN junction diode and

	finding its reverse breakdown voltage.
2.	**ZENER DIODECHARACTERISTICS** AIM-1: To design a basic voltage regulator circuit using Zener diode. AIM-2: To determine the reverse bias V-I characteristics of Zener diode and finding its reverse breakdown voltage.
3.	**FIELD EFFECT TRANSISTOR CHARACTERISTICS** AIM-1: To determine the output and transfer characteristics of JFET. AIM-2: To measure the voltage,gain of JFET.
4.	**NON-INVERTING OPERATIONAL AMPLIFIER (OP-AMP)** AIM:To design the non-inverting operational amplifier using IC741 OP-AMP and find its Gain and Frequency Response.
5.	**DIFFERENTIATOR AND INTEGRATOR CIRCUITS USING OP-AMP** AIM-1: To design differentiator circuit using IC741 OP-AMP and observe waveforms. AIM-2:To design integrator circuit using IC741 OP-AMP and observe waveforms.
6.	**IMPLEMENTATION OF BOOLEAN FUNCTION** AIM-1: To understand the AND Gate IC (IC 7408) and OR Gate IC (IC 7432) AIM-2: To implement a given Boolean expression using logic gate ICs.

Text Books:

1. Millman J., Halkias C.C., Parikh Chetan, "Integrated Electronics: Analog and Digital Circuits and Systems", Tata McGraw-Hill, 2/e.
2. Mano M.M., "Digital Logic and Computer Design", Pearson Education, Inc, Thirteenth Impression, 2011.

Reference Book:

1.Boylstead R.L., Nashelsky L., "Electronic Devices and Circuit Theory", Pearson Education, Inc, 10/e.

Gaps in the syllabus (to meet Industry/Profession requirements): NA

POs met through Gaps in the Syllabus: N/A.

Topics beyond syllabus/Advanced topics/Design: N/A

POs met through Topics beyond syllabus/Advanced topics/Design: N

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	**(60)**
Attendance Marks	**12**
Day-to-day performance Marks	**06**
Lab Viva marks	**20**
Lab file Marks	**12**
Lab Quiz-I Marks	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II Marks	**10**
Lab performance Marks	**30**

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping Course Outcomes onto Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	2	3	1	1	2	2	2	2			
CO2	3	3	1	2	3	1	1	2	2	2	2			
CO3	3	2	1	2	3	1	1	2	2	2	2			
CO4	3	3	1	2	3	1	1	2	2	2	2			
CO5	3	2	1	2	3	1	1	2	2	2	2			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

Mapping Between COs and Course Delivery (CD) methods:

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD5, CD9
CD2	Tutorials/Assignments	CO2	CD1, CD5, CD9
CD3	Seminars/ Quiz (s)	CO3	CD1, CD5, CD9
CD4	Mini Projects/Projects	CO4	CD1, CD5, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD5, CD9
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: ME24102

Course Title: Engineering Graphics

Pre-requisite(s): NIL

Co- requisite(s):NIL

Credits: 2 (L:0 T: 0 P:4)

Class schedule per week: 4

Class: B. Tech.

Semester / Level: SECOND

Branch: Mechanical Engineering

Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Understand the basic principles of Engineering Graphics, which include projections of 1D, 2D and 3D objects.
2.	Visualize a solid object (including sectioned) and convert it into drawing.
3.	Visualize different views of any object.
4.	Develop skill to draw objects using AutoCAD software.
5.	Inculcate the imagination and mental visualization capabilities for interpreting the geometrical details of common engineering objects.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Explain the fundamentals of Engineering Graphics and projection and acquire visualization skills.
CO2	Demonstrate the concept of projections of points and lines for various engineering applications.
CO3	Apply the concept of projections to construct planes and solids, and its orthographic projections which are positioned in various configurations..
CO4	Demonstrate the understanding of AutoCAD software commands to draw projections of points, lines, planes and solids.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction to Engineering Graphics, dimensioning and projections, orthographic projections, Fundamentals of First and Third Angle projection, Orthographic projections of points.	**9**
Module – II Orthographic projections of straight lines: lines parallel to HP and VP, lines inclined to HP and Parallel to VP, line inclined to VP and parallel to HP, line inclined to both reference planes. Orthographic projections of planes/lamina: lamina perpendicular to both HP and VP, lamina parallel to HP and perpendicular to VP (and vice versa), lamina inclined to HP and perpendicular to VP, lamina inclined to VP and perpendicular to HP, lamina inclined to both reference planes.	**9**
Module – III Projections of solids (cube, prism, pyramid, tetrahedron) - axis perpendicular to HP and inclined to VP and inclined to one or both planes. Section of solids: sectional plane perpendicular to one plane and parallel/inclined to another plane.	**9**
Module – IV Working with AutoCAD Commands, Cartesian Workspace, Basic Drawing & Editing Commands, Drawing: Lines, Rectangles, Circles, Arcs, Polylines, Polygons, Ellipses, Creating Fillets and Chamfers, Creating Arrays of Objects, Working with Annotations, Adding Text to a Drawing, Hatching, Adding Dimensions, Dimensioning Concepts, Adding Linear Dimensions, Adding Radial & Angular Dimensions, Editing the Dimensions.	**9**
Module – V Create views of points, lines, planes, and various types of solids (cube, prism, pyramid, tetrahedron, etc.) using AutoCAD software.	**9**

TEXTBOOKS:

1. Engineering Drawing by N. D. Bhatt, Charotar Publishing House Pvt.Ltd., 53rd, Edition, 2014.
2. Engineering Drawing and Graphics + AutoCAD by K. Venugopal, New Age International (P) Limited, 4th Reprint: June, 2017.

REFERENCE BOOKS:

1. Engineering Graphics with Autocad by J. D. Bethune, Prentice Hall, 2007.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) : NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	60
End Semester Test	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Lab Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Lab Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	√	√	√	√
Semester End Examination	√	√	√	√

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors	
CD2	Assignments/Seminars	
CD3	Laboratory experiments/teaching aids	√
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	
CD7	Simulation	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2		2				2		2	2	2	2
CO2	3	3	2		2				2		2	2	2	2
CO3	3	3	3	2	2			2	2		2	2	2	2
CO4	2	2	2	2	3			2	3	2	2	2	2	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD3
CO2	CD3
CO3	CD3
CO4	CD3

COURSE INFORMATION SHEET

Course Code: PE24102

Course Title: Workshop Practice

Pre-requisite(s): None

Co-requisite(s): None

Credits: 1 (L:0 T:0 P: 2)

Class schedule per week: 2

Class: B.Tech.

Semester / Level: SECOND

Branch: Production and Industrial Engineering

Name of Teacher:

Course Objectives:

This course enables the students to:

1	Familiarize with the basics of manufacturing processes.
2	Impart knowledge and skill to use tools, machines, equipment, and measuring instruments.
3	Practice on manufacturing of components using workshop trades.
4	Educate students on the safe handling of machines and tools.
5	Exercise individual as well as group activity with hands-on training in different workshop trades.

Course Outcomes:

At the end of the course, a student should be able to:

CO1	Be conversant with the basic manufacturing processes.
CO2	Identify and apply suitable tools and instruments for carpentry, foundry, welding, fitting, and conventional and modern machining.
CO3	Manufacture different components using various workshop trades.
CO4	Take safety and precautionary measures for self and machines during operations.
CO5	Develop skills to work as an individual or in a team during trade practices.

SYLLABUS

LIST OF EXPERIMENTS	(NO. OF PRACTICAL HOURS)
1. CARPENTRY SHOP **EXPERIMENT-I: Carpentry Tools and Instruments** **Objective**: To study the various tools, instruments, and equipment used in carpentry practice.	**2**
2. CARPENTRY SHOP **EXPERIMENT-II: Carpentry Practice** **Objective:** To perform the carpentry work by making a wooden job using different tools.	**2**
3. FOUNDRY SHOP **EXPERIMENT-I: Green Sand Moulding** **Objective:** To get acquainted with various tools and equipment used in making green sand mould (to practice green sand mould making with single-piece patterns).	**2**
4. FOUNDRY SHOP **EXPERIMENT-II: Aluminium Casting** **Objective:** To get acquainted with melting and pouring metal in a mould (given two-piece patterns of handle) and to make aluminium casting.	**2**
5. WELDING SHOP **EXPERIMENT-I: Manual Metal Arc Welding** **Objective:** To study arc welding processes including arc welding machines (AC & DC), electrodes and equipment. To join two pieces of given metal by the arc welding process.	**2**
6. WELDING SHOP **EXPERIMENT-II: Gas Welding** **Objective:** To study gas welding processes, including types of flames produced, filler metals and fluxes, etc. To join two pieces of given metal by the gas welding process.	**2**
7. FITTING SHOP **EXPERIMENT-I: Fitting Tools and Measuring Instruments** **Objective**: To study the various tools used in the fitting shop and perform fitting operations (like marking, chipping, hack-sawing, filing, drilling, etc.)	**2**
8. FITTING SHOP **EXPERIMENT-II: Fitting Assembly Practice** **Objective:** To make a job clamping plate as per the given drawing by fitting	**2**

operations and to check for its assembly with a given component.	
9. MACHINE SHOP **EXPERIMENT – I: Centre Lathe Machine** **Objective**: To study lathe machine and to machine a given job on the center lathe as per drawing.	**2**
10. MACHINE SHOP **EXPERIMENT-II: Shaper Machine** **Objective:** To study the Shaper machine and to machine a given job on the shaper as per drawing.	**2**
11. MODERN MACHINE SHOP **EXPERIMENT – I: CNC Lathe Machine** **Objective**: To provide an introduction to the functionality and operation of the CNC Lathe Machine through practical demonstration.	**2**
12. MODERN MACHINE SHOP **EXPERIMENT-II: CNC Surface Grinding Machine** **Objective:** To provide an introduction to the functionality and operation of the CNC Surface Grinding Machine through practical demonstration	**2**

Books recommended:

TEXTBOOK

1. S K Hajra Choudhury, A K. Hajra, "Elements of Workshop Technology: Vol- I and Vol -II", Media Promotors Pvt Ltd. **(T1)**
2. B S Raghuwanshi, "A course in Workshop Technology", Dhanpat Rai Publications. **(T2)**

REFERENCE BOOK

1. P.N. Rao, "Manufacturing Technology Vol-1and Vol-II", Tata McGraw Hill. **(R1)**
2. Kalpakjian, "Manufacturing Engineering and Technology", Pearson. **(R2)**

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	
CD3	Laboratory experiments/teaching aids	√
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	
CD7	Simulation	√

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Examination: Experiment Performance	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Course Outcome

Mapping of Course Outcomes (COs) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CO1	3	2	1	0	1	1	1	1	1	1	2	3	2	2
CO2	2	3	2	1	3	1	1	1	2	2	2	3	2	3
CO3	2	2	3	2	3	1	1	2	2	2	2	2	2	3
CO4	1	1	2	1	2	2	3	1	1	1	2	1	1	2
CO5	1	1	2	0	1	0	1	3	3	3	2	2	2	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

Mapping Between Course Outcomes (COs) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD3, CD6
CO2	CD1, CD3
CO3	CD1, CD3
CO4	CD1, CD3
CO5	CD3

COURSE INFORMATION SHEET

Course Code: MA24103

Course Title: Mathematics II

Pre-requisite(s): Mathematics - I

Co- requisite(s): --

Credits: 4 L: 3 T: 1 P: 0

Class schedule per week: 4

Class: B.Tech.

Semester / Level: II/1

Branch: All

Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	various methods to solve linear differential equations of second and higher order
2.	special functions viz. Legendre's and Bessel's and different properties associated with them
3.	diverse mathematical techniques for solving partial differential equations of first order, along with their applications in wave and heat equations using Fourier series
4.	the theory of functions of a complex variable, complex differentiation and integration
5.	about random variables and elementary probability distribution

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	investigate the occurrence of ordinary differential equations in real-life problems and identify the suitable methods available for their solutions.
CO2	develop skills to solve and implement various forms of differential equations and special functions in diverse domains.
CO3	learn to solve various forms of partial differential equations arising in real-world.
CO4	gain an understanding of complex variable functions and their properties in science and engineering.
CO5	comprehend and apply the concept of probability distributions in solving problems related to uncertainty.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Ordinary Differential Equations – I Linear differential equations, Wronskian, Linear independence and dependence of solutions, Linear differential equations of 2nd and higher order with constant coefficients, Operator method, Euler – Cauchy's form of linear differential equation, Method of variation of parameters.	**9**
Module – II Ordinary Differential Equations – II Ordinary and singular points of differential equation, Power and Frobenius' series solutions (root differ by non integer and equal roots). Bessel's differential equation, Bessel function of first kind and its important properties. Legendre's differential equation, Legendre's polynomial and its important properties.	**9**
Module – III Fourier series and Partial Differential Equations Fourier series: Euler formulae for Fourier series, Half range Fourier series. Partial Differential Equations: Method of separation of variables and its application in solving one dimensional wave and heat equations.	**9**
Module – IV Complex Variable-Differentiation & Integration Function of a complex variable, Analyticity, Analytic functions, Cauchy – Riemann equations. Cauchy's theorem, Cauchy's Integral formula, Taylor and Laurent series expansions. Singularities and its types, Residues, Residue theorem.	**9**
Module – V Applied Probability Discrete and continuous random variables, cumulative distribution function, probability mass and density functions, expectation, variance. Introduction to Binomial, Poisson and Normal Distribution.	**9**

TEXTBOOKS:

1. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. D. G. Zill and W.S. Wright, Advanced Engineering Mathematics, Fourth Edition, 2011.
3. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., McGraw Hill, 2004.
4. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing, 3rd Ed, 2009.
5. R. A. Johnson, I. Miller and J. Freund: Probability and Statistics for Engineers, PHI
6. S. C. Gupta and V. K. Kapoor: Fundamental of Mathematical Statistics, Sultan Chand and Sons

REFERENCE BOOKS:

1. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley India, 2009.
2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
3. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
4. G. F. Simmons, Differential Equations with Applications and Historical Notes, TMH, 2nd ed., 2003.
5. P. L. Meyer: Introductory Probability and Statistical Applications, Oxford & IBH.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) --

POS MET THROUGH GAPS IN THE SYLLABUS --

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN ---

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN --

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Laboratory experiments/teaching aids
CD5	Industrial/guest lectures
CD6	Industrial visits/in-plant training
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	1	0	0	0	1	2			
CO2	3	3	2	3	2	1	0	0	1	1	2			
CO3	3	3	2	3	2	1	0	0	1	1	2			
CO4	3	2	2	2	2	1	0	0	1	1	2			
CO5	3	3	2	2	2	1	1	1	1	2	3			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: PH24101

Course Title: Physics

Pre-requisite(s): Intermediate Physics and Intermediate Mathematics

Co- requisite(s): Mathematics I

Credits: 4 L: 3 T: 1 P: 0

Class schedule per week: 4

Class: B.Tech.

Semester / Level: I

Branch: All

Name of Teacher:

COURSE OBJECTIVES (numbers may vary depending on the course)

This course envisions to impart to students:

1.	The principles of physical optics and basic concept of fiber optics.
2.	Fundamental laws of electromagnetism leading to Maxwell's equations.
3.	The posulates of special theory of relativity, Lorenz transformation equation and their consequences: Einstein energy mass relation and relativistic energy-momentum relation
4.	The limitations of classical physics and basic concepts such as wave-particle duality, and working of quantum mechanics with the help of particles in a box problem
5.	Concepts of stimulated emission and working principle of laser with examples, concepts of nuclear physics and plasma physics

COURSE OUTCOMES (COs) (3 COs to 6 COs depending upon the course)

After the completion of this course, students will be able to:

CO1	analyse the intensity variation of light due to polarization, interference and diffraction.
CO2	formulate and solve the problems on electromagnetism
CO3	explain and apply concepts of special theory of relativity and its consequences
CO4	Apply the concepts of quantum mechanics such as wave-particle duality and obtain the solution of simple quantum mechanical problems.
CO5	explain working principle of lasers and to summarize its applications, describe basic concepts of nuclear and plasma physics

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I: **Physical Optics:** Polarization, Malus' Law, Brewster's Law, Double Refraction, Interference in thin parallel films, Interference in wedge-shaped layers, Newton's rings, Fraunhofer diffraction by single slit and double slit. Elementary ideas of fibre optics and application of fibre optic cables	**8**
Module – II: **Electromagnetic Theory:** Gradient, Divergence and Curl, Statement of Gauss theorem & Stokes theorem, Gauss's law, Applications, Concept of electric potential, Relationship between E and V, Polarization of dielectrics and dielctric constant, Boundary conditions for E & D, Gauss's law in magnetostatics, Ampere's circuital law, Boundary conditions for B & H, Equation of continuity, Displacement current, Maxwell's equations.	**8**
Module – III: **Special Theory of Relativity:** Introduction, Inertial frame of reference, Galilean transformations, Postulates, Lorentz transformations and its conclusions, Length contraction, time dilation, velocity addition, Mass change, Einstein's mass energy relation.	6
Module – IV: **Quantum Mechanics:** Planck's theory of black-body radiation, Compton effect, Wave-particle duality, De Broglie waves, Davisson and Germer's experiment, Uncertainty principle, Brief idea of Wave Packet, Wave Function and its physical interpretation, Schrodinger equation in one-dimension, free particle, particle in an infinite square well	9
Module – V **Modern Physics:** Laser-Spontaneous and stimulated emission, Einstein's A and B coefficients, Population inversion, Light amplification, Basic laser action, Ruby and He-Ne lasers, Properties and applications of laser radiation, Nuclear Physics: Binding Energy Curve, Nuclear Force, Liquid drop model, Introduction to Shell model, Applications of Nuclear Physics, Concept of Plasma Physics and its applications.	9

TEXTBOOKS:

- A. Ghatak, Optics, 4th Edition, Tata Mcgraw Hill, 2009
- Mathew N.O. Sadiku, Elements of Electromagnetics, Oxford University Press, 2001
- Arthur Beiser, Concept of Modern Physics, 6th edition, Tata McGraw- Hill, 2009
- F. F. Chen, Introduction to Plasma Physics and controlled Fusion, Springer, Edition 2016.

REFERENCE BOOKS:

1. Fundamentals of Physics, Halliday, Walker and Resnick

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment/Quiz	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
CO1	2	2	0	1	1	0	0	1	0	0	2			
CO2	2	2	0	1	1	0	0	1	0	0	2			
CO3	2	1	0	1	1	0	0	1	0	0	2			
CO4	2	1	0	1	1	0	0	1	0	0	2			
CO5	2	1	0	1	1	0	0	1	0	0	2			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: BE24101

Course Title: Biological Science for Engineers

Pre-requisite(s): -

Co- requisite(s): -

Credits: 2 (L:2 T: 0 P: 0)

Class schedule per week: 2

Class: B. Tech

Semester / Level: FIRST

Branch: Biotechnology

Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Understand fundamental concepts of biology relevant to engineering.
2.	Explore the structure and function of biological molecules and cells.
3.	Learn about genetic principles and molecular biology techniques.
4.	Understand the applications of biological science in various engineering fields considering global challenges and ethical considerations.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Comprehend and apply the fundamental concepts of biological sciences in the context of engineering.
CO2	Analyze the structure and function of biological molecules and cells and their relevance to engineering solutions.
CO3	Demonstrate understanding of genetic principles and molecular biology techniques and their applications in engineering.
CO4	Apply knowledge of biological sciences to innovate and develop solutions in various engineering domains and critically evaluate the role of biological sciences in addressing global challenges, including ethical and safety considerations.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module I: Introduction to Biological Sciences Overview and importance of biology in engineering, Origin of Life, Cell Theory and Structure.	**6**
Module II: Molecular Biology and Genetics Central Dogma of Molecular Biology, DNA, RNA and Protein structure and function, Mendelian Genetics, rDNA Technology and Genome Editing.	**6**
Module III: Biochemistry Cell Metabolism, Enzymes and Catalysis, Cell Communication and Signalling.	**6**
Module IV: Applications of Biological Sciences in Engineering Biomaterials, Bioinformatics, Biosensors and Bioelectronics (Biological Sensors- Ear & Eye), Synthetic Biology, Nanobiotechnology.	**6**
Module V: Global Challenges and Ethical Considerations Convergence of AI and Biology, Climate change and food security, Biosafety and Biohazards, and Ethical Considerations.	**6**

TEXTBOOKS:

1. Lehninger A, Principals of Biochemistry
2. Stryer L, Biochemistry
3. K. Wilson & K.H. Goulding, A biologist's guide to Principles and Techniques of Practical Biochemistry.
4. Biology for Engineers" by Arthur T. Johnson

REFERENCE BOOKS:

1. Purves et al, Life: The Science of Biology
2. R. Dulbecco, The Design of Life.
3. Biological Science Edited by Soper, Cambridge low price edition.
4. Synthetic Biology: A Primer" by Paul S. Freemont and Richard I. Kitney
5. "Introduction to Bioinformatics" by Arthur Lesk Genomes" by T.A. Brown

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	√	√	√	√
Semester End Examination	√	√	√	√

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

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

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: CS24101

Course Title: Programming for Problem Solving

Pre-requisite(s): School-level mathematics and Science

Co- requisite(s):

Credits: 4 L: 3 T: 1 P:0

Class schedule per week: 4

Class: UG

Semester / Level: II

Branch: ALL

Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Develop Programming Skill.
2.	Understand the fundamental Concepts of Coding
3.	Learn how to Debug Programs
4.	Convert Problems to Programs

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Formulate Algorithms for arithmetic and logical problems.
CO2	Translate the algorithms to programs.
CO3	Test and execute the programs and correct syntax and logical errors.
CO4	Apply programmatic skills for solving scientific problems.
CO5	Decompose problems into functions and structured programming.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Representation of an Algorithm: Flowchart/Pseudo code with examples. From algorithms to programs: source code, variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.	**6**
Module – II Structure of a C program, variables and data types, Operators – precedence and associativity, Evaluating expressions, Basic I/O – use of printf, scanf, getchar etc. and format specifiers, Conditional Branching statements – If, If - else, If-else- if, switch case, Writing nested conditional statements.	**8**
Module – III Iterative programming structures – for loops, while loops, do while loops. Understanding break and continue and their usage. Writing Nested loops, Arrays – creation and usage, Strings and string handling.	**8**
Module – IV Functions (including using built in libraries), Parameter passing in functions, call by value, Recursion, as a different way of solving problems, Nested function calls. Understanding scope and lifetime of a variable.	**8**
Module – V Structures - Defining structures, Accessing structures elements, Creating an array of Structures, Nested structures. Some advanced concepts – typedef, enum, macros. An introduction to pointers – understanding, creating pointers and accessing variables using pointers. Passing arrays to functions: idea of call by reference, passing parameters to main.	**10**

TEXTBOOKS:

1. Let us C, Yashwant Kanetkar, 18th Edition, BPB Publications
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
4. R.G.Dromey, How to Solve it by Computer, Pearson Education

REFERENCE BOOKS:

• Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

1. The syllabus focused on the concepts and basics of Program writing skills.
2. Industry often requires debugging of their existing programs/software compare to the new program, which is a knowledge beyond the basics, including real-world software (collection of programs) experience.
3. More memory management practices, file handling and library functions

POS MET THROUGH GAPS IN THE SYLLABUS: YES [PO1-PO5 & PO10-PO12]

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

File Handling with memory management, pre processor directives, Graphics, Data Arrangement, Task scheduling and assembly level programs.

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: YES

[PO1-PO5]

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

- **Student Feedback on Course Outcome**
- **Student Feedback on Faculty/Content Delivery**
- **Student Feedback on Evaluation Procedures**

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/Assignments
CD3	Seminars/ Quiz (s)
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Self-Learning, Group Study, Coding Contest

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**	**3**	**3**	**2**	**0**	**1**	**2**	**2**	**2**			
CO2	**3**	**3**	**3**	**3**	**3**	**2**	**0**	**1**	**2**	**2**	**2**			
CO3	**3**	**3**	**3**	**3**	**3**	**2**	**0**	**1**	**2**	**2**	**2**			
CO4	**3**	**3**	**3**	**3**	**3**	**2**	**0**	**1**	**2**	**2**	**2**			
CO5	**3**	**3**	**3**	**3**	**3**	**2**	**0**	**1**	**2**	**2**	**2**			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD3, CD5
CO3	CD3, CD5, CD7
CO4	CD2, CD3, CD4, CD6, CD7
CO5	CD1, CD3, CD5, CD7

COURSE INFORMATION SHEET

Course Code: EE24101

Course Title: Basics of Electrical Engineering

Pre-requisite(s):

Co- requisite(s): Basic Sciences

Credits: 3 L: 2 T: 1 P: 0

Class schedule per week: 03

Class: B.Tech.

Semester / Level: I (II)/01

Branch: All

Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	realize the electrical signals, elements, and their properties.
2.	understand the mathematical representation of AC, DC signals and theorems/laws for solving electrical circuits with variations of voltage and frequency.
3.	perceive the 3-phase AC signal representation and 3-phase circuit analysis for balanced and unbalanced condition.
4.	understand the characteristics of magnetic material and analysis of magnetic circuits.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	explain the voltage, current signals and their characteristics in electrical circuit elements.
CO2	apply the theorems/laws for electrical circuit analysis.
CO3	solve the electrical circuits for variable voltage and frequency to observe the resonance, power and power factor in the electric circuit.
CO4	analyze the 1-phase and 3-phase AC balanced and unbalanced circuits
CO5	apply the concept of magnetic circuits for magnetic circuit analysis.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction:** Importance of Electrical Engineering in day-to-day life, Electrical elements, properties (linear, non-linear, unilateral, bilateral, lumped and distributed, etc.) and their classification, Ideal and Real Sources, Source Conversion, Star-Delta conversion, KCL and KVL, Mesh current and Nodal voltage method.	**8**
Module – II **D.C. Circuits**: Steady state analysis with independent and dependent sources; Series and Parallel circuits. **Circuit Theorems:** Superposition, Thevenin's, Norton's, and Maximum Power Transfer theorems for Independent and Dependent Sources applied to DC circuits.	**8**
Module – III **Single-phase AC Circuits:** Common signals and their waveforms, RMS and Average value. Form factor & Peak factor of a sinusoidal waveform. **Series Circuits:** Impedance of Series circuits. Phasor diagram. Active Power. Power factor. Power triangle. **Parallel Circuits:** Admittance method, Phasor diagram, Power and Power factor Power triangle, Series-parallel Circuit, Power factor improvement, Circuit Theorems applied to AC circuits. **Series and Parallel Resonance**: Resonance curve, Q–factor, Dynamic Impedance, and Bandwidth.	**12**
Module – IV **Three-Phase AC Circuits:** Importance and use of a 3-phase network, types of 3-phase connections- Star and Delta, Line and Phase relations for Star and Delta connection, Phasor diagrams, Power relations, analysis of balanced and unbalanced 3-phase circuits, Measurement of Power in 3-phase star and delta network.	**6**
Module – V **Magnetic Circuits:** Introduction, Series-parallel magnetic circuits, Analysis of Linear and Non-linear magnetic circuits, Energy storage, A.C. excitation, Eddy currents and Hysteresis losses. **Coupled Circuits:** Dot rule, Self and mutual inductances, Coefficient of coupling, working of transformer.	**6**

TEXTBOOKS:

1. W. H. Hayt, Jr J. E. Kemmerly and S. M. Durbin, Engineering Circuit Analysis, 7th Edition TMH, 2010.
2. Hughes, Electrical Technology, Revised by McKenzie Smith, Pearson.
3. Fitzgerald and Higginbotham, Basic Electrical Engineering, McGraw Hill Inc, 1981

REFERENCE BOOKS:

1. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering, 3rd Edition, TMH, New Delhi, 2009.
2. Electrical Engineering Fundamental, Vincent Del Toro, Prentice Hall, New Delhi.
3. Rajendra Prasad, Fundamentals of Electrical Engineering, 2nd Edition, PHI, New Delhi, 2011.
4. Raymond A. DeCarlo, Prn-Min Lin, Linear Circuit Analysis Time Domain, Phasor and Laplace Transform Approaches, 2nd Edition, Oxford University, 2001
5. Abhijit Chakrabarti, Sudipta Nath, Chandan Kumar Chanda, Basic Electrical Engineering, Tata McGraw Hill Publication, 2009.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

1. Application of principles of magnetic circuits to electrical machines like transformers, generators and motors.
2. Field applications of three phase equipment and circuits in power system.
3. Applications of circuit theorems in electrical and electronics engineering

POS MET THROUGH GAPS IN THE SYLLABUS: 6, 4, 11

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

1. Concepts of electric, magnetic and electromagnetic fields.
2. 3 - Φ power generation, transmission, and distribution.
3. Power factor improvement for three phase systems.
4. Utility of reactive power for creation of electric and magnetic fields.

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: 3, 4, 6.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Quiz (s)	10
Mid Semester Examination	25
End Semester Examination	50
Assignment	10
Teacher Assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Self- learning such as use of NPTEL materials and internets
CD8	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**1**	**3**	**2**	**3**	**1**	**1**	**2**	**3**	**1**	**2**	**1**	**2**	
CO2	**3**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**3**	**1**	**2**	**3**	**3**	
CO3	**3**	**2**	**3**	**3**	**3**	**1**	**2**	**1**	**3**	**1**	**2**	**3**	**3**	
CO4	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**1**	**3**	**1**	**2**	**3**	**3**	
CO5	**3**	**2**	**1**	**1**	**3**	**1**	**2**	**1**	**3**	**1**	**2**	**3**	**3**	

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD5
CO2	CD1, CD2, CD4, CD5, CD7
CO3	CD1, CD2, CD5, CD7, CD8
CO4	CD1, CD2, CD5, CD7, CD8
CO5	CD1, CD2, CD4, CD5, CD7, CD8

COURSE INFORMATION SHEET

Course Code: PH24102

Course Title: Physics lab

Pre-requisite(s): Intermediate Physics

Co- requisite(s):

Credits: 1 L: 0 T: 0 P: 2

Class schedule per week: 2

Class: B.Tech.

Semester / Level: I

Branch: All

Name of Teacher:

COURSE OBJECTIVES

This course enables the students to:

1.	Understand the fundamentals of physical measurements and learn to account for inevitable errors in physical measurements.
2.	Understand and verify the basic principles of physics by hands-on experiments and making suitable measurements.
3.	Make electrical connections reliably to form functional circuits for measuring electrical quantities such as voltage, current, resistance, and resistivity
4.	Learn to set up different types of oscillating systems to study their characteristics, viz -a-viz resonant frequency, frequency response, phase relationship, bandwidth, and quality factor
5.	Develop an understanding of optical phenomena like dispersion, interference and diffraction and make measurements on the patterns produced to obtain physical quantities such as wavelength of light and refractive index of transparent materials.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Make reliable measurements and report results along with errors.
CO2	Wire simple electrical circuits for experimentally determining measurable electrical quantities.
CO3	Build electrical and mechanical oscillating systems, characterize them, and make measurements over them.
CO4	Construct setups to produce interference and diffraction patterns and make measurements for determining physical quantities.

SYLLABUS (List of experiments)

1. Error analysis in Physics Laboratory (CO: 1)
2. To determine the frequency of AC mains with the help of a sonometer. (CO:1, 2, 3)
3. To determine the resistance per unit length of a Carey Foster's bridge wire and resistivity of unknown wire. (CO:1, 2)
4. Measurement of electrical equivalent of heat (CO:1, 2)
5. To determine the wavelength of sodium lines by Newton's rings method (CO:1, 4)
6. To determine the frequency of tuning fork using Melde's Experiment (CO:1,3)
7. Measurement of voltage and frequency of a given signal using CRO (CO: 1,2, 3)
8. To determine the emf of a cell using stretched wire potentiometer (CO:1, 2)
9. Determination of refractive index of the material of a prism using spectrometer and sodium light (CO:1, 4)
10. To study the frequency response of a series LCR circuit (CO:1, 2, 3)
11. To study Lorentz force using Current balance (CO:1,2)
12. To study electromagnetic induction and verification of Faraday's laws. (CO:1,2,3)
13. To measure the wavelength of prominent spectral lines of mercury light by a plane transmission grating. (CO:1, 4)
14. To determine the Planck's constant using photocell and optical wavelength filters. (CO:1, 2)

REFERENCE MATERIALS:

Lab manuals (available on department website)

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizzes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	0	1	2	0	0	2	0	0	2			
CO2	2	1	0	1	2	0	0	2	0	0	2			
CO3	2	1	0	1	2	0	0	2	0	0	2			
CO4	2	1	0	1	2	0	0	2	0	0	2			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: CS24102

Course Title: Programming for Problem Solving Laboratory

Pre-requisite(s):

Co- requisite(s): Programming for Problem Solving (CS24101)

Credits: L: T: P:

Class schedule per week:

Class:

Semester / Level: Ist, 1

Branch: All

Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students:

1.	The basics of computer programming.
2.	Ideas about converting problem statements to programs.
3.	Ideas about handling data at scale.
4.	Knowledge about accessing the memory of a computer using code.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Write basic programs using fundamental control structures.
CO2	Demonstrate the accessing of arrays.
CO3	Write simple functions to modularize programs.
CO4	Work with user defined data types.
CO5	Access memory using pointers and manipulate data using them.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Programming using basic control structures including sequential programs, selection logic including nested selection logic switch structures.	3
Module – II Write programs using basic iterative structures, nested iterations, programs using looping with selections, controlled loop exit, Manipulating n-dimensional arrays.	3
Module – III Modularize programs using functions, functions calling functions, elementary string handling programs, recursive programs.	3
Module – IV Programs using user defined data types, arrays of user defined data types, basic usage of pointers, functions and pointers.	3
Module – V Advanced usage of pointers, string handling using pointers, parameterizing main, manipulating arrays using pointers.	3

TEXTBOOKS:

1) Programming in C, Yashwant Kanetkar, BPB Publications.

REFERENCE BOOKS:

1) C Programming, Byron Gottfried, Addison Wesley Press

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

1) Elementary file handling

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Laboratory Quiz	20
Laboratory Performance	30
Laboratory Viva	20
Continuous Evaluation	30

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	1	2			3	1					
CO2	3	3	2	1	2			3	1					
CO3	3	3	2	1	2			3	1					
CO4	3	3	2	1	2			3						
CO5	3	2	2	1	2			1						

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

COURSE INFORMATION SHEET

Course Code: EE 24102

Course Title: Electrical Engineering Laboratory

Pre-requisite(s): Physics, Fundamentals of Mathematics and Electrical Engineering.

Co- requisite(s):

Credits: 01 L: 0 T: 0 P: 2

Class schedule per week: 02

Class: B. Tech

Semester / Level: I (II)/1

Branch: EEE

Name of Teacher

Course Objectives

This course enables the students:

1.	To describe students' practical knowledge of active and passive elements and operation of measuring instruments
2.	To demonstrate electrical circuit fundamentals and their equivalent circuit models for both 1-φ and 3- φ circuits and use circuit theorems
3.	To establish voltage & current relationships with the help of phasors and correlate them to experimental results
4.	1. To conclude performance of 1 – Φ AC series circuits by resonance phenomena 2. To evaluate different power measurements for both 1-φ and 3- φ circuits

Course Outcomes

After the completion of this course, students will be able to:

CO1	classify active and passive elements, explain working and use of electrical components, different types of measuring instruments;
CO2	illustrate fundamentals of operation of DC circuits, 1-φ and 3- φ circuits and also correlate the principles of DC, AC 1-φ and 3- φ circuits to rotating machines like Induction motor and D.C machine
CO3	measure voltage, current, power, for DC and AC circuits and also represent them in phasor notations;
CO4	analyze response of a circuit and calculate unknown circuit parameters;
CO5	recommend and justify power factor improvement methods in order to save electrical

LIST OF EXPERIMENTS ***(The experiment list may vary to accommodate recent development in the field)***

EXPERIMENT – 1

Name: - Measurement of low and high resistance of a DC shunt motor

Aim: - (i) To measure low resistance of armature winding of DC shunt motor.

(ii) To measure high resistance of field winding of DC shunt motor.

EXPERIMENT – 2

Name: - AC RLC series circuit

Aim: - To obtain current and voltage distribution in AC RLC series circuit and draw the phasor diagram of voltage distribution.

EXPERIMENT – 3

Name: - Single phase power factor measurement by three voltmeter method

Aim: - To obtain power and power factor of the single-phase load using three voltmeter method and draw the phasor diagram.

EXPERIMENT – 4

Name: - AC RLC parallel circuit

Aim: - To obtain current and voltage distribution in a AC RLC parallel circuit and draw the current phasor diagram.

EXPERIMENT – 5

Name: - Single phase power factor measurement by three Ammeter method

Aim: -To obtain power and power factor of single-phase load using three ammeter method and draw the phasor diagram.

EXPERIMENT – 6

Name: -Study of resonance in a RLC series circuit

Aim: - To obtain the resonance condition in AC RLC series circuit and draw the phasor diagram.

EXPERIMENT – 7

Name: -Three phase Delta connection

Aim: - To obtain the relation between line and phase quantities in a three-phase Delta connected load and obtain the phasor diagram.

EXPERIMENT – 8

Name: - Three phase Star connection

Aim: -To obtain the relation between line and phase quantities in a three-phase Star connected load and draw the phasor diagram.

EXPERIMENT – 9

Name: - Measurement of three phase power by two wattmeter method.

Aim: - To measure the power input to a three-phase induction motor by two-wattmeter method and draw the phasor diagram.

EXPERIMENT – 10

Name: - Verification of superposition and Thevenin's Theorems.

Aim: - (i) To verify Thevenin's Theorem for a given circuit.

(ii) To verify Superposition Theorem for a given circuit.

Gaps in the syllabus (to meet Industry/Profession requirements)

1. Application of principles of magnetic circuits to electrical machines like transformers, generators and motors.
2. Visualize Phase sequence.

POs met through Gaps in the Syllabus: 1, 2, 4, 6.

Topics beyond syllabus/Advanced topics/Design

1. Assignment: Simulation of electrical circuits with dependent/independent sources by various techniques (Mesh current/Node Voltage/Thevenin's theorem/Norton's theorem/Maximum power transfer theorem etc.) using MATLAB/PSIM/C++ software.
2. Active/reactive power calculation for 3 – Φ circuits

POs met through Topics beyond syllabus/Advanced topics/Design: 3, 4, 5, 6.

Mapping lab experiment with Course Outcomes

Experiment	Course Outcomes				
	CO1	CO2	CO3	CO4	CO5
1	3	3	1	1	
2	3	3	3	3	3
3	3	3	3	3	3
4	3	3	3	3	3
5	3	3	3	3	3
6	3	3	3	3	
7	3	3	3	1	
8	3	3	3	1	1
9	3	3	3	2	2
10	3	3	2	2	

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	1	2	3	3	1	2	1	2	
CO2	3	2	3	2	3	1	2	3	3	1	2	3	3	
CO3	3	2	3	2	3	1	2	3	3	1	2	3	3	
CO4	3	2	3	2	3	1	2	3	3	1	2	3	3	
CO5	3	2	3	2	3	2	2	3	3	1	2	3	3	

Course Delivery methods	
CD1	Laboratory experiments/teaching aids
CD2	Mini projects/Projects
CD3	Tutorials/Assignments
CD4	Self- learning, such as the use of NPTEL materials and the internet

COURSEINFORMATIONSHEET

Course Code:EE24201

Course Title: Electrical Measurement and Instrumentation

Pre-requisite(s): Basic knowledge of Mathematics, Basic knowledge of Natural and Engineering Physics, Basic knowledge of Electrical circuits, Basic knowledge of Laplace transformation, Basic knowledge of digital electronics and communication.

Co- requisite(s):

Credits: 03 L: 3 T: 0 P:0
Class schedule per week: 03**Class:**
B. Tech

Semester/Level: III/2

Branch: EEE

Name of Teacher:

Course Objectives

This course enables the students:

1	To outline an idea of calibration, standards, different errors, static and dynamic characteristics of measurement system.
2	To explain the operating principle of different analog and digital instruments used for electrical parameter measurement.
3	To classify and outline the operation and construction of various AC and DC. Bridges for measurement and display devices.
4	To state the basic principle of commonly available transducers and their uses for measuring different electrical or non-electrical variables.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Identify and analyze errors and state the static and dynamic characteristics of instruments.
CO2	Explain the working of different analog instruments (PMMC, moving iron, electro dynamo meter type) and their use for measuring voltage, current, power, phase and Frequency.
CO3	Show how to balance and design different bridge networks to find the value of unknown components.
CO4	State the working of digital instruments, display devices and recorders.
CO5	Reproduce the different working principles of transducers and design transducers for measurement of non-electrical quantities.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction: Definition of measurement, Generalized input-output configuration of measuring instruments and instrumentation systems. Performance characteristics (static and dynamic), Accuracy, Precision, Types of error, Statistical analysis, Standards of measurement. Systems of units. Fundamental and derived units. Dimensions.	**5**
Module – II Instruments: Basic requirement of a measuring instrument. Introduction to D' Arsonval galvanometer, Construction and principle of Moving coil, Moving iron, Induction types of instruments, Measurement of voltage, current and power, phase, frequency, Range extension including current and potential transformers. Digital voltmeter, vector voltmeter, Vector Impedance meter and Q-meter.	**10**
Module – III Bridge: DC bridges for measurement of resistance Wheatstone bridges, Kelvin's double bridges and AC bridges for measurement of L, R, C& M, Maxwell's bridges, Anderson's bridges, Wien's bridges. Measurement of frequency, localization of cable fault.	**9**
Module – IV Oscilloscopes: CRT, Construction, Basic CRO circuits, Block diagram of a modern oscilloscope, Y- amplifiers, X-amplifiers, Triggering, Oscilloscopic measurement. Display Devices & Recorders: Digital display, LED, LCD, Strip chart recorder, X-Y recorder.	**10**
Module – V Transducers: Classification, Inductive, Resistive and Capacitive transducers, Analog and Digital Transducers with applications. Hall effect, Piezo Electric, Photovoltaic transducer. Measurement of temperature and pressure.	**6**

TEXTBOOKS:

1. Helfrick and Cooper -Modern Electronic Instrumentation and Measurement, Pearson Education, New Delhi.
2. Sawhney A.K. - Electrical & Electronic Measurement and Instrumentation, Dhanpat Rai & Son's

REFERENCEBOOKS:

1. Patranabis D–Sensorsand Transducers, Wheeler,1996.
2. Kalsi-Electronics Instrumentation, TMH Publication, New Delhi.
3. Deoblin–Measurement Systems.
4. Patranabis D–Principles of Industrial Instrumentation, TMH Publication, New Delhi, 1976.

5. Golding- Electrical Measurement, Wheeler Publication.

Gaps in the syllabus (to meet Industry/Profession requirements): Signal generators and signal analyzers, Data acquisition system.

POs met through Gaps in the Syllabus:1,2,3, 5,6,9,10,11.

Topics beyond syllabus/Advanced topics/Design: Process Measurement and Control

POs met through Topics beyond syllabus/Advanced topics/Design: 1,2,3,5,9,10,11.

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

2. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	1	0	1	3	1	3	3	2	1
CO2	3	2	2	1	3	1	0	1	3	1	3	3	1	1
CO3	3	2	2	2	3	1	0	1	3	1	3	3	2	1
CO4	3	3	2	2	3	2	0	1	3	1	3	3	1	1
CO5	3	3	2	3	3	2	1	2	3	1	3	3	2	1

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: EE24203

Course Title: Analog And Digital Circuits

Pre-requisite(s): Basic Electronics

Co- requisite(s): Circuit Theory, Basic electrical

Credits: 03 L: 3 T: 0 P:0

Class schedule per week: 03

Class: B. Tech

Semester/Level: III/2

Branch: EEE

Name of Teacher:

Course Objectives

1	Identify and describe the fundamental characteristics of electronic components such as diodes, BJTs, and FETs.
2	Explain the practical applications and functional roles of these components in electronic circuits.
3	Analyse the design and operational principles of various amplifier circuits.
4	Apply fundamental techniques for designing digital circuits and developing digital systems.
5	Evaluate different types of combinational and sequential logic circuits based on their performance and functionality.

Course Outcomes

Upon completion of the Course, the students will be able to:

CO1	Identify and describe the characteristics of various electronic components.
CO2	Explain the utilization and functional roles of these components in electronic circuits.
CO3	Analyse different operational amplifiers and small signal amplifier circuits using appropriate methods.
CO4	Apply the postulates of Boolean algebra to simplify combinational functions.
CO5	Design and evaluate combinational and sequential circuits for specific applications.

Syllabus:

MODULE	(NO. OF LECTURE HOURS)
Module – I PN JUNCTION DEVICES:PN junction diode –structure, operation and V-I characteristics, diffusion and transition capacitance Rectifiers – Half Wave and Full Wave Rectifier, – Display devices- LED, Laser diodes, Zener diode characteristics-Zener Reverse characteristics – Zener as regulator.	**8**
Module – II TRANSISTORS, JFET, MOSFET- structure, operation, characteristics and Biasing UJT, ANALOG AMPLIFIERS, Analysis of CE, CB, CC amplifiers- Gain and frequency response MOSFET small signal model– Analysis of CS and Source follower – Gain and frequency response- High frequency analysis, Sinusoidal Oscillators (RC, LC and Crystal), Multivibrators, The 555 timer. Operational Amplifiers: Op-Amp Basics, practical Op-Amp circuits, differential and Common mode operation, Inverting & Non-Inverting Amplifier, differential and cascade amplifier, Op-Amp applications.	**8**
Module – III FETs and Digital Circuits: FETs: JFET, V-I characteristics, MOSFET, low frequency CS and CD amplifiers, CS and CD amplifiers. Digital Circuits: Digital (binary) operations of a system, OR gate, AND gate, NOT, EXCLUSIVE OR gate, De Morgan Laws, NAND and NOR DTL gates, modified DTL gates, HTL and TTL gates, output stages, RTL and DCTL, CMOS, Comparison of logic families.	**8**
Module – IV Combinational Logic Circuits: Basic Theorems and Properties of Boolean Algebra, Canonical and Standard Forms, Digital Logic Gates, Karnaugh maps, two, three and four variable Karnaugh maps, simplification of expressions, Quine-McCluskey minimization technique, Product-of-Sums Simplification, Don't-Care Conditions, NAND and NOR Implementation, Exclusive-OR Function, Binary Adder-Subtractor, Decimal Adder, Binary Multiplier, Magnitude Comparator, Decoders, Encoders, Multiplexers.	**8**
Module – V Sequential Logic Circuits: Sequential Circuits, Storage Elements: Latches and flip flops, Analysis of Clocked Sequential Circuits, State Reduction and Assignment, Shift Registers, Ripple Counters, Synchronous Counters, Random-Access Memory, Read-Only Memory.	**8**

TEXTBOOKS:

1. Integrated Electronics: Analog and Digital Circuits and Systems, Jaccob Millman, Christos Halkias and Chethan D. Parikh, Tata McGraw-Hill Education, India.
2. Digital Design, 5/e, Morris Mano and Michael D. Cilette, Pearson.

REFERENCE BOOKS:

1. Electronic Devices and Circuits, Jimmy J Cathey, Schaum's outline series.
2. Digital Principles, 3/e, Roger L. Tokheim, Schaum's outline series.

Gaps in the syllabus (to meet Industry/Profession requirements): Simultaneous lab experiments, examination of digital IC datasheets to gain practical understanding

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

3. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	1	0	0	1	0	1	2	2	1
CO2	3	2	1	2	2	3	0	1	3	0	1	3	2	2
CO3	3	3	2	2	2	3	0	1	3	0	1	3	3	2
CO4	3	2	2	3	2	3	0	1	3	0	1	3	3	3
CO5	3	3	3	3	3	3	0	1	3	0	1	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD5, CD6
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD5, CD6, CD7
CO4	CD1, CD3
CO5	CD1, CD2, CD3. CD5, CD7

COURSE INFORMATION SHEET

Course Code: EE24253

Course Title: Engineering Electromagnetics

Pre-requisite(s):MA 24103 (Mathematics I), MA 24107 (Mathematics II)

Co- requisite(s): Vector analysis, Co-ordinate Geometry, Applied Mathematics

Credits: 04 L: 3 T: 1 P: 0

Class schedule per week: 04

Class: B. Tech

Semester/Level: III/2

Branch: EEE

Name of Teacher:

Course Objectives

The course objective is to provide students with an ability to:

A	Understand the basic laws dealing with Electrostatics and Magnetostatics. (It is covered in modules 1 and 2).
B	Derivation and Importance of Maxwell's equations in interpreting electromagnetic waves (It is covered in module 2).
C	Application of Maxwell's equations to describe wave behavior in various media (It is covered in modules 3, and 4)
D	To under reflection and refraction phenomena of electromagnetic waves (It is covered in module 4).
E	Design a simple antenna and evaluate its radiation efficiency (It is covered in module 5).

Course Outcomes

At the end of the course, the student will be able to:

CO1	Understand the basic laws of static electric fields & steady magnetic fields and along with time-varying Maxwell's equation in different forms (differential and integral).
CO2	Understand the importance of Poisson's equation in the determination of potential distribution and electric fields with respect to the boundary conditions.
CO3	Understand the boundary conditions to interpret the behavior of electric and magnetic fields at different media.
CO4	Examine the wave propagation phenomena in different media and its interfaces while associating its significance to the reflection and refraction of EM waves.
CO5	Evaluate the source of radiation: the antenna, its radiation patterns and different parameters.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Electrostatic and Magnetostatic Energy, Forces and Torques: Electrostatic energy: Electrostatic forces and torques in terms of stored electrostatic energy. Magnetic energy: Magnetic forces and torques in terms of stored magnetic energy.	**10**
Module – II Electrostatic Boundary-Value Problems: Introduction, Maxwell's Equation for static and time varying fields, Poisson's and Laplace's equations. Boundary conditions. Uniqueness theorem. Solution of one-dimensional Laplace's and Poisson's equations.	**10**
Module – III Plane Electromagnetic Waves: Wave equations. Helmholtz equations. Plane waves. Propagation of uniform plane waves in dielectric and conducting media. Polarization of plane waves.	**8**
Module – IV Reflection and Refraction of Plane Waves: Electromagnetic boundary conditions. Reflection of normally and obliquely incident plane waves from perfect conductor and dielectric. Total reflection. Total transmission.	**8**
Module – V Radiation and Antennas: Introduction. Scalar and vector potentials. Retarded potentials. Radiation from elemental electric dipole. Antenna pattern and antenna parameters. Thin linear antennas.	**8**

Textbook:

1. Cheng, D.K., "Field and Wave Electromagnetics", Pearson Education (Singapore) Pte. Ltd., 2nd Edn., 1989.
2. Hayt, W.H., J.A. Buck, "Engineering Electromagnetics", Tata Mc Graw Hill.

Reference Book:

1. Edward C. Jordan & Keith G. Balmain, "Electro-magnetic waves & Radiating System", PHI.
2. Deepak Sood, "Field & Wave, A Fundamental Approach", University Science Press.
3. S. C. Matapatra, Sudipta Mahapatra, "Principles of Electromagnetics", Tata McGraw Hill.
4. Matthew Sadiku, "Principles of Electromagnetics", Oxford University Press.

5. A. R. Harish, M. Sachidananda, "Antennas & Wave Propagation", Oxford University Press.

Gaps in the syllabus (to meet Industry/Profession requirements): Simulation based analysis of electromagnetic wave pattern.

POs met through Gaps in the Syllabus: 5

Topics beyond syllabus/Advanced topics/Design: Simulate Hertzian Dipole antenna.

POs met through Topics beyond syllabus/Advanced topics/Design: 5

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	0	0	1	0	1	1	1	1
CO2	3	2	1	2	2	1	0	0	1	0	1	1	1	1
CO3	3	2	1	2	2	1	0	0	1	0	1	1	1	1
CO4	3	2	2	3	2	1	0	1	2	1	3	1	2	1
CO5	3	2	3	3	2	1	0	1	3	1	3	1	2	1

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD3
CO2	CD1, CD3
CO3	CD1, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: EE24207

Course Title: Introduction to System Theory

Pre-requisite(s): Basic knowledge of Mechanics, Mathematics and Principles of Electrical Engineering

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: III/2

Branch: EEE

Name of Teacher:

Course Objectives

This course enables the students:

1	to outline the fundamentals of common signals, systems and recall interpret the list of electrical and non-electrical components
2	to summarize different transform methods, state-space techniques and different stability conditions of linear time-invariant system using Routh-Hurwitz criteria
3	to analyze the transient and steady-state performance of first order and second order systems when subjected to different standard signals and also the absolute stability using above criterion.
4	to actualize the electrical, mechanical, hydraulic and thermal systems using differential equations, transfer functions and state variables

Course Outcomes

After the completion of this course, students will be able to:

CO1	describe characteristics of different signals and systems
CO2	interpret the transform domains like Laplace equations, concept of poles and zeros, Fourier equations and time-domain state-space techniques
CO3	solve mathematical models of electrical and non-electrical components with the knowledge of system science, related mathematics of simple engineering problems and concept of analogous quantities.
CO4	relate Laplace equations, Fourier equations and time-domain state-space techniques to solve any given linear ordinary differential equations and analyze transient and steady-state performance of a first order and second order linear time-invariant system using standard test signals
CO5	evaluate and formulate electrical or non-electrical linear time invariant systems for desired transient behavior, steady state errors and stability

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction to signals and Systems: Definition, Basis of classification, Representation of common signals and their properties, system modeling, Analogous System: Introduction, D Alembert's Principle, Force – voltage and Force – Current analogies, Electrical analogue of mechanical, hydraulic and Thermal systems.	**7**
Module – II Fourier Transform Method: Introduction, Fourier Transform pair, Amplitude spectrum and phase spectrum of signals, Sinusoidal transfer function, Laplace Transform Method: Introduction, Laplace Transform pair, Laplace Transformation of common functions, Gate function, Step function and Impulse function, Laplace Theorems: shifting, initial value, final-value and convolution theorems. Inverse Laplace Transform by partial fraction expansion and convolution integral method.	**9**
Module – III System Analysis: System Analysis by Laplace Transform Method, System response, Natural, forced, transient and steady state responses, Transfer function and characteristic equation, Superposition integral, Concept of poles and zeros, Nature of system response from poles and zeros.	**8**
Module – IV System Stability: Concept of stability, Types, Necessary and sufficient conditions, Routh-Hurwitz stability criterion, Limitations and its applications to closed-loop systems.	**8**
Module – V State-Space Concept: Introduction, Definition: State, State variable, State vector and state space, State space representation, Derivation of State model from transfer function, Bush form and Diagonal canonical form of state model, non-uniqueness of state model, Derivation of transfer function from state model, Transition Matrix and its properties, Solution of time-invariant state equation.	**8**

Textbooks:

1. Analysis of Linear Systems – D.K. Cheng, Narosa Publishing House, Indian Student Edition.
2. Control System Engineering – Nagrath & Gopal, New Age International Pvt. Ltd., New Delhi, 2nd edition.

Reference Books:

1. Networks and Systems – D. Roy Choudhury, New Age International Pvt. Ltd., New Delhi, 2010.
2. Signals and Systems - Simon Haykin, Wiley 2nd Ed., 2002.
3. Linear Systems and Signals – B.P. Lathi, 2nd Ed., Oxford University Press, 2004.

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation

CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	1	0	0	1	0	0	2	3	1
CO2	3	2	1	1	3	0	0	0	3	0	1	2	3	1
CO3	3	3	2	1	3	1	0	0	3	0	2	2	2	0
CO4	3	3	3	2	3	1	0	0	3	0	2	2	3	2
CO5	3	3	3	3	3	1	0	0	3	0	2	2	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD7, CD3, CD6
CO2	CD1, CD2, CD7, CD6
CO3	CD1, CD2, CD7, CD6
CO4	CD1, CD2, CD7, CD6
CO5	CD1, CD2, CD3, CD6

COURSE INFORMATION SHEET

Course Code: EE24209

Course Title: Circuit Theory

Pre-requisite(s): Basic theorem of Principle of Electrical Engineering

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: II/2

Branch: EEE

Name of Teacher:

Course Objectives

This course enables the students to:

A.	list the properties and discuss the concepts of graph theory
B.	solve problem related to network theorems
C.	illustrate and outline the multi-terminal network in engineering
D.	select and design of filters

Course Outcomes

After the completion of this course, students will be able to:

CO 1.	solve problems related to DC and AC circuits
CO 2.	interpret network analysis techniques
CO 3.	determine response of circuits consisting of dependent sources
CO 4.	analyse linear and non-linear circuits
CO 5.	design the filters with help of Electrical element

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Network Topology: Definition and properties, Matrices of Graph, Network Equations & Solutions: Node and Mesh transformation; Generalized element; Source transformation; Formulation of network equations; Network with controlled sources; Transform networks; Properties of network matrices; Solution of equations; Linear time invariant networks; Evaluation of initial conditions; Frequency and impedance scaling.	**8**
Module – II Network Theorem: Substitution theorem, Tellegen's theorem, Reciprocity theorem for both DC and AC Circuits.	**5**
Module – III Multi-terminal Networks: Network function, transform networks, natural frequency (OCNF and SCNF); Two port parameters, Equivalent networks.	**9**
Module – IV Elements of Network Synthesis: Positive real function, Reactance functions, Foster 1, Foster 2, Cauer 1 and Cauer 2 Form Realizations (LC Network, RC Network, RL Network)	**9**
Module – V Approximation: Filter specifications; Butterworth approximation for filter order 1 and 2 (Low Pass filter); Chebyshev approximation; Frequency transformation for High Pass filter.	**8**

Textbooks:

1. V.K. Aatre, Network Theory & Filter Design, New Age International Pvt. Ltd., New Delhi.
2. M.S. Sukhija, T.K. Nagsarkar, Circuits and Networks, Oxford University Press, 2nd ed., New Delhi.

Reference Books:

1. M.E. Van Valkenberg, Introduction to Modern Network Synthesis, John Wiley & Sons (1 January 1966).
2. Balabanian, N. and T.A. Bickart, “Electric Network Theory”, John Wiley & Sons, New York, 1969.
3. C. L. Wadhwa, Network Analysis and Synthesis, New Age International Pvt. Ltd., New Delhi.

Gaps in the syllabus (to meet Industry/Profession requirements): Practical aspects and demonstration of electrical and non-electrical systems.

POs met through Gaps in the Syllabus:

Demonstrate appropriate inter-personal skills to function effectively as an individual, as a member or as a leader of a team and in a multi-disciplinary setting (PO9)

Be able to comprehend and write effective reports and design documentations; give and receive clear instructions; make effective presentations and communicate effectively and convincingly on complex engineering issues with the engineering community and with society at large. (PO10)

Be conscious of the financial aspects of all professional activities and shall be able to undertake projects with appropriate management control and control on cost and time. (PO11)

Recognize the need for continuous learning and will prepare himself/ herself appropriately for his/her all- round development throughout the professional career. (PO12)

Topics beyond syllabus/Advanced topics/Design:

Design of filter using operational amplifier.

POs met through Topics beyond syllabus/Advanced topics/Design:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects

CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	0	0	0	3	0	0	3	2	1
CO2	3	3	2	3	3	0	0	0	3	0	1	1	1	1
CO3	3	3	2	3	3	0	0	0	3	0	1	2	2	1
CO4	3	3	2	3	3	0	0	0	3	0	1	2	2	0
CO5	3	3	2	3	3	1	0	0	3	0	1	2	2	0

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1
CO2	CD1
CO3	CD1 and CD2
CO4	
CO5	

COURSE INFORMATION SHEET

Course Code: EE 24251

Course Title: DC Machines & Transformers

Pre-requisite(s): Basics of Electrical Engineering

Co- requisite(s):

Credits: 04 L: 3 T: 1 P: 0

Class schedule per week: 04

Class: B. Tech

Semester/Level: IV/2

Branch: EEE

Name of Teacher:

Course Objectives

This course enables the students:

A.	To comprehensively explore the basic principles of transformer and DC machines and analyze their steady-state behaviour.
B.	To examine the characteristics of static and dynamic DC machines
C.	A technique to draw armature winding of a DC machine and magnetic circuit of a transformer to evaluate their performance.
D.	Analyse the performance characteristics, speed control methods and testing techniques of DC machines

Course Outcomes

After the completion of this course, students will:

1.	Recall the fundamental principles, constructional features, classifications, and EMF equations of single-phase and three-phase transformers, as well as DC machines.
2.	Explain the working principles, different connections, characteristics, and performance aspects of transformers, DC generators, and DC motors.
3.	Apply standard testing methods (O.C., S.C., Sumpner's, brake test, etc.) to determine equivalent circuit parameters, efficiency, and voltage regulation of transformers and DC machines.
4.	Analyze the performance of transformers and DC machines under various operating conditions, including load sharing, armature reaction, commutation, and speed control of DC machines
5.	Evaluate the suitability and efficiency of different types of transformers and DC machines for specific industrial applications based on performance, economy, and operational characteristics

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I **Single Phase Transformers:** Introduction to the transformer, Basic Principle of operation, Classification, Rating, Construction of single phase transformer and Practical considerations, transformer winding, Ideal and physical transformers, EMF equation, transformation ratio, Phasor diagram, Performance analysis, Equivalent circuit, Losses and efficiency, Condition for maximum efficiency, Determination of equivalent circuit parameters by O.C. and S.C. tests, Per-unit calculation, Voltage regulation, all day efficiency.	**8**
Module – II **Three-Phase Transformer:** Advantage, Principle of operation, Connections of 3-phase transformer, Transformer vector grouping, Open delta connection, Three-phase to two-phase conversion (Scott connection) and six-phase conversion, three winding transformers, rating. OC & SC Test, Polarity test, Sumpner's back-to-back test. Parallel operation and Load sharing in single & three phase transformers. **Different types of transformers:** Autotransformer- construction, working, advantage & disadvantage and application. Introduction to Power transformers, Distribution transformers, Instrument transformers, Tap changing transformers, Pulse transformers, Welding Transformers, Transformer cooling, grounding, maintenance, and rating.	**8**
Module – III **Basic Concept of Rotating Machines:** Electromagnetism, Electromagnetic induction, Flux Linkage, Force on a conductor in a magnetic field & between two current-carrying conductors, statistically & dynamically induced EMF, Magnetomotive Force (MMF), principle of electromechanical energy conversion, Classification of Rotating Machines, Electromagnetic Torque, Constructional parts of DC machines and their function. Armature Winding, Ring Winding, Drum Winding, type of DC Machine Winding, Principle of DC Generator and its operation, EMF generated in DC Generator, Principle of DC Motor.	**8**
Module – IV **DC Generators:** Types of DC Machines, EMF equation, Losses in DC Generator, Power Stages, Efficiency, Condition for maximum efficiency, Armature reaction, Compensating winding, Inter-poles, Process of Commutation, Reactance Voltage, Methods of improving commutation, equaliser rings, Method of excitation, Characteristics of DC Generators- Magnetization, Process of voltage build-up of shunt generator, Internal and external characteristics, voltage regulation, Critical resistance and Critical speed, Parallel operation of DC generators, Applications of DC Generators.	**8**
Module – V **DC Motors:** Basic equation for voltage, Back EMF, Power, condition for maximum power, armature Torque, Rotational losses, and speed of DC Motors. Operating characteristics of DC Motors – speed –back emf & flux, Torque-current, Speed-current, and Torque-speed characteristics. Speed regulation, Speed control of DC motors, Starters for DC Motors, Electric Breaking. Testing of DC machines: Break	**8**

test, Swinburne's, Hopkinson's, and Series field tests, Retarding or Running Test. Calculation of efficiency. Applications for DC Motors, Special DC motors and Brushless DC Motor.	

Textbooks:

1. I. J. Nagrath, D.P. Kothari, Electric Machines, 4th Edition, TMH, New Delhi, 2014.
2. P. S. Bimbhra, Electrical Machines, Khanna Publishers, New Delhi, 7th Edition 2014.

Reference books:

1. A. E. Fitzgerald, Charles Kingsley, Stephen D. Umans; Electric Machinery, McGraw Hill Education (India) Pvt. Ltd, Noida, 6th Edition, 2003.
2. Alexander Suss Langsdorf; Theory of Alternating Current Machinery, McGraw-Hill, New York 1955.
3. Smarajit Ghosh, Electrical Machines; Pearson, New Delhi, 2nd Edition, 2012

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design: Design of Electrical Machines

POs met through Topics beyond syllabus/Advanced topics/Design: PO3

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars

CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	0	0	1	0	0	0	0	0	1	3	2	0
CO2	3	2	1	1	2	1	0	0	1	0	2	3	3	1
CO3	2	3	2	2	3	0	0	1	1	1	2	3	3	2
CO4	2	3	2	3	3	1	0	2	1	2	2	3	3	2
CO5	2	2	2	2	3	2	1	1	1	2	3	3	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1
CO2	CD1
CO3	CD1 and CD2
CO4	
CO5	

COURSE INFORMATION SHEET

Course Code: EE24253

Course Title: Digital Signal Processing

Pre-requisite(s): Fundamentals of transform methods, Signals and Systems, Filter theory.

Co- requisite(s):

Credits: 04 L: 3 T: 1 P: 0

Class schedule per week: 04

Class: B. Tech

Semester/Level: IV/2

Branch: EEE

Name of Teacher:

Course Objectives

This course enables the students to:

1	Compare different signals, systems, filters and DSP Processors and explain different properties of discrete time systems like folding, shifting, scaling, convolution etc.
2.	Construct different realization structures (Direct form I, II, Cascade, Parallel etc.) of LTI discrete time systems.
3.	Apply various techniques like Z-transform, DFT and FFT to determine transfer function and predict frequency response of discrete-time systems.
4.	Design digital IIR and FIR filters using filter approximation theory, frequency transformation techniques and window techniques and compare the response.
5.	Apply and discuss the use of DSP processors in processing of 1D and 2D signals for real-time applications.

Course Outcomes

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

CO1	Explain the concepts of different types of signals, systems, filters and DSP Processors and their properties.
CO2	Classify systems based on linearity, causality, shift-variance, stability criteria and construct different realization structures (Direct form I, II, Cascade, Parallel etc.) of LTI discrete time systems.
CO3	Evaluate system response of the system using convolution methods, frequency transformation technique, DFT, DIF-FFT or DIT-FFT algorithm, window techniques.
CO4	Design FIR and IIR filters for real time application and compare their response.
CO5	Apply and discuss the use of DSP processor in processing of 1D and 2D signals for real-time applications and recommend environmentally friendly solution.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction:** Classification of Discrete-time Signals and systems, Shanon's sampling theorem, Difference equation, Properties of discrete time system (linearity, time-variance), convolution, BIBO stability, Structure for realization of LTI discrete time systems, Direct form I&II, Cascade, Parallel.	**8**
Module – II **Frequency Domain Analysis:** Z-transform definition, region of convergence (ROC), Relationship between Laplace and Z-transforms. Discrete Time Fourier Transform (DTFT) and Discrete Fourier Transform (DFT), Periodic convolution, Direct evaluation of DFT, FFT algorithms- decimation in time and frequency, Relationship between Fourier and Z-transforms.	**10**
Module – III **Filter Function Approximations and Transformations.** Review of approximations of ideal analog filter response, Butterworth filter, Chebyshev Type I & II. Frequency Transformations: Frequency transformation in analog domain, frequency transformation in digital domain. Design of IIR Filter based on Impulse invariance method and Bilinear transformation.	**8**
Module – IV **Design of FIR Filters:** Characteristic of FIR filters with linear phase, Symmetric and antisymmetric FIR filters, Design of linear phase FIR filters using windows and frequency sampling methods, comparison of FIR and IIR filters.	**8**
Module – V **Application of DSP:** Introduction to DSP processors, Types of architectures, DSP support tools, code composer studio, compiler, assembler and linker, Introduction TMS320 C6x architecture, Digital signal processing application in the area of biomedical signal, speech, and image.	**6**

Textbooks:

2. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing, Principles, Algorithms and Applications, Third edition, Pearson International Edition.
3. Alan V. Oppenheim Ronald W. Schafer, Digital Signal Processing, PHI, India.

Reference Book:

1. S. Salivahanan C Gnanapriya, Digital Signal Processing, Tata McGraw Hill Education Private Limited.
2. Antonious, Digital Filter Design, Mc-Graw-Hill International Editions.

Gaps in the syllabus (to meet Industry/Profession requirements):

Examine different signal processing techniques such as STFT, Wavelet Transform etc. in real-time applications.

Implementation of 1D, 2D digital filters in many important applications such as image compression, video processing etc.

POs met through Gaps in the Syllabus: PO3, PO4, PO5, and PO6

Topics beyond syllabus/Advanced topics/Design: Adaptive Signal Processing, Image Processing, Application of TMS kit.

POs met through Topics beyond syllabus/Advanced topics/Design:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	0	2	0	1	0	0	1	2	3	2	1
CO2	3	3	2	2	2	0	1	0	0	1	2	2	3	1
CO3	3	3	2	3	3	0	1	0	0	1	2	2	3	2
CO4	3	3	3	3	3	0	2	0	0	1	2	2	3	2
CO5	3	2	3	2	3	2	3	2	2	2	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD5, CD6
CO3	CD1, CD2, CD3, CD5, CD6
CO4	CD1, CD2, CD3, CD5, CD6
CO5	CD1, CD2, CD3, CD6

COURSE INFORMATION SHEET

Course Code: EE24255

Course Title: Microprocessor and Embedded Systems

Pre-requisite(s): Analog and Digital Electronics

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: IV/2

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions to impart to students to:

1	Comprehend the basic functions, structure, concept and definition of embedded systems.
2	Interpret role of ATMEGA8 microcontroller, AVRATMEGA 328, ATMEGA 2560 Micro-controller in the development of embedded systems
3	Correlate different serial interfacing protocols (SPI, TWI, I2C, USART)
4	Understand interfacing of different peripherals (ADC, DAC, LCD, motors).
5	Evaluate design cost of any given embedded system application.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Explain basic building blocks of an embedded system.
CO2	Apply modern hardware/software tools for building prototypes of embedded systems.
CO3	Analyze the system performance in terms of accuracy and energy efficiency.
CO4	Evaluate computational and economic cost of complex real time applications.
CO5	Design embedded systems for real time control of complex engineering systems as per system specification, ensuring reliability, security and safety in order to carryout large scale projects of socio-economic importance.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Architecture of Microprocessors General definitions of minicomputers, microprocessors, microcontrollers, Introduction to 8085 Microprocessor, 8086 Architecture-Functional diagram. Register Organization, Memory Segmentation. Programming Model, Physical memory organization, Interrupts of 8086.	**8**
Module – II Architecture of Microcontrollers 8051 Microcontroller hardware- I/O pins, ports, Counters and Timers-Interrupts. 8051 Microcontroller Programming and Applications 8051 instruction set – Addressing modes – Brief introduction to assembly language instruction set.	**8**
Module – III Embedded Processors & Systems: AVRATMEGA8 Atmel AVRATMEGA 328, ATMEGA 2560, Micro-controller Introduction, Major features, Architecture, Application and programming, Timers/Counters, ADC, USART, SPI, TWI, Vectored Interrupts with emphasis on external interrupts.	**8**
Module – IV Peripherals and Interfacing: Adding Peripherals and Interfacing-Serial Peripherals and Interfacing-Serial Peripheral Interface (SPI) Inter Integrated Circuit (I2C), Adding a Real-Time Clock with I2C, Adding a Small Display with I2C Serial Ports-UARTs, RS-232C & RS-422, Infrared Communication, USB, Networks- RS-485, Controller Area Network (CAN), Ethernet Analog Sensors - Interfacing External ADC, Temperature Sensor, Light Sensor, Accelerometer, Pressure Sensors, Magnetic-Field Sensor, DAC.	**8**
Module – V Microcontroller applications in Motor speed control, power converter voltage and current regulation, power system protection, and process control.	**8**

Textbooks:

1. Catsoulis, John, "Designing Embedded Hardware", First/Second Edition, Shroff Publishers & Distributors Pvt. Ltd., New Delhi, India.

2. Vahid, Frank and Givargis, Tony, "Embedded System Design-A Unified hardware/Software Introduction", John Wiley & Sons, (Asia) Pvt Ltd., Replika Press Pvt., Delhi-110040.

3. Mazidi & Mazidi, "AVR Microcontrollers & Embedded Systems using Assembly & C Pearson Education

Reference books:

1. Stuart R. Ball, “Embedded Microprocessor Systems, Real World Design”, Second Edition, Newnes publication.

Gaps in the syllabus (to meet Industry/Profession requirements): Computation of algorithm complexity.

POs met through Gaps in the Syllabus: PO4

Topics beyond syllabus/Advanced topics/Design: Compute number of clock cycles required for UART and RS232 Communication

POs met through Topics beyond syllabus/Advanced topics/Design: PO4

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	2	2	1	1	1	3	2	1
CO2	3	3	3	3	3	3	2	2	2	2	1	3	2	2
CO3	3	3	3	3	3	3	3	3	2	2	2	3	3	2
CO4	3	3	3	3	3	3	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD3
CO2	CD1, CD2, CD5, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2. CD3
CO5	CD1, CD2, CD5, CD6

COURSE INFORMATION SHEET

Course Code: EE24257

Course Title: Electric Energy Generation and Control

Pre-requisite(s): Basic Electrical Engineering

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: IV/3

Branch: EEE

Name of Teacher:

Course Objectives

This course enables the students to:

A.	enumerate the load characteristics, energy generation scenario and understand the principle of operation of different types of power generation systems.
B.	relate the structure and principles of the controls related to electrical power generating stations.
C.	outline power generation from renewable energy sources and assess impact of such non-polluting energy conversion systems.
D.	compare salient features of different generating stations and substantiate sustainable and economic generation.

Course Outcomes

After the completion of this course, students will be able to:

CO1	understand the significance of load demand, load characteristics and the tariff desired for generation planning and expansion
CO2	recognize the significance of various components of the conventional power generation plants and explain the principle of their operation for bulk energy generation.
CO3	apply the basic knowledge of electric power generation as well as control related to real and reactive power for load-frequency and voltage control.
CO4	identify the operation of solar and wind-based energy generation needed for sustainable and exponential energy demand
CO5	contrast and choose non-conventional energy sources for sustainable energy generation.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Load Characteristics: Introduction, load, connected load, demand, demand interval, maximum demand, demand factor, average load, load factor, diversity factor, utilization factor, pant factor, loss factor, load curve, load duration curve, tariff: Introduction, different types of tariffs, interconnection of power systems.	**8**
Module – II Thermal Stations: Operating principle and cycle, Selection of site for a thermal station, layout, main components, boiler, economizer, air preheater, super heater, reheater, condenser, feed heater, cooling powers, FD and ID fans, Coal handling plant, water treatment plant, Ash handling plant, Types of boilers and their characteristics, Steam turbines, and their characteristics, governing system for thermal stations.	**8**
Module – III Hydro Electric Stations: Selection of sites, layout, classification of hydro plants, general arrangement and operation of a hydro-plant, governing system for hydel plant, types of turbines, micro-hydel and pump-storage hydel power plant.	**6**
Module – IV Solar Energy and Wind Energy: Solar Radiation, its computation and measurement; principles of PV energy conversion, PV cell, module, array, I-V and P-V characteristics, efficiency; effect of temperature, fill factor, inter connections of solar cells: Identical and Non-identical cells in series and parallel, Interconnecting PV modules. Energy from the wind; Basic laws and concept of aerodynamics, types of wind turbines; Performance and efficiency of wind machines.	**10**
Module – V Introduction to additional conventional and non-conventional sources: Nuclear power stations, diesel generation, Tidal and Wave Energy, Geothermal Energy, Bio-Energy, Chemical Energy.	**6**

TEXTBOOKS

1. Power Plant Engineering - PK Nag TMH publications, 2nd Edition.
2. A Textbook on Power System Engg. – A Chakravarti, ML Soni, PV Gupta and U.S. Bhatnagar, Dhanpat Rai & Co., New Delhi, 2nd Edition.

REFERENCE BOOKS

1. Elements of Electrical Power Station Design-MV Deshpande, Pitman and Sons Ltd.
2. Electric Power Generation, Transmission and Distribution - S.M. Singh, Prentice Hall of India, Delhi.
3. Generation, Distribution and Utilization of Electrical Power – C.L. Wadhwa, New Age Publications.

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

3. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	0	1	2	0	0	0	1	2	2	1
CO2	3	3	2	2	1	0	1	1	0	0	1	3	2	1
CO3	3	3	3	2	2	1	2	2	1	0	1	3	3	2
CO4	2	2	2	1	2	2	3	1	1	1	2	2	2	2
CO5	2	2	2	1	1	2	3	1	1	1	2	2	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: EE24301

Course Title: AC Rotating Machines

Pre-requisite(s): Principle of Electrical Engineering and DC Machines and Transformer

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: V/3

Branch: EEE

Name of Teacher:

Course Objectives

This course enables the students:

1.	the basic principles of operation of ac dynamic machines and analyze their steady – state behaviour;
2.	examination and discrimination of characteristics of ac rotating machines;
3.	a technique to draw winding diagram and circle diagram to validate performance of an Induction motor;
4.	knowledge to design and recommend high performance machines for applications in industries, homes and offices

Course Outcomes

After the completion of this course, students will be able to:

CO1	**Explain and analyze** the construction, working principles, and excitation systems of **synchronous generators**, including cylindrical and salient pole rotors.
CO2	**Evaluate and interpret** the performance characteristics of synchronous generators, including **voltage regulation, armature reaction, and synchronization** with infinite bus bars.
CO3	**Examine and model** the operational principles, phasor behavior, and performance characteristics of **synchronous motors**, including the impact of excitation control on power factor and efficiency.
CO4	**Investigate and compare** the operational characteristics, equivalent circuit models, and performance parameters of **three-phase and single-phase induction motors**, including starting methods, torque-speed behavior, and efficiency considerations under different load conditions.
CO5	**Apply** theoretical and experimental techniques to select, specify, and evaluate AC machines for industrial, commercial, and residential applications.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Basic Concept of A.C. Rotating Machines:** Introduction to Armature winding, Integral slot and fractional slot winding, Distribution factor (Kd), Pitch factor (Kp) and winding factor (Kw). Production of rotating magnetic field, EMF and torque equations, Effect of tooth harmonics and methods of reduction.	**4**
Module – II **Synchronous Machines:** **Synchronous Generator:** Construction, Cylindrical rotor and salient pole rotor, Principle of operation, Excitation system, Effect of winding factor on EMF, Armature reaction, Circuit model, Phasor diagram, O.C. and S.C. tests, Short-circuit ratio, Determination of voltage regulation by synchronous impedance, MMF and zero power factor methods. **Performance Characteristics of Synchronous Generator:** Two reaction theory, Phasor diagram, Power-angle characteristic of synchronous generators, Synchronizing power and torque, Synchronizing methods, Parallel operation of synchronous generator, Effect of change in excitation and mechanical power input on load sharing, Operation of alternator on infinite bus bars, Slip test.	**18**
Module – III **Synchronous Motor:** Construction, Principle of operation, Equivalent circuit, Phasor diagram, Circuit model, Effect of change in excitation on armature current and power factor, Starting of synchronous motor, Synchronous condenser, Hunting, Applications.	**5**
Module – IV **3-ϕ Induction Motor:** Introduction, Construction, Principle of operation, Slip and rotor frequency, Comparison with transformer, Equivalent circuit model, Representation of mechanical load, No load and blocked rotor tests. Torque and power output, Losses and efficiency, Separation of losses. **Performance Characteristics of 3-phase Induction Motor:** Circle Diagram, Torque-slip characteristics, Effect of rotor resistance, Starting torque and maximum torque, Starting and speed control methods, Cogging and crawling, Introduction to induction generator, Applications.	**14**
Module – V **Single-phase Induction Motor:** Introduction, Double revolving field theory, Crossfield theory, Torque-speed characteristic, Equivalent circuit model, Starting methods, Applications.	**5**

Textbooks:

1. D.P.Kothari and I.J.Nagrath; Electric Machines, TMH New Delhi, 4th Edition, 2010

Reference books:

1. A.E. Fitzraul, Charles Kinsley, Stephen D. Umansd ; Electric Machinery, McGraw Hill Education (India) Pvt. Ltd., Noida, Indian 6th Edition 2003
2. E.H. Langsdrof; Theory of Alternating Current Machinery, McGraw-Hill New York 1955.

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	0	1	1	0	0	1	3	2	1
CO2	3	3	2	2	2	0	1	1	0	0	1	3	3	1
CO3	3	3	3	2	2	1	1	1	0	0	1	3	3	2
CO4	3	3	2	2	2	1	1	1	0	0	1	3	3	2
CO5	3	3	3	2	2	1	2	1	1	1	2	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4
CO5	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course Code: EE24303

Course Title: Control Theory

Pre-requisite(s): Applied Mathematics, Introduction to System Theory

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: V/3

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions to impart to students to:

A.	State and explain the basic concepts of control systems and its components and develop the mathematical model of a system Block Diagram and signal flow graph various methods to represent a system.
B.	Classify different types of control systems and basic control actions.
C.	Solve different control problems and construct root locus, Bode plot and Nyquist plots for different systems.
D.	Analyze and interpret the stability of control systems using time and frequency domain techniques.
E.	Design suitable controller and compensator for different industrial applications.

Course Outcomes

After the completion of this course, students will be able to:

CO1.	Develop a closed loop system and represent system in terms of block diagram, signal flowgraph, state diagrams and state model.
CO2.	Apply techniques such as root locus, Bode plot and Nyquist plot for a system.
CO3.	Solve problems and analyze performance and stability of system using time and frequency domain techniques.
CO4.	Employ time and frequency domain approaches to analyze and evaluate the stability of control systems.
CO5.	Develop a controller and compensator that are adequate for various industrial applications.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction: Examples of control systems and applications, Basic components of control systems, Open-loop and closed-loop control systems, Effect of feedback, Classification of the control system. Linearization of non-linear systems using Taylors series. Modeling. Block-diagrams representation of control systems, Block diagram reduction, Signal Flow Graph (SFG)- Basic properties of SFG, SFG algebra, Gain formula to SGP, Application of gain formula to block diagrams.	**8**
Module – II Time Domain Analysis of Control Systems: Transient and steady-state response, Time response specifications, Typical test signals, Steady-state error, and error constant, Stability-Absolute, relative and conditional stability, Dominant poles of a transfer function, Root locus concept, Properties and construction of root locus, Determination of relative stability from root locus, Root sensitivity to parameter variation, Root contours, Systems with transportation lag and effect of adding poles or zeros.	**8**
Module – III Frequency Domain Analysis of Control Systems: Frequency response specifications, Correlation between time and frequency domain, bode plot, Determination of stability using Bode plot, Nyquist stability criterion, Nyquist Plot, Polar Plot, Theory of Magnitude phase plot, Constant M, constant N-circle and Nichols chart.	**8**
Module – IV Control System Components: Sensors and encoders in control system, Potentiometer, Tachometers, incremental encoders, Synchros, Operational Amplifiers.	**6**
Module – V Basic control actions: on-off control, P, PI, PD and PID. Introduction to design, lead, lag, and lead-lag compensation in the time domain with the root locus concept.	**8**

Textbooks:

1. J. Nagrath & Gopal, "Control Systems Engineering", 4th Edition New Age International Publication.
2. K. Ogata, "Modern Control Engineering",3rd Edition, Pearson Education.

Reference books:

1. Norman Nise, "Control System Engineering, 4th Edition, Wiley.
2. Graham C. Goodwin, "Control System Design", PHI.
3. B. C. Kuo, "Automatic Control System", 7th Edition, PHI

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	0	0	0	1	1	1	3	2	1
CO2	3	2	2	3	3	0	0	0	0	1	2	3	3	1
CO3	3	3	2	3	2	0	0	0	0	1	2	3	3	1
CO4	3	2	3	3	2	0	0	0	0	1	2	3	3	1
CO5	3	2	3	3	3	0	0	0	1	2	2	3	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD3, CD6
CO3	CD1, CD2, CD5, CD6
CO4	CD1, CD2, CD5, CD6
CO5	CD1, CD2, CD5, CD6, CD7

COURSE INFORMATION SHEET

Course Code: EE24305

Course Title: Power Electronics

Pre-requisite(s): Analog Electronics, Digital Electronics

Co- requisite(s): Semiconductor devices, Frequency analysis

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: V/3

Branch: EEE

Name of Teacher:

Course Objectives

The course objective is to provide students with an ability to:

A.	Describe various type of high-power switches and their switching technique.
B.	Explain operating principle of power electronic converters with voltage and current waveforms and illustrate their applications in electrical technology.
C.	Apply different converters for energy management
D.	Analysis and performance evaluation of power electronics-based technology.
E.	Planning and design procedure for a power electronics-based system.

Course Outcomes

At the end of the course, the student will be able to:

CO1.	List different types of high-power semiconductor switches and interpret their operating characteristics.
CO2.	Classify various kinds of power converters. Explain the working principle of power converters. Solve problems of voltage regulation with the help of power converters.
CO3.	Analysis of power electronic converters using time domain and frequency domain techniques in order to Identify design parameters and controller parameters for high-performance converters.
CO4.	Estimate the cost and long-term impact of power-based installations.
CO5.	Develop new power converters and plan to design a large-scale power processing unit. Play the role of a dynamic leader or supporter in a team of skilled professionals by engaging in continuous learning and upskilling.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Scope of power electronics, Overview of high-power semiconductor switches, Dynamic and static characteristics of MOSFET, IGBT and GTO, power diodes, and diode circuits.	**10**
Module – II Operating principle of thyristor, Dynamic characteristics of SCR, Gate characteristics, series and parallel operation of SCR, two transistor analogy of SCR, Rating and protection of SCR, SCR Triggering circuit, and commutation circuits.	**10**
Module – III Single phase controlled, Half-wave, Full-wave rectifier with R, RL and RLE loads, Single phase semi-converter, Effect of Source impedance, Performance evaluation of converter using Fourier series analysis, Three phase uncontrolled rectifier with resistive load, Three phase half wave, Full wave controlled rectifiers with R-load, R-L Load, 3-phase semi-converter, RMS, Average value, Fourier analysis, THD, HF and PF of converter.	**10**
Module – IV Chopper, Introduction, Principle of operation, Control strategies, Step-up and step-down chopper, Chopper configuration, Type A, B, C, D & E chopper working principle.	**7**
Module – V Single phase inverter, VSI and CSI, Analysis with R, and RL loads, 180o and 120o mode of operation of 3-phase VSI, SPM, MPM and Sinusoidal PWM techniques, Series inverters, Overview of Electric drive.	**8**

Textbook:

1. M.D. Singh, K. B. Khanchandani, Power Electronics, TMH, New Delhi 2008.
2. P. S. Bimbhra, Power Electronics, Khanna Publications, 5th Edition, New Delhi, 2012.

Reference Book:

1. M.H. Rashid, Power Electronics: Circuits, Device and Applications, 2nd Edn, PHI, New Jersey, 2003.
2. Mohan, Underland, Robbins; Power Electronics Converters, Applications and Design, 3rd Edn. 2003, John Wiley & Sons.
3. R.S. Ramshaw, Power Electronics Semiconductor Switches, Chapman & Hall 2nd Edition, 1993, Chennai.

Gaps in the syllabus (to meet Industry/Profession requirements): Role of converters for renewable energy integration

POs met through Gaps in the Syllabus: PO5

Topics beyond syllabus/Advanced topics/Design: Simulation of grid connected SPV system

POs met through Topics beyond syllabus/Advanced topics/Design: PO5

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	2	2	1	1	1	3	2	1
CO2	3	3	3	3	3	3	2	2	2	2	1	3	2	2
CO3	3	3	3	3	3	3	3	3	2	2	2	3	3	2
CO4	3	3	3	3	3	3	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD5, CD6
CO4	CD1, CD2, CD3
CO5	CD1, CD5, CD6

COURSE INFORMATION SHEET

Course Code: EE24307

Course Title: Electrical Power Transmission and Distribution

Pre-requisite(s):EE101 Basics of Electrical Engineering

Co- requisite(s):PH113 Physics

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: V/3

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions imparting the following objectives to students:

A.	To interpret overhead transmission lines by resistance, inductance and capacitance considering single phase, three phase single circuit, and double circuit line.
B.	To represent transmission and distribution lines by transmission line constants and to conceptualise the design of transmission and distribution systems in line with enhancing transmission line efficiency and voltage regulation.
C.	To depict the mechanical design concepts like effective sag and insulator string efficiency.
D.	To infer the parameters of the underground cable and different issues like electrostatic stress, resistance and capacitance. line charging current.
E.	To interpret voltage and current distribution for different types of distribution networks and the effect of reactive power injection on voltage improvements

Course Outcomes

After the completion of this course, students will be able to:

CO1.	Evaluate the different electrical parameters of the different types of overhead conductors, such as solid conductors, stranded conductors of single phase, three phase single circuits, and double circuit lines.
CO2.	Select the proper voltage and size of the transmission line conductor following the proper mathematical equations of voltage and power in the context of voltage regulation, efficiency, corona etc..
CO3.	Explain the core concept involving the mechanical design of lines to keep effective sag considering the working tension at pole ends, conductor weight, effect of wind velocity and ice loading, and number of insulators in the context of string efficiency.
CO4.	Understand the effect of electrostatic stress, resistance, and capacitance in underground cable design.
CO5.	Apply the understanding in designing distribution systems in the context of satisfying voltage constraints.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction and Overhead Transmission Line Introduction: Structure of a power system, Effect of transmission voltage, Over-Head Transmission Line: Types of conductors, bundle conductor, resistance calculation, skin effect, inductance and capacitance of overhead lines single phase and three phase single circuit and double circuit lines, Transposition and its effects, corona effect.	**9**
Module – II Mechanical design of transmission line: Types of Overhead line insulators, potential distribution over a string of suspension insulators, methods of enhancing string efficiency Sag: Sag tension, length calculation, effect of wind and ice loading.	**8**
Module – III Characteristics and Performance of transmission line: Representation of short, medium and long transmission lines, Transmission Line Constants, Voltage regulation, Ferranti effect, SIL, Power flow in terms of line constants, Design of Transmission Line.	**7**
Module – IV Underground cable: Overhead lines Versus Underground Cable, Types of cables and insulators, electrostatic stresses, grading of cables, Insulation resistance, capacitance of 3-phase cable, heating of cable, Dielectric Loss.	**7**
Module – V Distribution Systems: Feeders, distributors, service mains, redial and ring main system, different types of DC and AC distribution systems, calculation, Design of a radial distribution system, Voltage control: Dependency on reactive power, method of reactive power injection at load end.	**6**

Textbooks:

1. Power System Analysis – Hadi Saadat, Tata McGraw-Hill Edition.
2. Power System Engineering – A. Chakrabarti, M. L. Soni, P. V. Gupta, U. S. Bhatnagar.

Reference Books:

1. Modern Power System Analysis – D. P. Kothari, I. J. Nagrath, Tata-McGraw Hill.
2. Electric Energy Systems Theory - An Introduction – O. I. Elgerd, TMH Edition.
3. Electric Power System – C. L. Wadhwa, New Age International Publishing.
4. Principles of Power System - V.K.Mehta and Rohit Mehta, S.Chand

Gaps in the syllabus (to meet Industry/Profession requirements): More examples

from practical network for more complex design problem.

POs met through Gaps in the Syllabus: PO3, PO4, PO5

Topics beyond syllabus/Advanced topics/Design: Transmission Line Design Problem, Power Circle Diagram, Basics of FACT devices

POs met through Topics beyond syllabus/Advanced topics/Design: PO3, PO4, PO5

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	1	1	1	0	0	1	1	1	2	3	1
CO2	3	2	3	2	2	2	1	0	1	2	1	3	3	2
CO3	3	1	1	1	1	1	1	0	1	1	1	2	2	1
CO4	3	1	1	1	1	1	1	0	1	1	1	2	1	1
CO5	3	2	2	1	1	2	1	0	1	2	1	2	2	1

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD4
CO2	
CO3	CD1, CD2, CD4
CO4	CD1, CD2, CD4
CO5	CD1, CD2, CD4

COURSE INFORMATION SHEET

Course Code: EE24351

Course Title: Power System Analysis

Pre-requisite(s): Basics of Electrical Engineering, Electrical Power System Transmission and distribution

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VI/3

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions imparting the following objectives to the students:

A.	To describe power system by single line, impedance and reactance diagrams;
B.	To explain steady state operation of large-scale power systems and analyze power flow problems using numerical methods;
C.	To demonstrate the voltage and current condition of power systems under symmetrical fault conditions
D.	To understand the representation of sequential network and apply Thevenin Equivalent technique to evaluate the currents and voltages at unsymmetrical fault condition.
E.	To Formulate and analyze the dynamics of power systems for small and large disturbances and to identify the methods for enhancing the power system stability.

Course Outcomes

After the completion of this course, students will be able to:

CO1.	outline per unit representation of power system and explain with suitable examples;
CO2.	apply different methodologies to solve load flow problems and evaluate their efficacies;
CO3.	understand the consequences for short circuit events in power systems and solve the short circuit current and voltages under symmetrical fault.
CO4.	construct different sequence networks and solve the short circuit current and voltages under unsymmetrical faults
CO5.	solve different types of power system stability problems and recommend commensurate remedial measures;

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction:** Power System Components and their representation: Components representation, Single Line diagram, Per unit system representation, advantages of Per unit system, Transformer effect in per unit system, Reactance diagram, Impedance diagram.	**8**
Module – II **Load flow Analysis:** Load flow problem, Different types of buses, Y_{bus} formulation, Derivation of load flow equations, Solution technique using Gauss- Siedel and NR method for Load Flow Problems, Sparsity and Gaussian Elimination Technique.	**10**
Module – III **Symmetrical Short Circuits Analysis:** Short circuit of a Synchronous machine on no load, short-circuit of loaded synchronous machine, Thevenin's equivalent and Z-Bus formulation Technique.	**6**
Module – IV **Symmetrical Components:** Transformation, Phase shift in star-delta transformer, Sequence impedance and sequence networks of transmission line, Synchronous machine, Transformer and load. **Unsymmetrical Short Circuits:** Symmetrical component analysis of unsymmetrical short circuits, Single line to ground fault, Double line to ground fault and line to line fault.	**10**
Module – V Power system stability problem, Swing equation, System response to small disturbances, Power angle equation and diagram, Transient stability, Equal area criterion, Measures for improving transient stability.	**6**

Textbooks:

1. Electric Energy Systems Theory - an Introduction by Olle I. Elgerd; McGraw Hill Education.
2. Power System Analysis by Grainger and Stevenson; Tata McGraw Hill, NewDelhi

Reference Books:

1. Modern Power System Analysis by Nagrath – Kothari, McGraw Hill Education, New-Delhi,2003.
2. Electrical Power Systems by C. L. Wadhwa, New Age International, 2005

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1	3	1	0	1	3	0	2	2	1	2
CO2	3	3	3	2	3	3	1	1	3	1	2	1	1	3
CO3	3	3	3	2	2	3	2	1	3	1	3	1	1	3
CO4	3	3	3	3	2	3	1	1	3	1	3	1	2	3
CO5	3	3	3	3	2	3	2	1	3	1	3	2	2	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2

COURSE INFORMATION SHEET

Course Code: EE24353

Course Title: Electric Drives

Pre-requisite(s): Principles of Electrical Engineering, Electrical Machines, Power Electronics

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VI/4

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions to impart to students to:

A.	Explain the components of an electric drive system and understand their functions;
B.	Describe the dynamics of an electromechanical system
C.	Choose an appropriate electric drive as per the application and requirements;
D.	Select a proper size of the motor as per the load requirements and develop the closed loop control and asses the performance of the drive in terms of stability, capabilities of regeneration and flexibility in control.
E.	Performance evaluation, planning and design procedure for a complex power electronics based drives system.

Course Outcomes

After the completion of this course, students will be able to:

CO1.	Define performance parameters of various types of electric drives system
CO2.	Apply mathematical modelling technique to develop dynamic model of electric drives system
CO3.	Analyze stability, reliability to enhance time domain dynamic performance parameter of a electric drive for specific applications.
CO4.	Evaluate cost effectiveness, energy efficiency and performance merit of electric drive system in order to plan and execute industrial projects of large scale and socio-economic importance.
CO5.	Design an innovative electric drive systems using state of art technology with a focus on building a career specializing in the field of electric drive and recognize the need of continuous learning and to have motivation for playing lead role in a team of technical experts from interdisciplinary fields.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Electrical Drives: An Introduction, Parts of Electrical Drives; ac and dc Drives, fundamental torque equations, Speed torque conventions and multi-quadrant operation; calculation of equivalent drive parameters, Different load torques and their nature; steady state stability; load equalization.	**6**
Module – II Selection of Motor rating and its control: Introduction, thermal model of a motor, Classes of Motor Duty cycle, selection of motor and its rating, Closed-loop and open loop control of drives, Modes of Operation; speed control & Drive classifications; closed - loop control of Drives; speed and current sensing; manual, semi-automatic & automatic control.	**6**
Module – III D.C. Motor Drives: Introduction, Performance characteristics of DC Motors & their Modifications; Starting of DC motors & their Design, Electric Braking; Speed Control of DC motor; Converter controlled DC Drives; Single phase converter drives, three phase converter drives, Dual converter drives, Chopper controlled dc drives, Closed loop control of dc motor, selection of components and their specifications for Dc drives.	**6**
Module – IV **Phase Controlled Induction Motor Drives:** Introduction, Speed-torque characteristics, Starting & Braking of IM; effects of unbalancing and harmonics on IM, Speed Control techniques, Stator voltage control, Closed Loop schemes for phase-controlled IM drives, Rotor resistance control, Slip speed control, Slip power recovery schemes. Frequency Controlled Induction Motor Drives: Scalar control, Variable frequency control, constant volts/Hz control, Voltage source inverter (VSI) control using PWM techniques, Closed Loop speed control of VSI drives, Control from a current source Inverter (CSI), Closed Loop speed control of CSI drives, Comparison of CSI and VSI drives. Selection of components and their specification for AC drives.	**12**
Module – V **Synchronous Motor Drives**: Starting, Pull-in and Braking with Fixed Frequency Supply; Variable Speed Drives, Modelling and control of PMAC machine, Close loop speed control of Synchronous Machines.	**5**

Textbooks:

1. G.K. Dubey, Fundamentals of Electrical Drives, Narosa publication, New Delhi.
2. R. Krishnan, Electric Motor Drives-modeling, analysis and control.

Reference Books:

1. S.K.Bhattacharya & Brijinder Singh, Control of Electrical Machines.

2. Mukhtar Ahmad, Industrial Drives and Control.
3. S.K.Pillai, A first course on Electrical Drives.
4. M. Chilikin, Electric Drives.
5. C. L. Wadhwa, Generation, Distribution and Utilization of Electrical energy

Gaps in the syllabus (to meet Industry/Profession requirements): Simultaneous lab experiments should be in the same semester.

POs met through Gaps in the Syllabus: PO3, PO4

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	0	2	0	1	0	0	0	0	3	2	0
CO2	3	3	2	3	2	0	0	0	0	0	0	2	3	1
CO3	2	3	2	3	2	2	1	0	0	0	0	2	3	1
CO4	2	2	3	2	3	2	3	1	1	1	2	1	2	3
CO5	2	2	3	2	3	2	2	2	3	3	3	2	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD6, CD7

COURSE INFORMATION SHEET

Course Code: EE24401

Course Title: Switchgear and Protection

Pre-requisite(s): Knowledge in Electrical Machines, Power Transmission and Distribution, Measurement and Instrumentation, Analysis of Power System.

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VI/4

Branch: EEE

Name of Teacher:

Course Objectives

A.	Outline the importance of power system protection and significance of protective components.
B.	Impart information and knowledge of construction, operating principle, and types of protection relays and circuit breakers.
C.	Explain the protection schemes of different components of power system, like generator, transmission line, transformers, motors, feeders, and busbar.
D.	Giving knowledge of advance protective devices and protection schemes, like numeric and static relays, DC circuit breaker, wide-area measurement and system integrity protection scheme.

Course Outcomes

After the completion of this course, students will be able to:

CO1.	List and define protection schemes and protective devices applicable to power system network.
CO2.	Describe the construction and operating principle of relays and circuit breakers.
CO3.	Illustrate the unit and non-unit types of protection scheme.
CO4.	Use/apply the protection schemes for protection of power system components.
CO5.	Recommend protection scheme for a power system network.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction to power system protection and protective relaying Overview of Power System Protection - Need for Power System Protection, types of Protection, primary and Back-Up Protection, protection zones, Components of Protection System. Protective Relaying: Concept of protection relay. Electromechanical and Electromagnetic relaying – construction, operating principle of over current relay, directional relay, differential relay, distance relays. Static relaying, and microprocessor based numeric relaying – components, construction and operating principle, application to over-current, directional, differential and distance protection. Advantages, limitations of numeric relaying over electromagnetic and static relay.	**10**
Module – II Unit Protection Generator Protection: using electromagnetic relay and digital relay: Protection against stator and rotor faults and abnormal operating conditions such as unbalanced loading, loss of excitation, over speeding. Motor Protection: Introduction, Protection against phase fault, ground fault and abnormal operating conditions. Transformer Protection: using electromagnetic relay and digital relay: Types of faults, over current protection, Differential protection, Differential relay with harmonic restraint, Protection against high resistance ground faults, Inter-turn faults, Buchholz relay.	**8**
Module – III Feeder, Transmission Line and Bus-bar Protection Transmission Line and Feeder Protection: Application of over current protection, directional protection, distance protection (Impedance relay, Reactance relay, MHO relay) using electro-magnetic and numeric relays, carrier-aided protection. Bus-bar Protection Schemes: Differential Protection with Overcurrent Relays, protection with Percentage Restrained Differential Relays, Bus High Impedance Voltage Differential Protection..	**8**
Module – IV Introduction to PMU, WAMS and SIPS Introduction to Phasor measurement units (PMUs), Phasor Estimation and Frequency Estimation in Wide area measurement systems (WAMS), WAMS architecture, Introduction to adaptive protection schemes. Architecture of SIPS, Classification of SIPS, SIPS application for generator and transmission line protection.	**6**
Module – V Circuit Breakers Arc formation, and mechanism of arc interruption, equivalent circuit of circuit breaker (CB), arc voltage, re-striking and recovery voltage, fault clearing time. Classification of CBs, Construction of Air CBs, Vacuum CBs, SF6 CB, Testing and rating of CBs. Problems with DC current interruption, DC circuit breakers, Construction and arc interruption in mechanical, solid-state and hybrid DC circuit breaker.	**8**

Textbooks:

1. Power System Protection & Switch Gear: Badriramand Vishwa Karma, TMH Publications, 2nd edition, 2013.
2. Switch Gear and Protection Sunil S. Rao, Khanna Publications, 3rd edition, 2008.

Reference Books:

1. Power System Protection & Switch Gear: Ravindranath & Chander, New Age Publications, 2nd edition, 2014.
2. The Art and Science of Protective Relaying: C. Russel Mason, Wiley Bastern Ltd, 1956.

Gaps in the syllabus (to meet Industry/Profession requirements):
POs met through Gaps in the Syllabus:
Topics beyond syllabus/Advanced topics/Design:
POs met through Topics beyond syllabus/Advanced topics/Design:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	1	1	2	1	0	3	0	2	3	2	3
CO2	3	3	3	2	1	2	1	0	3	0	1	3	2	3
CO3	2	3	3	3	2	2	2	1	3	1	2	3	3	3
CO4	2	3	3	3	3	2	2	1	3	1	2	3	2	3
CO5	2	3	3	3	3	2	3	1	3	2	2	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3, CD6
CO5	CD1, CD2, CD3, CD6

PROGRAM ELECTIVES

List of Program Electives (PE) Courses

Programme Elective - I		
Semester	**Course Code**	**Course Title**
FIFTH	EE24325	Sensors and Transducers
	EE24327	Fundamentals of Communication System
	EE24328	Electrical Engineering Materials
	EE24329	Computational Techniques in Electrical Engineering
	EE24331	Embedded Systems and Applications
	EE24333	Industrial Instrumentation
Programme Elective - II		
SIXTH	EE24371	EHV AC Power Transmission
	EE24373	Sustainable Energy Sources
	EE24375	Sensing Technology and Applications
	EE24377	Power Semiconductor Devices
	EE24381	Internet of Things
	EE24383	Machine Learning
	EE24385	Artificial Intelligence for Electrical Engineering
	EE24387	Special Electrical Machines
Programme Elective - III		
SIXTH	EE24385	Bioinstrumentation and Concepts
	EE24387	Applied Control Theory
Programme Elective - III Lab.		
SIXTH	EE24386	Bioinstrumentation Lab.
	EE24388	Applied Control Lab.
Programme Elective - IV		
SEVENTH	EE24411	Specifications & Estimation of Electrical Installations
	EE24421	Robotics
	EE24413	Utilization of Electrical Power
	EE24415	High Voltage Engineering
	EE24417	HVDC and FACTS
	EE24419	Testing & Commissioning of Electrical Equipment
	EE24XXX	Microgrid Operation and Control
	EE24423	Advanced Power System Analysis and Control
	EE24425	Nonlinear and Adaptive Control
	EE24427	Power Conversion Techniques
	EE24459	Smart Power System
	EE24429	Power Electronics Application
	EE24431	Electric Vehicles
	EE24433	Blockchain Application in Power Systems
	EE24437	Embedded Control of Switching Power Converters
	EE24439	Introduction to Autonomous Vehicles
	EE24441	Introduction to Demand Side Management
Programme Elective - V		
SEVENTH	EE24451	Electrical Machine Design
	EE24457	Hybrid Electric Vehicle
	EE24453	Computer Aided Power System Analysis
	EE24455	Advanced Power Electronics
Programme Elective - V Lab.		
SEVENTH	EE24452	Computer Aided Electrical Machine Design Lab.
	EE24454	Computer Aided Power System Analysis Lab.
	EE24456	Advanced Power Electronics Lab.
	EE24458	Electric Vehicle Lab.
	EE24460	Smart Grid Lab.

COURSE INFORMATION SHEET

Course Code: EE24325

Course Title: Sensors and Transducers

Pre-requisite(s): Basic electrical, Physics

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: V/3

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions imparting to students the:

A.	Importance of sensor and transducer
B.	Identification of mechanical and electromechanical sensor
C.	Familiarity with thermal, radiation and magnetic sensor
D.	Application of sensor
E.	Recent trend in sensor technology

Course Outcomes

After the completion of this course, students will be:

CO1.	Familiar with different types of sensors and transducers
CO2.	Able to analyze the performance characteristics
CO3.	Able to identify the particular sensor relevant to the area of application
CO4.	Capable of integrating various engineering principles to design suitable sensors
CO5.	Able to find the current trends of sensor

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Basic idea of sensors and transducers, Principles of operation and their classification, Characteristics of sensors. Conventional sensors Type: Based on Resistive principles- Potentiometer and Strain Gauge. Based on Inductive principles- Ferromagnetic Plunge type, LVDT. Based on capacitive principles- The parallel plate capacitive sensor, Variable Permittivity Capacitive Sensor Electrostatic and Piezoelectric Transducers, Quartz Resonators and Ultrasonic Sensors. Based on Magnetic principles: Magneto resistive, Hall effect, Inductance and Eddy current sensors. Electromagnetic Flow Meter.	**10**
Module – II Thermal Sensors: Acoustic Temp Sensor, Nuclear Thermometer, Magnetic Thermometer, Resistance Change Type thermometric sensor, Thermo emf, Junction Semiconductor Types, Thermal Radiation, Quartz Crystal. Radiation Sensors: Basic Characteristics, Photo-emissive Cell and Photomultiplier, Photoconductive Cell-Photovoltaic and Photojunction Cell, Position-Sensitive Cell Fibre Optic Sensors.	**10**
Module – III Smart Sensors: Introduction, Primary Sensors Excitation, Amplification, Fitters, Converters, Compensation, Information Coding/Processing.	**7**
Module – IV Recent trends in sensor technologies: Introduction, Film Sensors, Semiconductor IC technology, Micro-electromechanical System (MEMS), Nano Sensors, Application of Sensors: Automotive Sensors, Home Appliance Sensors, Aerospace Sensors.	**8**
Module – V Digital Transducers: Digital Encoder, Shaft Encoder, Switches: Pressure, Level, Flow, Temperature, Proximity Switches, Limit Switches and its types, Isolators (or Barriers).	**7**

Textbooks:

1. Sensors and Transducers, 2nd Edition by D. Patranabis, 2nd edition, PHI Learning Pvt. Limited, New Delhi.
2. Instrumentation and control, D Patranabis, PHI Learning Pvt. Limited, New Delhi, 2011.

Reference Books:

1. Electronics instrumentation by H. S. Kalsi, TMH.
2. Electrical & Electronics Measurements and Instrumentation by A. K. Shawhney, Dhanpat Rai & Sons.

Gaps in the Syllabus (to meet Industry/Profession requirements)

Field applications of sensors, Concept of telemetering, Usage of LabVIEW, MATLAB and other modern tools, Interfacing data for processing and analysis

POs met through Gaps in the Syllabus: PO3, PO4, PO5.

Topics beyond syllabus/Advanced topics/Design

- Transmitters and receivers

• Tele-metering

• Usage of modern tools

POs met through Topics beyond syllabus/Advanced topics/Design: PO2, PO3, PO5.

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	1	1	3	0	0	2	1	1	3	3	2
CO2	3	2	2	3	2	2	0	0	3	1	2	3	3	2
CO3	3	2	3	2	2	3	1	0	3	2	2	3	3	3
CO4	3	3	3	3	2	3	1	1	3	3	3	3	3	3
CO5	3	3	3	3	2	1	1	1	3	3	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3, CD6
CO5	CD1, CD2, CD3, CD6

COURSE INFORMATION SHEET

Course Code:EE24327

Course Title: Fundamentals of Communication System

Pre-requisite(s): Good understanding of mathematical tools like integration, differentiation etc.

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: V/3

Branch: EEE

Name of Teacher:

Course Objectives

This course enables the students:

A.	Explain communication systems and representation of signals.
B.	Explain different methods of analog modulation and demodulation schemes, their design, operation and applications.
C.	Explain different methods of digital modulation and demodulation schemes, their design, operation and applications.
D.	Evaluate the performance of communication system in the presence of noise.

Course Outcomes

After the completion of this course, students will be able to:

CO1.	Demonstrate an understanding of communication system and representation of signals.
CO2.	Demonstrate an understanding of different methods of amplitude modulation and demodulation schemes, their design, operation and applications.
CO3.	Demonstrate an understanding on different methods of angle modulation and demodulation schemes, their design, operation and applications.
CO4.	Demonstrate an understanding of different methods of digital modulation, their design, operation and applications.
CO5.	Evaluate the performance of communication systems in the presence of noise.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Representation of Signals and Systems: Fourier series, Fourier Transform, Properties of Fourier Transform, Signal power and power spectral density, Signal energy and energy spectral density, Dirac delta function and its applications, Elements of a Communication system, Block diagram of digital communication system.	**10**
Module – II Amplitude Modulation Systems: Basics of Amplitude modulation, Square law modulator, Switching modulator Square law demodulator, Envelop Detector, Double side band suppressed carrier modulation. Balanced and Ring Modulators, Coherent modulator, Single side band modulation, Frequency Discrimination and phase discrimination modulators, Coherent detection of SSB, Introduction to Frequency Division Multiplexing and Time Division Multiplexing, Superheterodyne AM receiver and its characteristics.	**7**
Module – III Angle modulation - demodulation communication systems: Basic of Frequency and phase modulation, Single tone frequency modulation, NBFM, WBFM, Transmission bandwidth of FM wave, Indirect and Direct methods of FM generation, Frequency Discriminator, phase locked Loop demodulator, Super heterodyne F.M. receiver.	**7**
Module – IV Digital Modulation Techniques: Sampling Quantization, PCM, DPCM, DM, ADM, Binary modulation, generation and detection of binary modulated wave, DPSK, QPSK, Matched filter, satellite Communication System, Transponder.	**10**
Module – V Noise: Short Noise, Thermal noise, White Noise, Noise figure, Noise figure of an amplifier, Noise figure of amplifiers in cascade, Noise temperature, Noise Equivalent Bandwidth, Noise due to several amplifiers in cascade	**7**

Textbooks:

1. Simon Haykin, “Communication Systems”, Wiley Eastern Limited, New Delhi, 2016, 2/e.
2. B. P. Lathi and Zhi Ding, “Modern Digital and Analog Communication Systems”, Oxford University Press, 2011, 4/e, (Indian Edition)

Reference books:

1. John G. Proakis and Masoud Salehi, "Fundamentals of Communication Systems" Pearson Education, Inc., New Delhi, 2013.
2. Bruce Carlson and Paul B. Crilly, "Communication Systems: An Introduction to signals and Noise in Electrical Communication", Tata McGraw Hills Education Pvt. Ltd., New Delhi, 2011, 5/e.

Gaps in the syllabus (to meet Industry/Profession requirements): Nil

POs met through Gaps in the Syllabus: Nil

Topics beyond syllabus/Advanced topics/Design: Nil

POs met through Topics beyond syllabus/Advanced topics/Design: Nil

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	0	2	0	0	0	1	1	2	3	2	1
CO2	3	3	2	1	2	0	0	0	1	1	2	3	3	1
CO3	3	3	2	1	2	0	0	0	1	1	2	3	3	1
CO4	3	3	3	2	2	0	0	0	1	1	2	3	3	2
CO5	3	3	2	3	3	0	0	0	2	2	3	3	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	
CO2	
CO3	
CO4	
CO5	

COURSE INFORMATION SHEET

Course Code:EE24328

Course Title: Electrical Engineering Materials

Pre-requisite(s): Basic knowledge of Physics, Chemistry and Material Science

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: V/3

Branch: EEE

Name of Teacher:

Course Objective

The objectives of this course are to:

1	Provide fundamental knowledge of atomic structure, bonding, and crystal structures relevant to electrical engineering materials.
2	Develop understanding of dielectric properties of insulating materials and their applications in electrical systems.
3	Explain the behavior and applications of gaseous, liquid, solid, and composite insulating materials.
4	Familiarize students with different types of magnetic materials and their applications in electrical devices.
5	Introduce the concept of superconductivity, its types, and practical applications in engineering.

Course Outcome

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

CO1	Explain atomic models, bonding mechanisms, crystal structures, and band theory of solids.
CO2	Analyze the properties of insulating materials and classify dielectrics based on polarization mechanisms.
CO3	Evaluate the characteristics of gaseous, liquid, solid, and composite insulating materials used in electrical systems.
CO4	Differentiate between various magnetic materials, their properties, and engineering applications.
CO5	Interpret the principles of superconductivity and assess its role in advanced engineering applications.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Recapitulation of Atomic structure: Rutherford's and Bohr's Model of Hydrogen atom; Nuclear binding energy and mass defect. Review of wave nature of matter: Schrödinger equation, Wave mechanical theory of atomic structure; Different Energy states. Review of different types of Bonding: Stable interatomic distance; Ionic, covalent, metallic and Van der Waals Bonding. Crystal Structures: Crystal defects. Electron energy levels Band theory of solids; Conductors, Insulators, and Semiconductors	**8**
Module – II Properties of Insulating Materials: Mechanical, Chemical and Thermal; Electrical properties: Volume Resistivity, Surface resistivity, Dielectric constant, Dielectric dissipation factor, Breakdown voltage and Dielectric strength. Dielectric polarisation: Polar and non-polar dielectrics; Electronic, Ionic and Dipole polarisation; Classification of dielectrics by polarisation mechanism; Dielectric polarisation and relative permittivity. Relaxation models: Brief overview; Introduction to Electrets.	**8**
Module – III Gaseous dielectrics: Pure and mixed gases, Applications. Liquid dielectrics: Natural and synthetic dielectrics; Transformer oil; Ester oils; Factors influencing dielectric properties of liquids. Solid insulating materials: Natural and synthetic resins; elastomers; fibrous materials; Ceramic materials; mica and micanites. Varnishes, compounds, oil-paper insulation, and impregnating process. Composite insulating materials: Advantages of using composite insulation; Concept of reinforced materials; Base and filler materials; Applications. Polymer Dielectrics and Applications, cross-linked polyethylene	**8**
Module – IV Magnetic Materials: Atomic interpretation of ferromagnetic materials, Atomic exchange force, crystallographic forces, magnetic anisotropy, magnetostriction, Curie-Weiss law, Curie law, Curie temperature of ferromagnetic materials, soft magnetic material, CRGO, Ni-Fe alloy and applications, hard magnetic materials Alnico, Alcomax and application. Ferrite-ferromagnetic materials and their applications, Piezo-electric materials.	**8**
Module – V Super Conductivity: Theory of super conductivities, critical field, critical current density, transition temperature normal and superconductivity steps, types of superconductors, high-temperature superconductors and applications.	**8**

Textbooks:

1. Adrianus J. Dekker, Electrical Engineering Material, 1 edition, 2015, Pearson Education India.
2. Electrical Engineering Material by B.M. Tareev, Mir Publication, 1980.
3. Dielectric Materials and Applications by A. Von Hipple.
4. High voltage Engineering by Zaengl and Kuffel

Reference Books:

1. Adrianus J. Dekker, Electrical Engineering Material, 1 edition, 1970, Prentice Hall India Learning Private Limited.

Gaps in the Syllabus (to meet Industry/Profession requirements):
POs met through Gaps in the Syllabus:
Topics beyond syllabus/Advanced topics/Design
POs met through Topics beyond syllabus/Advanced topics/Design:
Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	0	2	0	0	0	0	0	2	3	2	0
CO2	3	3	0	0	2	0	0	0	0	0	2	3	3	0
CO3	3	3	2	2	2	0	0	0	0	0	2	3	3	0
CO4	3	2	2	2	2	0	0	0	0	0	1	3	3	0
CO5	3	2	2	2	2	0	0	0	0	0	1	3	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code:EE24329

Course Title: Computational Techniques in Electrical Engineering

Pre-requisite(s): Basics of signals and systems, Digital Signal Processing, Filter theory.

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: V/3

Branch: EEE

Name of Teacher:

Course Objectives

This course enables the students to:

1	Understand the basics of Scientific Computing Techniques.
2	Be acquainted with the solving methodology of soft computing technique in power systems operation and control.
3	Analysis of ANN based systems for function approximation in application to load forecasting.
4	Evaluate fuzzy based systems for load frequency control in power systems.
5	Design of different problems of optimization in power systems and power electronics.

Course Outcomes

At the end of the course, a student should be able to:

CO1	Identify the scientific computing techniques and their roles in building intelligent machines.
CO2	Recognize an appropriate scientific computing methodology for an engineering problem.
CO3	Apply fuzzy logic and reasoning to handle uncertainty while solving engineering problems.
CO4	Analysis of neural network and genetic algorithms to combinatorial optimization problems.
CO5	Classify neural networks to pattern classification and regression problems and evaluated its imparts while being able to demonstrate solutions through computer programs.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction to Scientific Computing: Solution of Non-Linear Equations, Numerical Solution of Ordinary Differential Equation, Public-Domain Software Tools, Optimization Overview, Gradient-Based Methods, Linear Programming, Constrained Optimization Algorithm, Multi- Objective Optimization.	**10**
Module – II Introduction to Computational Intelligent Techniques: Introduction, Definition and importance of Computational intelligent Techniques, Main Components of Computational intelligent Techniques: Fuzzy Logic Artificial Neural Networks, Swarm and Evolutionary Algorithms, Hybrid Intelligent Systems.	**10**
Module – III Artificial Neural Network and Applications: Introduction, Artificial Neuron Structure, ANN Learning: Back-Propagation Learning, Unsupervised Learning, Radial Basic Function (RBF), Support Vector Machine (SVM), Recurrent Neural Network, Deep Neural Network.	**7**
Module – IV Fuzzy Logic, Evolutionary Algorithms and Applications: Introduction Of Fuzzy Logic, Fuzzy Cartesian Product, Fuzzy Relation, Defuzzification Methods, System's Modelling and Simulation Using Fuzzy Logic Approach, Selection of Defuzzification Method, Fuzzy Control System. Genetic Algorithm, Particle Swarm Optimization, Other Recent Heuristic Optimization Techniques.	**8**
Module – V Applications of Computational Techniques to Electrical Engineering: Applications of Artificial Neural Network, Genetic Algorithms, Fuzzy and Hybrid Systems in Power System Applications: Economic Load Dispatch, Unit Commitment, Condition Monitoring. Short Term Electrical Load Forecasting Applications of Soft Computing Techniques In Power Electronics and Control Applications	**8**

Textbooks:

1. Neural Networks: A Comprehensive Foundation - Simon Haykin, IEEE, Press, MacMillan, N.Y 1994.
2. S. Rajasekaran, G. A. Vijayalakshmi, Neural Networks, Fuzzy logic and Genetic algorithms, PHI publication.
3. Fuzzy logic with Engineering Applications – Timothy J. Ross, McGraw-Hill International Editions.
4. Fuzzy Sets and Fuzzy logic:- Theory and Applications - George J. Klir and Bo. Yuan, Prentice- Hall of India Private Limited.

Reference Books:

1. Chaturvedin Devendra K, Soft Computing Techniques and its Applications in Electrical Engineering, Hardcover ISBN:- 97-8-3-540-77480-8, Springer.
2. Kalyanmoy Deb, Optimization for Engineering Design, PHI publication

3. Kalyanmoy Deb, Multi-objective Optimization using Evolutionary Algorithms, Willey Publication
4. Kevin Warwick, Arthur Ekwue, Rag Aggarwal, Artificial intelligence techniques in power systems. IEE Power Engineering Series-22.

Gaps in the Syllabus (to meet Industry/Profession requirements):

1. Visualize different soft computing techniques in real time.
2. Hardware implementation of soft computing techniques in real time.

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design: Soft computing application to image processing, video processing.

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	0	2	1	0	0	0	0	2	2	2	1
CO2	2	3	2	2	2	0	0	0	0	0	2	2	3	1
CO3	2	2	2	2	3	0	0	0	0	0	2	2	3	2
CO4	2	2	3	2	3	0	0	0	0	0	2	2	3	3
CO5	2	2	3	2	3	0	0	0	0	0	2	2	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation – 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1
CO2	CD1
CO3	CD1, CD2
CO4	
CO5	

COURSE INFORMATION SHEET

Course Code: EE24331

Course Title: Embedded Systems and Applications

Pre-requisite(s): Microprocessors and Embedded Systems

Co- requisite(s): Digital Electronics and C programming

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VII/4

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions to impart to students to:

1	Comprehend the basic functions, structure, concept and definition of embedded systems.
2	Interpret ATMEGA8 microcontroller and TMS320C6713 processors in the development of embedded systems
3	Correlate different serial interfacing protocols (SPI, TWI, I2C, USART)
4	Understand interfacing of different peripherals (ADC, DAC, LCD, motors).
5	Evaluate design cost of any given embedded system application.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Explain basic building blocks of an embedded system.
CO2	Apply modern hardware/software tools for building prototypes of embedded systems.
CO3	Analyse the system performance in terms of accuracy and data security.
CO4	Evaluate computational and economic cost of complex real time applications.
CO5	Design embedded systems for real time control of complex engineering systems as per system specification, ensuring reliability, security and safety in order to carryout large-scale projects of socio-economic importance.

SYLLABUS:

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction & Basic Concepts of Computer Architecture: Embedded Systems Overview, Processor Technology-General purpose processors (Software), Single purpose processors (Hardware), Application-Specific processors; IC Technology-Full-custom/VLSI, Semicustom ASIC (Gate Array and standard cell), PLD Computer Architecture Concepts Memory, Input/Output, DMA, Parallel and Distributed computers, Embedded Computer Architecture, Brief Introduction to FPGA processor.	**8**
Module – II Peripherals and Interfacing: Adding Peripherals and Interfacing-Serial Peripherals and Interfacing-Serial Peripheral Interface (SPI) Inter Integrated Circuit (I2C), Adding a Real-Time Clock with I2C, Adding a Small Display with I2C Serial Ports-UARTs, RS-232C & RS-422, Infrared Communication, USB, Networks- RS-485, Controller Area Network (CAN), Ethernet Analog Sensors - Interfacing External ADC, Temperature Sensor, Light Sensor, Accelerometer, Pressure Sensors, Magnetic-Field Sensor, DAC.	**8**
Module – III DSP-based controllers: Texas Instrument's TMS320C6713 DSP processor Introduction, Major features, Architecture, Application and programming, Real-time audio signal data acquisition and processing.	**8**
Module – IV Embedded Processors & Systems: Atmel AVRATMEGA 328, ATMEGA 2560, Micro-controller Introduction, Major features, Architecture, Application and programming, Timers/Counters, ADC, USART, SPI, TWI, Vectored Interrupts with emphasis on external interrupts.	**6**
Module – V C2000 series TI DSP processors: Texas Instruments Delfino F28379D architecture, Introduction to CCS Studio, ADC interface and sampling program for motor speed feedback, PWM Generation program for inverter control, Timer Counter program, interrupt subroutine handling. IoT based wireless sensor network, introduction to Internet of Things (IoT)? Potential IoT Applications, IoT Enabling Technologies: Sensors and Actuators, RFID and NFC (Near Field Communication)	**10**

Textbooks:

1. Catsoulis, John, "Designing Embedded Hardware", First/Second Edition, Shroff Publishers & Distributors Pvt. Ltd., New Delhi, India.
2. Vahid, Frank and Givargis, Tony, "Embedded System Design-A Unified hardware/Software Introduction", John Wiley & Sons, (Asia) Pvt Ltd., Replika Press Pvt., Delhi-110040.

3. Mazidi & Mazidi, "AVR Microcontrollers & Embedded Systems using Assembly & C Pearson Education.
4. Rulph Chassaing, “Digital Signal Processing and Applications with C6713 and C6416 DSK”, John Wiley and Sonspublication

Reference books:

1. Stuart R. Ball, “Embedded Microprocessor Systems, Real World Design”, Second Edition, Newnes publication.
2. Nasser Kehtarnavaz, “Real Time Digital Signal Processing based on the TMS320C6000”, Elsevier publication.

Gaps in the Syllabus (to meet Industry/Profession requirements): Computation of algorithm complexity

POs met through Gaps in the Syllabus: PO4

Topics beyond syllabus/Advanced topics/Design: Compute number of clock cycles required for UART and RS232 Communication

POs met through Topics beyond syllabus/Advanced topics/Design: PO4

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher’s assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher’s assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	2	2	1	1	1	3	2	1
CO2	3	3	3	3	3	3	2	2	2	2	1	3	2	2
CO3	3	3	3	3	3	3	3	3	2	2	2	3	3	2
CO4	3	3	3	3	3	3	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD3, CD7
CO2	CD1, CD6
CO3	CD1, CD2, CD4
CO4	CD1, CD2
CO5	CD1, CD2

COURSE INFORMATION SHEET

Course Code: EE24333

Course Title: Industrial Instrumentation

Pre-requisite(s): Electrical Measurement and Instrumentation

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: V/3

Branch: EEE

Name of Teacher:

Course Objectives

This course aims to provide the students with adequate knowledge about:

A.	The operating principles of sensors and systems used for the measurement of physical variables such as force, torque, velocity, pressure, flow, level, etc.
B.	Sensor signal conditioning.
C.	Application aspects of sensors and measurement systems used in professional practice, specifically in industrial automation.
D.	Data transmission techniques, selection criteria.

Course Outcomes

After the completion of this course, students will be able to:

CO1.	Understand the basic components used in process industries.
CO2.	Explain and analyse the signal conditioning and data transmission techniques and transmitters used in industries.
CO3.	Analyse the operating principle of sensors used to measure velocity, acceleration, and flow.
CO4.	Understand and evaluate various pressure and level measurement systems.
CO5.	Explain the operating principle of force and torque measurement systems.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction to Instrumentation system: Characteristics of Instrument. Actuators, Transducers, Transmitters, Final control elements. Introduction to electronic, pneumatic, digital, and electrical transmitters. Hardware/software sensor linearization techniques.	**9**
Module – II Signal conditioning: Introduction, Interfacing circuits, Amplifiers, Modulation, Demodulation, Filtering. Basics of Data transmission: IEEE-488 bus, RS 232, and RS 485 interface. Pneumatic and Hydraulic Instrumentation system. Smart transmitters. HART protocol. Overview of sensor-actuator networks, field bus.	**9**
Module – III Measurement of velocity and acceleration: Actuation, Transduction, Transmission and Control for tachometers, stroboscopes, gyroscope, accelerometers. Proximity Sensors. Flow measurement: Fluid properties. Flowmeters. Criteria for selection of flowmeters.	**9**
Module – IV Measurement of Pressure: Elastic pressure sensors. Pressure gauge. Pressure switch. Actuator and Electronic pressure transmitters. Calibration and installation of pressure measuring devices. Measurement accessories. Vacuum measurement. Level measurement: Point level measurement, Continuous level measurement.	**9**
Module – V Force and Torque measurement systems: Strain gauge signal processing. Load cells. Introduction to industrial weighing systems and belt conveyor weighing systems. Weigh feeders. Principle of torque measurement in rotating shafts. Introduction to vibration measurement and monitoring.	**9**

Textbooks

1. Principles of Industrial Instrumentation, D. Patranabis, Tata McGraw Hill.
2. Measurement Systems Application and Design, E.O. Doebelin, Tata McGraw Hill.
3. Fundamentals of Industrial Instrumentation, Alok Barua, Wiley.
4. Measurement & Instrumentation: Trends & Applications, M.K. Ghosh, S. Sen, and S. Mukhopadhyay.

Reference books

1. Liptak B.G, Instrumentation Engineers Handbook (Measurement), Chilton Book Co.,
2. John G Webster, Measurement, Instrumentation and Sensors, Handbook, CRC Press.
3. Principles of Measurement, John Bentley, Pearson.
4. Measurement and Instrumentation Principles, A. S. Morris, Butterworth-Heinemann.

Gaps in the Syllabus (to meet Industry/Profession requirements): Industrial process related design concepts

POs met through Gaps in the Syllabus: PO3, PO4

Topics beyond syllabus/Advanced topics/Design: Industrial automation

POs met through Topics beyond syllabus/Advanced topics/Design: PO3, PO4

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	0	1	0	1	0	0	0	2	3	2	1
CO2	3	3	2	2	2	0	1	1	0	0	2	3	3	1
CO3	3	3	2	2	2	0	1	1	0	0	2	3	3	2
CO4	3	3	2	2	2	0	1	1	0	0	2	3	3	2
CO5	3	2	2	2	1	0	1	0	0	0	1	3	3	1

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: EE24371

Course Title: EHV AC Power Transmission

Pre-requisite(s): Knowledge of Physics, Mathematics, Principle of Electrical Engineering, Electromagnetic Theory, Power System Transmission and Distribution Switch Gear and Protection

Co- requisite(s):

Credits: 03 L: 3 T: 0 P:0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VI/3

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions imparting the following objectives to students:

A.	To provide the concept of calculation line resistance, inductance, capacitance and ground return parameters for N-conductor bundle
B.	To make the students understand the field of point charge, line charge and then surface voltage gradient for bundle conductor.
C.	To expose the effect of compensators in voltage dynamic of EHV buses.
D.	To expose the students about the calculation process of electrostatic and electromagnetic field for bundle conductor and their effects.
E.	To provide the core concept of HVDC system and the working principles of converters, harmonic generation and filtration.

Course Outcomes

After the completion of this course, students will be able to:

CO1.	To determine the line parameters of bundle conductors.
CO2.	To formulate mathematical equations for different factors that causes the operational limitations for EHV line like surface voltage gradients, electrostatic field.
CO3.	To determine the required size of compensators for EHV line.
CO4.	To understand the core concept involving the different components in schematic diagram of HVDC system and their performance.
CO5.	To understand the nature of harmonics generated by converters and to comprehend the importance of filter.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Maxwell's coefficients, Sequence inductance and capacitance, Charge Matrix, Effect of Ground wire.	**6**
Module – II Surface Voltage-gradient on bundled conductors, Mangoldt's formula, Gradient factors & their use, Ground level electrostatic field of EHV lines.	**8**
Module – III Power frequency over-voltage control, Series and shunt compensation, Generalised Constants of Compensated line, Static Var Compensators (SVC/SVS). Switching over-voltages in EHV Systems.	**9**
Module – IV Six-pulse Bridge Circuit: waveforms and relevant equations, Twelve-pulse converter, Advantages of higher pulse number, Bipolar to monopolar operation, Converter performance with phase control, Commutation and effect of reactance.	**9**
Module – V Introduction to HVDC Transmission system, Economical advantages, Technical advantages, Critical distance, Submarine transmission. Inverter, Equivalent circuit of HVDC system, Schematic diagram, Reactive power consideration in HVDC system, Harmonics, Filters in HVDC system.	**9**

Textbooks:

1. Extra High Voltage AC Transmission Engineering (2nd Ed.)by R. D. Begamudre, Wiley Eastern Ltd.
2. HVDC Power Transmission Systems by K. Padiyar, Wiley Eastern Ltd.

Gaps in the Syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	2	2	0	0	0	0	0	0	3	2	0
CO2	3	3	2	2	2	0	1	0	0	0	0	2	3	0
CO3	2	2	3	2	2	0	1	0	0	0	0	2	3	0
CO4	2	2	2	3	3	0	0	0	0	0	0	2	3	1
CO5	2	2	2	2	3	0	1	0	0	0	0	2	3	1

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD3, CD6
CO3	CD1, CD2, CD4
CO4	CD1, CD2
CO5	CD1, CD2

COURSE INFORMATION SHEET

Course Code: EE24373

Course Title: Sustainable Energy Sources

Pre-requisite(s): Mathematics, Basic Electrical Engineering, Physics

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 0

Class: B. Tech

Semester/Level: VI/3

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions imparting the following objectives to the students:

A	To describe current and future prospects of conventional and renewable based energy system scenario
B	To develop comprehensive control and technological understanding in solar PV system components
C	To demonstrate wind energy systems and its fundamentals of converting wind energy to electrical energy with control strategies
D	To provide a foundation for understanding the general principles and fundamentals of energy storage technology design and operation with control aspects

Course Outcomes

After the completion of this course, students will be:

CO1	Understand the present prospects of conventional and non-conventional energy systems and find future trends of energy;
CO2	Analyze the basics of solar energy, construct the solar PV (photovoltaic) system for on and off grid scenario and its use cases for different applications;
CO3	Analyze the basics of wind energy and operational aspects of wind energy system;
CO4	Analyze different technologies used in the energy storage systems, their usage and applications like V2G/G2V;
CO5	Solve different control aspects of renewable based systems for on and off grid conditions, it's quality problems and recommend commensurate remedial measures;

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Various non-conventional energy resources- Introduction, availability, classification, relative merits and demerits. Introduction to wave energy, small hydro-based plants, Hybrid power plants.	**5**
Module – II Introduction of PV cells, panels and their working. Performance of PV plants in different scenarios. Maximum power point methods, Grid-connected single-phase/three-phase PV inverter schemes and control, types of grid interface. Grid codes standards for grid-connected PV systems.	**10**
Module – III Introduction of wind energy, panels, and their working. Power estimation in wind, Wind energy conversion principles, Components of wind energy Conversion Systems. Working principle of different types of wind turbines and their operations. Wind power Conversion Technologies and applications. Integration and control of the different types of wind turbines.	**10**
Module – IV Introduction of Energy storage (ESS), and their requirements. Need of energy storage; Different modes of Energy Storage, Working principle of different types of ESS and their operations. Introduction of Fuel cell and their working principle. Electric Vehicle integration (V2G, G2V).	**10**
Module – V Integration of distributed generators to the existing system. Effects on the grid by RE systems integration. Control and operation of various renewable energy resources. Introduction of microgrid.	**10**

Textbook/References

1. Photovoltaics Fundamentals, Technology, and Practice, Konrad Mertens, Wiley, 2018, ISBN No. 13: 978-1119401049.
2. Bent Sørensen, Renewable Energy, AP, Fifth Edition.
3. Godfrey Boyle, Renewable Energy: Power for a Sustainable Future, OXFORD, Third Edition

Gaps in the Syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	2	2	1	1	1	3	2	1
CO2	3	3	3	3	3	3	2	2	2	2	1	3	2	2
CO3	3	3	3	3	3	3	3	3	2	2	2	3	3	2
CO4	3	3	3	3	3	3	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: EE24375

Course Title: Sensing Technology and Applications

Pre-requisite(s): Electrical Measurement and Instrumentation

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VI/3

Branch: EEE

Name of Teacher:

Course objectives

This course enables the students:

A.	To outline the characteristics of a sensor and its modeling.
B.	To understand the fabrication technologies of micro-sensors.
C.	To explain the operating principle of different sensors used for measurement of physical parameters and chemical analytes.
D.	To classify and understand the operation and design of optical sensors.
E.	To be acquainted with biosensors and smart sensors and develop the ability to design them using the existing knowledge.

Course Outcomes

After the completion of this course, students will be able to:

1.	Identify and analyze the characteristics of sensors in general.
2.	Understand and evaluate different technologies used for fabrication of micro-sensors.
3.	Analyze various physical and electrochemical sensors, their design, and applications.
4.	Understand the working of different optical sensors and their application.
5.	Design and evaluate different smart sensors and biosensors.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Sensing principles, sensor architecture, sensor types and classification, characteristics, Sensor modeling in time and frequency domain.	**5**
Module – II Micro machining techniques- bulk, surface and other micromachining methods, Photolithography, Wet and Dry Etching, Thin Film Deposition and Growth Electroplating, Molding, Bonding and Sacrificial Processes, Polymer Processing and Rapid Prototyping. Microelectronics compatible sensors technology; principles of design, fabrication, and characterization of miniature sensors	**10**
Module – III Sensors for physical measurands: Strain, force, pressure, acceleration, flow, volume, temperature, bio-potentials. Sensors for chemical analytes: Amperometric sensors, Potentiometric sensors, Conductometric sensors, Impedimetric sensors, Ion-selective electrodes, ISFETs, Clark electrode.	**10**
Module – IV Optical sensors, Absorbance based sensors, Fluorescence based sensors, Nanotechnology and Nanoparticle based sensors. μ-TAS: Fluid Control Components, Sample Handling, Separation Components and Detection.	**10**
Module – V Biosensors: Introduction, Classification, Immunosensors, Catalytic sensors. Miniature Biosensors, Biosensor Arrays and Implantable Devices Smart/Intelligent sensors, sensor arrays and networks.	**10**

Reference books

1. Microsystem Technology in Chemistry and Life Sciences, A. Manz and H. Becker, Eds., Springer-Verlag, New York, 1999.
2. Fundamentals of Microfabrication: The Science of Miniaturization, Marc J. Madou, Second Edition, CRC Press; 2nd edition, 2002.
3. John G. Webster (ed.): Medical Instrumentation - Application and Design; Houghton Mifflin Co., Boston, 1992.
4. Richard Aston: Principles of Biomedical Instrumentation and Measurement, Merril Publishing Co., Columbus, 1990.
5. Richard S.C. Cobbold: Transducers for Biomedical Measurements: Principles and Applications, John Wiley & Sons, 1974.
6. Ernest O. Doeblin: Measurement Systems, Application and Design, McGraw-Hill, 1985.
7. A.P.F. Turner, I. Karube& G.S. Wilson: Biosensors: Fundamentals & Applications, Oxford University Press, Oxford, 1987.

Gaps in the Syllabus (to meet Industry/Profession requirements): Selection of sensor design criteria

POs met through Gaps in the Syllabus: PO5, PO6

Topics beyond syllabus/Advanced topics/Design: Sensing design and implementation

POs met through Topics beyond syllabus/Advanced topics/Design: PO3

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	1	1	0	0	0	2	3	2	1
CO2	2	3	2	2	2	1	1	0	0	0	2	2	3	1
CO3	3	3	2	3	2	1	1	0	0	0	2	3	3	2
CO4	2	2	2	2	2	1	1	0	0	0	1	2	2	1
CO5	3	2	3	2	3	2	1	0	1	1	2	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: EE24377

Course Title: Power Semiconductor Devices

Pre-requisite(s): Basic Electronics

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VI/3

Branch: EEE

Name of Teacher:

Course Objectives

This course enables the students to:

A.	Identify different types of modern semiconductor-based switching devices and their operating characteristics
B	Explain working principles of semiconductor devices such as Thyristors and PMOSFET.
C.	Analyze protection circuit and firing circuit.
D.	Evaluate performance parameters of a semiconductor device
E.	Design protection for power semiconductor devices.

Course Outcomes

At the end of the course, a student should be able to:

CO1.	List different types of semiconductor devices and remember their operating characteristics. Explain the working principle of different semiconductor devices.
CO2.	Classify different types of power converters. Show suitability of a power converter for a particular application. Solve power management related problems with application of electronics-based topologies.
CO3.	Outline shortcomings of each class of power devices and solve them using proper circuits such as firing circuits and protection circuit.
CO4.	Estimate the cost and long-term impact of power electronics technology on a large-scale project of socio-economic importance.
CO5	Design protection circuits such as thermal protection, dv/dt protection and di/dt protection for power converters.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction:** Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); Device selection strategy– On-state and switching losses – EMI due to switching – Power diodes – Types, forward and reverse characteristics, switching characteristics – rating.	**8**
Module – II **Current Controlled Devices:** BJT‟s – Construction, static characteristics, switching characteristics; Negative temperature coefficient and second breakdown; – Thyristors – Physical and electrical principle underlying operating mode, Two transistor analogy – concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; series and parallel operation; comparison of BJT and Thyristor – steady state and dynamic models of BJT &Thyristor- Basics of GTO, MCT, FCT, RCT.	**8**
Module – III **Voltage Controlled Devices:** Power MOSFETs and IGBTs – Principle of voltage-controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs – and IGCT. New semiconductor materials for devices – Intelligent power modules- Integrated gate commutated thyristor (IGCT) – Comparison of all power devices.	**8**
Module – IV **Firing and Protection Circuits:** Necessity of isolation, pulse transformer, optocoupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. – Over voltage, over current and gate protections; Design of snubbers.	**8**
Module – V **Thermal Protection:** Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapour – phase cooling; Guidance for hear sink selection – Thermal resistance and impedance -Electrical analogy of thermal components, heat sink types and design – Mounting types- switching loss calculation for power device.	**8**

Textbooks:

1. M.H. Rashid,“Power Electronics: Circuits, Device and Applications”,2nd Ed.n, PHI, New Jersey, 1993.
2. Mohan, Underland, Robbins; Power Electronics Converters, Applications and Design, 3rd Edn., 2003, John Wiley & Sons Pte. Ltd.
3. M. D. Singh, K. B. Khanchandani, “Power Electronics”, 2nd Edn., Tata McGraw- Hill, 2007.

Reference Books:

1. R. Krishnan, “Electric Motor Drives: Modeling, Analysis and Control”, 1st Edn., Prentice Hall,2001.
2. B. K. Bose, “Modern Power Electronics & AC Drives” , 1st Edn., Prentice Hall, 2001
3. L. Umanand, “Power Electronics: Essentials & Applications”, 1st Edn. Wiley India Private Limited, 2009.
4. Jeremy Rifkin, “Third Industrial Revolution: How Lateral Power Is Transforming Energy, the Economy, and the World”, 1st Edn., St. Martin‟s, Press, 2011.

Gaps in the Syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	2	2	1	1	1	3	2	1
CO2	3	3	3	3	3	3	2	2	2	2	1	3	2	2
CO3	3	3	3	3	3	3	3	3	2	2	2	3	3	2
CO4	3	3	3	3	3	3	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD5, CD6

COURSE INFORMATION SHEET

Course Code: EE24381

Course Title: Internet of Things

Pre-requisite(s): Data Communication and Computer Networking

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VI/3

Branch: EEE

Name of Teacher:

Course Objectives

This course enables the students:

6.	To understand Internet of Things concepts, and IoT enabled technologies.
7.	To comprehend hardware and software components of IoT.
8.	To understand solution framework for IoT applications.
9.	To comprehend different security protocols in IoT.
10.	To learn about implementation of different case studies/mini projects.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Comprehend Internet of Things concepts, and IoT enabled technologies.
CO2	Able to Implement hardware and software components of IoT.
CO3	Design solution framework for IoT applications.
CO4	Comprehend security protocols in different IoT applications.
CO5	Able to Implement mini projects and different case studies.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction to IoT** Introduction to Internet of Things- Definition and Characteristics of IoT, Sensors, Actuators, Physical Design of IoT: IoT Protocols, IoT communication models, IoT Communication APIs, IoT enabled Technologies: Wireless Sensor Networks, Cloud Computing, Embedded Systems, IoT Levels and Templates, M2M and IoT Technology & Analytics.	**8**
Module – II **Elements of IoT** Hardware Components: Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components: Programming API's (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.	**8**
Module – III **IoT Application Development** Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage: Unstructured data storage on cloud/local server, Authentication, authorization of devices.	**8**
Module – IV **Security in IoT protocols** Application Layer, Data and Analytics for IoT, IoT Middleware, Data analytics for IoT, Big Data analytics tools and technology.	**8**
Module – V **IoT Case Studies** IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation.	**8**

Textbooks:

1. "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", D. Hanes, G. Salgueiro, P. Grossetete, R. Barton, J. Henry,1st edition, Pearson India Pvt. Ltd.
2. "Internet of Things: Architecture and Design", Raj Kamal, McGraw Hill

Reference books:

1. "Introduction to Internet of Things: A practical Approach, Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, ETI Labs
2. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases'', Pethuru Raj and Anupama C. Raman, CRC Press.
3. "Internet of Things", Jeeva Jose, Khanna Publishing House, Delhi

Gaps in the Syllabus (to meet Industry/Profession requirements):
POs met through Gaps in the Syllabus:
Topics beyond syllabus/Advanced topics/Design
POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	1	2	0	0	1	2	3	2	1
CO2	3	2	3	2	3	1	1	0	2	1	2	3	3	1
CO3	3	3	3	2	3	2	2	1	2	1	2	2	3	2
CO4	2	3	2	2	2	3	3	1	1	1	2	2	2	1
CO5	3	2	3	2	3	2	2	1	3	2	3	3	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD3, CD4
CO4	CD1, CD2, CD3, CD4
CO5	CD1, CD2, CD3, CD4

COURSE INFORMATION SHEET

Course Code: EE24383

Course Title: Machine Learning

Pre-requisite(s):MA 103 (Mathematics I), MA 107 (Mathematics II).

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VI/3

Branch: EEE

Name of Teacher:

Course Objectives

The course objective is to provide students with ability to:

A.	Explain the concepts and principles of learning from data.
B.	Design and implement different machine learning algorithms that improve their performance on some set of tasks with experience.
C.	Illustrate and summarize the techniques of machine learning algorithms for program synthesis.
D.	Apply machine learning techniques to solve practical problems in electrical engineering.
E.	Develop adaptive laws for hybridization of new models from the existing machine learning algorithms.

Course Outcomes

At the end of the course, the student will be able to:

CO1	Identify the suitability of machine learning algorithms based on the application and data.
CO2	Assess the current state of the art in machine learning and be able to begin to conduct original research in machine learning.
CO3	Comprehend machine learning algorithms and their use in data-driven knowledge discovery and program synthesis.
CO4	Identify, formulate and solve machine learning problems that arise in practical applications.
CO5	Develop new hybrid models from the existing machine learning algorithms.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction: Introduction to Machine Learning, The concept Learning task, General-to- specific ordering of hypotheses, Version spaces, Inductive bias, Over-fitting, Cross-Validation, Machine Learning Applications.	**10**
Module – II Probabilistic Models: Maximum Likelihood Estimation, MAP, Bayes Classifiers, Minimum description length principle, Bayesian Networks, Inference in Bayesian Networks, Bayes Net Structure Learning.	**8**
Module – III Supervised learning: Decision Tree Learning, Instance-Based Learning: k-Nearest neighbor algorithm, Support Vector Machines, Support vector machines for classification and regression, Kernel methods, Basic of Artificial Neural Networks, Linear threshold units, Perceptron's, Multilayer networks and back-propagation. Ensemble learning: Boosting, Bagging, Random Forest.	**10**
Module – IV Unsupervised learning: K-means and Hierarchical Clustering, Fuzzy-C-means, Gaussian Mixture Models, EM algorithm, Hidden Markov Models.	**10**
Module – V Computational Learning Theory: Probably Approximately Correct (PAC) learning, Sample complexity, Computational complexity of training, Vapnik-Chervonenkis (VC) dimension, Reinforcement Learning.	**8**

Reference Books:

1. Tom Mitchell. Machine Learning. McGraw Hill, 1997.
2. Christopher M. Bishop. Pattern Recognition and Machine Learning. Springer 2006.
3. Richard O. Duda, Peter E. Hart, David G. Stork. Pattern Classification. John Wiley & Sons, 2006.
4. E. Alpaydin, Introduction to Machine Learning, Prentice Hall of India, 2006.

Gaps in the Syllabus (to meet Industry/Profession requirements):

- Application of principles of machine learning in the area of electrical engineering.
- State-of-the-art Machine Learning techniques and how to apply them.
- Emphasize how Machine Learning can be used to provide insights and create value from data.

POs met through Gaps in the Syllabus: PO5, PO6, PO7

Topics beyond syllabus/Advanced topics/Design:

Recent trends in deep learning and representation learning
Natural language processing

POs met through Topics beyond syllabus/Advanced topics/Design: PO6, PO11

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	1	0	0	0	1	2	3	2	1
CO2	2	3	2	3	2	1	1	1	0	2	3	2	2	3
CO3	3	2	3	2	3	1	1	1	0	1	2	3	3	2
CO4	3	3	3	3	3	2	1	1	1	1	2	3	3	2
CO5	2	2	3	3	3	1	1	1	1	2	3	2	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD6
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3, CD6
CO5	

COURSE INFORMATION SHEET

Course Code: EE24385

Course Title: Artificial Intelligence for Electrical Engineering

Pre-requisite(s):MA 103 (Mathematics I), MA 107 (Mathematics II)

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 0

Class: B. Tech

Semester/Level: VI/3

Branch: EEE

Name of Teacher:

Course Objectives

The course objective is to provide students with an ability to:

1	To apprehend the importance of Artificial Intelligence.
2	To apply the soft computing technique for solving the problems of power and control.
3	To develop ANN, fuzzy and GA based model for power and control application
4	To develop optimization-based model for real time applications.

Course Outcomes

At the end of the course, the student will be able to:

CO1	Understand the basic of Artificial Intelligent techniques.
CO2	Be acquainted with how the soft computing technique can be used for solving the problems of power systems operation and control.
CO3	Design of ANN based systems for function approximation used in load forecasting.
CO4	Design of Fuzzy based systems for load frequency control in power systems
CO5	Solve problem of Optimization in power systems.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction to Artificial Intelligence:** Introduction, Definition of Artificial Intelligence, Importance of Soft Computing, Main Components of Soft Computing: Fuzzy Logic, Artificial Neural Networks, Introduction to Evolutionary Algorithms, Hybrid Intelligent Systems, Single and multi-objective optimization.	**10**
Module – II **Artificial Neural Network and Supervised Learning:** Introduction, Artificial Neuron Structure, ANN Learning; Back-Propagation Learning, Properties of Neural Networks, Generalized Neuron Models, Factors Affecting the Performance of Artificial Neural Network Models, Application of GN Models to Electrical Machine Modeling, Electrical Load Forecasting Problem: Short Term Load Forecasting Using Generalized Neuron Model, Aircraft Landing Control System Using GN Model.	**10**
Module – III **Introduction to Fuzzy Set Theoretic Approach:** Introduction, Uncertainty and Information, Types of Uncertainty, Introduction of Fuzzy Logic, Fuzzy Set, Operations on Fuzzy Sets, Fuzzy Intersection, Fuzzy Union, Fuzzy Complement, Fuzzy Concentration, Fuzzy Dilation, Fuzzy Intensification, α-Cuts, Characteristics of Fuzzy Sets, Demorgan's Law, Fuzzy Cartesian Product, Various Shapes of Fuzzy Membership Functions, Methods of Defining of Membership Functions, Fuzzy Relation, Defuzzification Methods.	**7**
Module – IV **Applications of Fuzzy Rule Based System:** Introduction, System's Modeling and Simulation Using Fuzzy Logic Approach, Selection of Variables, their Normalization Range and the Number of Linguistic Values, Selection of Shape of Membership Functions for Each Linguistic Value, Selection of Fuzzy Union and intersection Operators, Selection of Defuzzification Method, Steady State D.C. Machine Model, Transient Model of D.C. Machine, Fuzzy Control System, Power System Stabilizer Using Fuzzy Logic.	**8**
Module – V Introduction, Crossover, Mutation, Survival of Fittest, Population Size, Evaluation of Fitness Function, Applications of Artificial Neural Network, Genetic Algorithms and Fuzzy Systems for Power System Applications: voltage control, voltage stability, security assessment, feeder load balancing, AGC, Economic load dispatch, Unit commitment, Condition monitoring	**5**

Reference Books:

1. S. Rajasekaran, G. A. Vijayalakshmi, Neural Networks, Fuzzy logic and Genetic algorithms, PHI publication.
2. Chaturvedi, Devendra K, Soft Computing Techniques and its Applications in Electrical Engineering, Hardcover ISBN:- 978-3-540-77480-8, Springer.
3. Kalyanmoy Deb, Optimization for Engineering Design, PHI publication
4. Kalyanmoy Deb, Multi-objective Optimization using Evolutionary Algorithms, Willey Publication
5. Kevin Warwick,Arthur Ekwue,Rag Aggarwal, Artificial intelligence techniques in power systems.IEE Power Engineering Series-22

Gaps in the Syllabus (to meet Industry/Profession requirements):

1. Application of principles of artificial intelligence techniques.
2. Practical application of artificial neural network towards artificial intelligence.
3. Simulation modelling of fuzzy based artificial intelligence approach in the field of electrical and electronics engineering.

POs met through Gaps in the Syllabus: PO4, PO5, PO6

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	0	2	1	0	0	0	1	2	2	1	0
CO2	2	3	2	2	3	2	1	0	0	1	2	3	3	1
CO3	2	3	3	2	3	1	1	0	0	2	2	3	3	2
CO4	2	3	3	2	3	1	1	0	0	2	2	3	3	2
CO5	2	3	3	3	3	2	2	0	0	2	2	3	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3, CD6
CO4	CD1, CD2, CD3, CD6
CO5	CD1, CD2, CD3, CD6

COURSE INFORMATION SHEET

Course Code: EE24387

Course Title: Special Electrical Machines

Pre-requisite(s): Basics of Electrical Engineering, Engineering Electromagnetic

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VI/3

Branch: EEE

Name of Teacher:

Course Objectives

This course enables the students:

A.	Explain the working principle of different types of special electrical machines such as PMBLDC, SRM, Stepper Motor, etc
B.	Analyze the dynamic performance of electrical machines based on mathematical modelling.
C.	Compare dynamic performance in terms of speed response and torque response of different machines.
D.	Design power circuits and protection circuits for the drive system based on a special electric machine.
E.	Evaluate the design cost of closed-loop control based electrical drive system in case of a special electrical machine

Course Outcomes

After the completion of this course, students will:

CO1.	describe the method of electromagnetic torque generation in electrical machines such as PMBLDC, SRM, Stepper Motor etc
CO2.	Apply knowledge of mathematical modelling to develop a state-space model of the PMBLDC machine and SRM.
CO3.	Compare the transient behaviour of different special electric machines.
CO4.	Design power converters and protection circuits for the drive system of special electric machines.
CO5.	Optimize the cost of a power converter-based electrical drive system for a special electrical machine

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Permanent Magnet Brushless DC Motors: Fundamentals of permanent magnet types-principle of operation magnetic circuit analysis-emf and torque equations.	**6**
Module – II Permanent Magnet Synchronous Motor: Principle of operation–EMF and Torque equations, Power controllers, Torque speed characteristics, Digital controllers, Constructional features, operating principle and characteristics of synchronous reluctance motor.	**10**
Module – III Switched Reluctance Motors: Constructional features, Principle of operation, torque prediction Characteristics, Power controllers, Control of SRM drive-Sensor less operation of SRM– Applications.	**7**
Module – IV Stepper Motors: Constructional features, Principle of operation, Linear and Nonlinear analysis, Characteristics–Drive circuits–Closed loop control–Applications, High-Speed Operation of Stepper- Motors: Pull-out torque/speed, characteristics of Hybrid stepper motors.	**10**
Module – V Other Special Machines and Firing and Protection Circuits: Principle of operation and characteristics of Hysteresis motor, Linear motor –Applications. The necessity of isolation, pulse transformer, optocoupler–Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. – Over voltage, over current and gate protections; Design of snubbers.	**10**

Textbook:

1. Gopal Dubey, "Power semiconductor-controlled Drives", Prentice Hall Inc., New Jersey, 1989.
2. Krishnan R., “Electric Motor Drives-Modeling, Analysis and Control”, Prentice Hall of India Pvt. Ltd., New Delhi, 2007.
3. E. G. JANARDANAN, “SPECIAL ELECTRICAL MACHINES”, PHI Learning Pvt. Ltd., 01-Jan-2014

Reference Book:

1. Bimal K. Bose, “Modern power electronics and AC drives”, Pearson Education (Singapore) Ltd., New Delhi, 2005.
2. Sheperal, Wand Hully, L. N. "Power Electronic and Motor control" Cambridge University Press Cambridge, 1987.

Gaps in the Syllabus (to meet Industry/Profession requirements): State Estimation methods

POs met through Gaps in the Syllabus: PO5

Topics beyond syllabus/Advanced topics/Design: MRAC based state estimation for permanent

synchronous motor.

POs met through Topics beyond syllabus/Advanced topics/Design: PO4, PO5

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	0	0	1	1	0	0	0	0	3	2	0
CO2	3	3	2	2	2	0	0	0	0	0	0	2	3	0
CO3	2	2	2	2	2	1	0	0	0	0	0	2	3	0
CO4	2	2	3	2	3	0	0	0	1	1	0	3	3	2
CO5	1	2	2	1	3	1	2	1	2	1	2	2	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD6
CO3	CD1, CD2, CD4
CO4	CD1, CD2
CO5	CD1, CD2

COURSE INFORMATION SHEET

Course Code: EE24385

Course Title: Bioinstrumentation and concepts

Pre-requisite(s): Basic Electrical and Electronics measurement

Co- requisite(s): Fundamental knowledge of the human physiological system

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VI/3

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions to impart to students to:

A.	To impart knowledge for interdisciplinary, applied engineering and technology.
B.	With respect to design consideration, to understand the standard structure of biomedical instrumentation systems.
C.	To learn the technicality associated with instrumentation and design of basic bio signal and imaging equipment.
D.	To understand the engineering aspects for safety and hazards associated with biomedical instruments.
E.	To make the students able to perform multidisciplinary research for the development of healthcare systems.

Course Outcomes

After the completion of this course, students will be able to:

CO1.	Understand the general physiology for man-machine interaction in medical environment.
CO2.	Understand the fundamentals of the concept and design of biomedical equipment.
CO3.	Understand the importance of medical data for better healthcare.
CO4.	Analyse the electrical hazards associated with medical equipment so that the safety equipment can be devised or suggested.
CO5.	Work in an interdisciplinary team.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Physiology of cardiac system, pulmonary system, urinary system, nervous system and muscles. Generation and propagation of action potentials in muscle, heart and nervous system.	**8**
Module – II Electrocardiograph; Electromyograph; Electroencephalograph; Phonocardiograph; Plethysmograph; Pulmonary function test devices; Non-Invasive and Invasive Blood Pressure measurement.	**8**
Module – III Pacemaker; Defibrillator; Anesthesia machine; Ventilator; Heart-Lung machine; Hemodialysis machine; Audiometry and Hearing aids; Nerve and Muscle stimulators; Therapeutic and Surgical diathermies.	**8**
Module – IV Generation of X-ray; X-ray imaging device; Catheterization system; Computer Assisted Tomography; Generations of Computer Assisted Tomography System.	**8**
Module – V Ultrasound and Doppler equipment; Magnetic Resonance Imaging device; Functional Imaging with Gamma camera; Single Photon Emission Tomography; Positron Emission Tomography.	**8**

Textbooks:

1. Textbook of Medical Physiology by A. C. Guyton, 8th edition, Prism Indian Publication, Bangalore, 1991.
2. Handbook for Biomedical instrumentation by R. S. Khandpur, 3rd edition, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2014.

Reference Books:

1. Medical instrumentation, Application &Design by J. G. Webstar, 4th edition, Wiley Student Edition, New Delhi, 2009.
2. Introduction to Biomedical Equipment Technology by J. J. Kar and J. M. Brown, 4th edition, Pearson India Education Services Pvt. Ltd., Noida, 2016.

Gaps in the Syllabus (to meet Industry/Profession requirements):

Electrophysiological and metabolic understanding of the vital organs.

Engineering design concept of biomedical equipment.

Concepts of signal and image processing.

POs met through Gaps in the Syllabus: PO1, PO3, PO5

Topics beyond syllabus/Advanced topics/Design:

Fundamentals of biochemistry.

Protective measures in handling medical equipment.

Understanding of hospital organization for installation of medical devices.

POs met through Topics beyond syllabus/Advanced topics/Design: PO1, PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	0	0	2	1	0	0	0	2	2	2	0
CO2	3	2	3	2	3	0	0	0	0	0	2	3	3	1
CO3	2	2	1	2	2	0	2	0	0	2	2	2	2	1
CO4	2	3	2	2	2	2	3	0	0	0	0	2	2	1
CO5	0	0	0	0	0	0	0	3	3	3	2	1	2	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD3, CD4
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3, CD6
CO5	CD4, CD5

COURSE INFORMATION SHEET

Course Code: EE24387

Course Title: Applied Control Theory

Pre-requisite(s): Basic electrical Engineering, physic system theory and fundamentals of control system

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VI/3

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions to impart to students to:

A.	To acquaint students with concepts of state variables.
B.	To deliver comprehensive knowledge of mathematical modelling of linear/nonlinear system.
C.	To elucidate basics of designing the control problem.
D.	To brief them on theory of adaptive control theory.
E.	To acquaint students with concepts of nonlinearity in control problem.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Find out the ABCD parameter of a system
CO2	Able to solve the pole placement design
CO3	Simulate the control problem and analyses
CO4	Handle the nonlinearity in control system design
CO5	Able to design and provide a control topology for given engineering system.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Concepts of State, State Variables: Development of state-space models. State and state equations, State equations from transfer function from state equations. State transition matrix, Solution of State equation, Transfer Matrix, State variables and linear discrete-time systems.	**9**
Module – II Controllability and Observability: Controllable and observable State models, Controllability and observability for discrete-time systems.	**9**
Module – III State Variable Feedback: Asymptotic state observers. Control system design via pole placement	**9**
Module – IV Optimal Control Systems: Introduction, Performance indices, Optimal control problems- Transfer function approach, State variable approach; Parameter optimization. Stability of Non-Linear Systems: Stability concepts. Stability analysis using Lyapunov's Direct method; Popov's stability criterion.	**9**
Module – V Non-Linear Systems: Introduction. Common nonlinearities. Methods of studying non-linear systems: Linearization; Describing function analysis; Phase plane analysis. Adaptive Control Systems: Performance indices. Adaptive Controllers, Identification of dynamic characteristics of the plant.	**9**

Textbooks:

1. Control Systems Engineering-I. J. Nagrath & M. Gopal.

Reference books:

1. Modern Control System Theory-M. Gopal.
2. Modern Control Engineering-K. Ogata.
3. Control Systems-N. K. Sinha.

Gaps in the Syllabus (to meet Industry/Profession requirements):

Transducer and sensor mathematical model.

Real time simulation and analysis of control system.

Application of artificial intelligent topology for control system.

POs met through Gaps in the Syllabus: PO1, PO5, PO6

Topics beyond syllabus/Advanced topics/Design:

Digital signal processing.

Actuator and sensor moulding.

Neural network and AI system.

POs met through Topics beyond syllabus/Advanced topics/Design: PO3, PO5

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	0	0	0	0	1	0	3	2	0
CO2	2	3	3	2	2	0	0	0	1	1	0	2	3	0
CO3	2	2	3	3	3	0	0	1	1	2	1	2	3	2
CO4	2	3	2	3	2	0	1	0	1	1	1	2	2	2
CO5	3	3	3	2	3	1	1	1	2	2	1	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation – 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

COURSE INFORMATION SHEET

Course Code: EE24411

Course Title: Specifications & Estimation of Electrical Installations

Pre-requisite(s): Basic electrical

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: IV/2

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions imparting to students the:

A.	Concept of electrical wiring
B.	Identification of the load distribution
C.	Familiarity with selection of conductors, switching and protection elements
D.	Estimation of electrification
E.	Knowledge, specification and planning of transmission and distribution lines.

Course Outcomes

After the completion of this course, students will be:

CO1.	Familiar with electrical wiring, planning and estimation.
CO2.	Able to analyze the electrical load distribution
CO3.	Able to estimate the costing of electrification for residential, commercial, and industrial.
CO4.	Capable of designing and implementation of electrical wiring.
CO5.	Able to understand the technical and commercial bid for transmission and distribution system.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Interior Wiring System: Different wiring systems, Comparison of the various systems, Choice of wiring systems. Adequate lighting, Earthing, Materials used for the electrification, Estimation of wiring installations.	**10**
Module – II Power Installation: Load calculations, Wire size selection, Power circuit wiring materials used and their specifications Estimation for motor installation, Pump-sets, Workshops, and theatre.	**12**
Module – III Transmission and Distribution Lines: Planning and surveying, Applicable IE rules, Materials required for 400 kV, 11 kV, and 400 V lines. Estimates of 400 kV, 11 kV lines, and 400 Volts/230 Volts distribution system, Distribution transformer installation, and estimation.	**8**
Module – IV Specification: Importance of specification, ISI specification of alternators, Transformers, Induction motors, Circuit breakers, Panels for transformers, Overhead line conductors, Insulators	**7**
Module – V Underground cables: types, ratings, testing, and applications. Storage batteries and earthing electrodes.	**6**

Textbooks:

1. Surjit Singh, Electrical Estimating and Costing
2. Dharmpal Rai & K.R. Gangadhar Rao, Electrical Estimating & Energy Management

Gaps in the Syllabus (to meet Industry/Profession requirements):

- Coordination with civil work.
- Testing of electrical installation.
- Usage of software and other modern tools for optimized estimation of wiring.

POs met through Gaps in the Syllabus: PO4, PO5, PO6

Topics beyond syllabus/Advanced topics/Design:

- Transmitters and receivers
- Tele-metering
- Usage of modern tools

POs met through Topics beyond syllabus/Advanced topics/Design: PO5, PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	0	2	1	1	0	2	2	2	3	2	1
CO2	3	3	2	2	2	1	1	1	1	1	2	3	3	1
CO3	2	2	2	1	3	1	2	1	1	2	3	2	2	2
CO4	3	3	3	2	3	2	2	1	2	2	3	3	3	2
CO5	2	2	2	1	3	1	2	2	2	3	3	2	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD5, CD6, CD7
CO2	CD1, CD5, CD6, CD7
CO3	CD1, CD5, CD6, CD7
CO4	CD1, CD5, CD6, CD7
CO5	CD1, CD5, CD6, CD7

COURSE INFORMATION SHEET

Course Code: EE24421

Course Title: Robotics

Pre-requisite(s): Engineering Mathematics, Signal and systems, Control Theory, Basic programming knowledge.

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: V/3

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions to impart to students to:

1.	Outline fundamentals of robotics and discuss different types of sensors and basic programming languages used for robotics
2.	Describe direct and inverse kinematics of robots and to illustrate techniques used for planning robot motions in order to solve meaningful manipulation tasks.
3.	Explain different methods for control of robotic manipulators.
4.	Appraise the use of robotic vision in different field of robotics and compile all the techniques discussed.
5.	Propose solution in the in the field of robotics using state-of-the-art techniques.

Course Outcomes

After the completion of this course, students will be able to:

CO1	enumerate characteristics of robots, sensors used and basic programming languages
CO2	visualize and associate direct and inverse kinematics to real life problems.
CO3	to explain and analyse different techniques for planning robot motions and control of robotic manipulators
CO4	assess the techniques of computer vision necessary in the field of robotics
CO5	solve real life problems based on direct and inverse kinematics and simulate different controllers.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction of Robotics:** Evolution of Robots and Robotics. What is and what is not a robot. Robot classification. Robot specifications. Robot applications. Direct Kinematics: Coordinate frames; Rotations; Homogeneous coordinates; D-H representation; The Arm Equation **Inverse Kinematics:** Inverse Kinematics Problem. General properties of solutions. Tool configuration. Robotic work cell.	**8**
Module – II **Workspace Trajectory and Trajectory Planning:** Workspace analysis. Workspace envelope. Workspace fixtures. Pick and place operation. Continuous path motion. Interpolated motion. Straight line motion.	**8**
Module – III **Sensing and Control of Robot Manipulators:** Computed torque control; Near Minimum time control; Variable structure control; Non-Linear decoupled feedback control; Resolved motion and Adaptive control. **Robotic Sensors:** Different sensors in robotics: Range; Proximity; Touch; Torque; Force and others.	**8**
Module – IV **Robotic Vision**: Image acquisition. Imaging geometry, Image processing: Preprocessing; Segmentation and Description of 3-D structures; Recognition and interpretation.	**8**
Module – V **Robot Programming Languages:** Characteristics of Robot level languages. Task level languages: Task planning; Problem reduction; Use of predicate logic; Robot learning; Expert systems.	**8**

Textbooks:

1. 1. Fundamental of Robotics: Analysis and Control- Robert J. Schilling.
2. Robotics: Control, Sensing, Vision and Intelligence- K. S. Fu, R.C. Gonzalez and Lee.

Reference books:

1. 1. Robotics and Control – R. K. Mittal and I. J. Nagrath.

Gaps in the Syllabus (to meet Industry/Profession requirements): Simulation to meet real time implementation of techniques for control of robots.

POs met through Gaps in the Syllabus: PO3, PO5, PO6

Topics beyond syllabus/Advanced topics/Design: Simulation given to students as assignments.

POs met through Topics beyond syllabus/Advanced topics/Design: PO3, PO5, PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	0	2	0	0	0	0	1	2	2	2	1
CO2	3	3	2	1	2	0	0	0	0	1	2	2	3	2
CO3	3	3	3	2	2	0	0	1	1	1	2	2	3	2
CO4	2	2	2	2	3	0	0	1	1	2	2	1	3	2
CO5	3	3	3	3	3	0	0	1	2	2	2	2	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3, CD5, CD6

COURSE INFORMATION SHEET

Course Code: EE24413

Course Title: Utilization of Electrical Power

Pre-requisite(s): BEE, Electrical Machines

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VI/3

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions to impart to students to:

A.	To explain the requirements of ideal traction supply system, train movement and energy consumption and the various methods of speed control of traction motors.
B.	To outline the knowledge of various methods of heating and welding and their applications.
C.	To list the laws of illumination, sources of illumination, flood lighting and street lighting and outline the knowledge of components of PLC and PLC programming
D.	Recall the knowledge of motor control circuits and their components, interlocking methods, different control methods and their applications.

Course Outcomes

After the completion of this course, students will be able to:

CO1.	Explain the concept of the following: Duty cycle of a train speed control of traction motors
CO2.	Show a basic understanding of variety of tools and techniques (based on physics) used in heating, welding
CO3.	Design illumination schemes
CO4.	Reproduce the knowledge of various methods of motor control and PLC programming.
CO5.	Solve numerical problems on different engineering topics related to this subject

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Electric Traction: Introduction, Requirements of Ideal Traction System Supply system for electric traction, Train movement Energy consumption. Co-efficient of adhesion, the traction motors starting, Breaking of Traction motors.	**6**
Module – II Speed Control of Traction Motor: Semiconductor converter-controlled drives of Traction Motor, Chopper controlled DC traction motor drives. PWM Voltage source inverter (VSI) Induction motor drives, load commutated inverter fed synchronous motor drivers, CSI squirrel Cage IM drive, PWM VSI Squirrel cage IM drive. Drives of Diesel Electric Traction Motors: Diesel Engine driven D.C Generator Feeding dc series motors. Diesel Engine driven three-phase alternator supplying dc motors	**8**
Module – III Heating & Welding: Introduction, Different methods of heating, Temperature control of resistance furnace, Induction heating, Dielectric heating, Electric welding, Different welding methods, current control of welding transformer, Ultrasonic and laser welding. Illumination: Introduction, Nature of radiation, Definitions. Polar curve, Law of Illumination, Luminous Efficacy, Source of light, Incandescent, Vapor, Fluorescent Lighting calculations, Flood lighting, Street lighting.	**10**
Module – IV PLC: Introduction, Ladder diagram fundamentals of PLC: Introduction, Basic components, and their symbol, Fundamentals of ladder diagram. PLC configurations. System Block Diagram, Update- solve the ladder Network. Fundamental PLC Programming: Physical components Vs. Program components, Internal Relays, Disagreement circuit. Ladder program, Execution sequence, Flip-Flop circuits, Mnemonic programming code: AND ladder rung, entering normally closed contracts, OR ladder rung, Simple branches, Complex branches.	**10**
Module – V Motor Control Circuit Components, Interlocking methods for reversing control, Sequence control, Schematic and wiring diagram for motor control circuits, Remote control operation of an IM, Motor driven pump for a water tank, automatic water level control, Sequence operation of motors with interlocking arrangements.	**7**

Textbooks:

1. Generation, Distribution and Utilisation of Electric Power, C. L. Wadhwa, Revised Edition, Wiley–1993.
2. Electrical Design and Estimating and Costing, K. B. Raina and S. K. Bhattacharya, Reprint 2001, New Age International (P) Ltd., Publishers– 1991.
3. Fundamentals of Electrical Drives, G. K. Dubey, Second edition, Narosa Publication, New Delhi- 2001
4. Programmable Logic Controllers, John R. Hackworth and Frederick D. Hackworth Jr., Third edition, Pearson Education–2008.

Reference Books:

1. Utilisation of Electric Power, N. V. Suryanarayana, Reprint 2003, New Age International (P) Ltd., Publishers, New Delhi – 1994.
2. Utilisation of Electric Power, Taylor, London: English ersities Press, 1955.

Gaps in the Syllabus (to meet Industry/Profession requirements): Nil

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design: Nil

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	0	2	1	2	0	0	0	2	3	2	1
CO2	2	2	1	0	2	0	2	0	0	0	1	2	2	0
CO3	2	2	3	2	3	1	2	0	0	0	2	2	3	1
CO4	3	2	2	2	3	0	1	0	1	1	2	3	3	2
CO5	3	3	2	2	2	0	1	0	0	0	2	2	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: EE24415

Course Title: High Voltage Engineering

Pre-requisite(s): Fundamental of Electrical and Electronics Engineering, Electromagnetics Field, Electrical Measurement, Electrical Insulating Material

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VII/4

Branch: EEE

Name of Teacher:

Course Objectives

1	To educate students about electric field stress.
2	To give exposure about different types of electrical insulation
3	To give information about conduction and breakdown in different types of electrical insulation
4	To impart knowledge about the methods of generation and measurement of high voltage and current for testing
5	To train the students for the design of high voltage laboratory

Course Outcomes

Students will be able to

CO1	Gain skillful knowledge of controlling electrical stress in electrical systems and properly using electrical insulating media.
CO2	identify possible reasons for the failure of electrical insulation
CO3	explore remedial measures for the failure of electrical insulation.
CO4	Understand the principle of high voltage measurement systems.
CO5	design circuits for generation of high voltage and current, electrical insulation system, and set up high voltage lab

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction: Electric Field Stresses, Gas/Vacuum as Insulator, Liquid Breakdown, Solid Breakdown, Estimation and Control of Electric Stress.	**5**
Module – II Conduction and Breakdown in Gases: Gases as Insulating Media, Ionization Processes, Townsend's Current Growth Equation, Townsend's Criterion for Breakdown, Breakdown in Electronegative Gases, Time Lags for Breakdown, Streamer Theory of Breakdown in Gases, Paschen's Law, Breakdown in Non-Uniform Fields and Corona Discharges, Post-Breakdown Phenomena and Applications, Vacuum Insulation.	**6**
Module – III Conduction and Breakdown in Liquid: Liquids as Insulators, Pure Liquids and Commercial Liquids, Conduction and Breakdown in Pure and Commercial Liquids. Conduction and Breakdown Solid Dielectrics: Introduction, Intrinsic Breakdown, Electromechanical and Thermal Breakdown, Breakdown of Solid Dielectrics in Practice, Breakdown in Composite Dielectrics	**5**
Module – IV Generation High Voltage and Currents: Generation of high DC voltages, Generation of High alternating voltages, Generation of impulse voltages, Generation of impulse currents, Tripping and control of impulse generators. Measurement of High Voltage and Currents: High direct current voltages, high AC and impulse voltages, and High impulse currents.	**7**
Module – V Design, Planning and Layout of High Voltage Laboratories: Introduction, Test Facilities provided in high voltage laboratories, Activities and studies in high voltage laboratories, Classification of high voltage laboratories, Size and Rating of large size high voltage laboratories, Grounding of impulse testing laboratories.	**5**

Textbook:

1. High Voltage Engineering, MS Naidu and V. Kamaraju, 4th edition, TMH New Delhi.
2. High Voltage Engineering Fundamentals, E. Kuffel and W S Zaengl, Pergamon Press, Oxford.

Reference Book:

1. High Voltage Engineering, C L Wadhwa, 2nd edition, New Age International (P) Limited, Publishers, New Delhi.

2. Electrical Breakdown of Gases, 2nd edition, JM, Meek and JD, Crages, John Wiley, New York.

Gaps in the Syllabus (to meet Industry/Profession requirements): HVDC and HVAC Power Transmission, Insulation Coordination.

POs met through Gaps in the Syllabus: PO3, PO4

Topics beyond syllabus/Advanced topics/Design: Insulation simulation and design using software, lightning.

POs met through Topics beyond syllabus/Advanced topics/Design: PO5, PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	0	2	2	1	0	0	1	2	3	3	2
CO2	2	3	2	2	1	1	2	0	0	1	2	3	3	2
CO3	2	3	3	2	2	1	2	0	0	1	2	3	3	2
CO4	3	2	2	3	3	2	1	0	0	1	2	3	3	2
CO5	3	2	3	2	3	2	2	0	1	1	2	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3, CD5
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3, CD6, CD7

COURSE INFORMATION SHEET

Course Code: EE24417

Course Title: HVDC and FACTS

Pre-requisite(s): Knowledge of basic power system, power electronics, and control system courses.

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VII/4

Branch: EEE

Name of Teacher:

Course Objectives

This course enables the students to:

A.	Identify the significance of HVDC System
B.	Understanding the AC/DC conversion and its components and Interpretation of reactive power harmonics in HVDC system.
C.	Define different types of FACTS devices and their need in emerging power system.
D.	Describe the operations of FACTS controller in a large-scale power system and to solve the power flow problems using efficient numerical methods suitable for computer simulation.

Course Outcomes

After the completion of this course, students will be able to:

CO1.	To list significance/ importance/ advantages of HVDC systems over EHVAC systems, types, and application of HVDC system
CO2.	To explain different converters and inverters for converting AC to DC & DC to AC conversion and to interpret the reactive power, harmonics in HVDC system, its effect and filtering.
CO3.	Explain the operating principles, modelling, and control systems of different FACTS Controllers/Devices.
CO4	Solve and analyze power flow with FACTS devices using efficient numerical methods.
CO5.	Discuss the techniques of practical FACTS controller design for various applications, such as, enhancing power transfer, stability, and damping, preventing voltage instability etc.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction to HVDC transmission:** Comparison with EHV AC power transmission, HVDC system configuration and components.	**7**
Module – II **Principles of AC/DC conversion:** Converter connections, Waveforms, Relevant Equations, Reactive Power requirements.	**8**
Module – III **Harmonics and Filters:** Waveforms of a-c bus currents in Star/Star, Star/delta&12-phase converters and their Fourier-series representations, non-characteristic harmonics, Harmful Effects of Harmonics, DC side harmonics, Filters and detuning, Cost considerations of filters.	**8**
Module – IV **FACTS Concept and THYRISTOR-BASED FACTS CONTROLLER:** Introduction to FACTS Devices: Need for FACTS in emerging power systems – Definitions–Types of FACTS– FACTS and High Voltage DC (HVDC) Transmission. Static Var Compensator (SVC)–Functional description and structures – Control components and Models – Concepts of voltage control –Controls and Applications, MATLAB Implementation.	**10**
Module – V **VOLTAGE SOURCE CONVERTER (VSC) BASED FACTS CONTROLLER:** Static Synchronous Compensator (STATCOM): Functional description and structure, Models, Controls and Applications, MATLAB Implementation.	**7**

Textbooks:

1. HVDC Power Transmission Systems by K. Padiyar, Wiley Eastern Ltd.
2. Direct Current Transmission by E. W. Kimbark, Wiley Inter Science-New-York
3. R. M. Mathur and R. K. Varma, "Thyristor-Based FACTS Controllers for Electrical Transmission Systems", IEEE Press and John Wiley & Sons, New York, USA, Feb. 2002, ISBN: 978-0-471-20643-9
4. Understanding of FACTS by N. G. Hingorani & L. Gyugyi, IEEE Press.

Reference Books:

1. HVDC Transmission by J. Arillaga, Peter Peregrinus Ltd; London U.K., 1983
2. Power Transmission by Direct Current by E. Uhlman, Springer Verlag, Berlin Helberg, 1985
3. N. G. Hingorani and L. Gyugyi, "Understanding FACTS", IEEE Press, New York, USA, 1999.
4. Y. H. Song and A. T. Johns, eds, "Flexible AC Transmission Systems (FACTS)", IEE Press, U. K., 1999
5. "FACTS Applications", IEEE-PES Publication 96 TP 116-0, 1996.

6. "Modeling of Power Electronics Equipment (FACTS) in Load Flow and Stability Programs", CIGRETF 38.01.08, Technical Brochure 145, August 1999.

Gaps in the Syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	0	2	1	2	0	0	1	1	3	2	1
CO2	3	3	2	2	3	1	2	2	0	1	1	3	3	2
CO3	3	2	3	3	3	1	2	2	1	2	1	3	3	2
CO4	3	3	3	3	3	1	2	2	1	2	2	3	3	2
CO5	3	2	3	2	3	1	3	2	2	2	2	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation – 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2
CO2	CD1, CD2
CO3	CD1, CD2
CO4	CD1, CD2
CO5	CD1, CD2

COURSE INFORMATION SHEET

Course Code: EE24419

Course Title: Testing and Commissioning of Electrical Equipment

Pre-requisite(s): Electrical Machines and Switchgear and Protection.

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VI/3

Branch: EEE

Name of Teacher:

Course Objectives

The course is designed to:

1	Provide knowledge of installation, testing, commissioning, and maintenance practices for electrical equipment such as transformers, induction motors, synchronous machines, and switchgear.
2	Familiarize students with relevant codes of practice, standards, and testing procedures for electrical apparatus.
3	Develop an understanding of mechanical, electrical, and thermal stresses encountered by equipment during operation and commissioning.
4	Train students in interpreting test results, diagnosing faults, and applying corrective measures.
5	Inculcate awareness of safety, reliability, and preventive maintenance schedules for electrical equipment.

Course Outcomes

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

CO1	**Explain** the specifications, installation requirements, and commissioning procedures for transformers, induction motors, synchronous machines, and switchgear.
CO2	**Conduct** routine and special commissioning tests such as insulation resistance, polarity, earth resistance, temperature rise, and performance tests
CO3	**Analyze** test results to evaluate the operational condition, performance, and efficiency of electrical equipment.
CO4	**Demonstrate** the ability to identify common faults, perform troubleshooting, and suggest remedial actions
CO5	**Apply** relevant IS/IEC codes, standards, and safety practices during testing and commissioning activities accordingly prepare documentation for reliable and safe operation of electrical equipment.

MODULE	(NO. OF LECTURE HOURS)
Module – I Transformers: Specification, Installation- Location and sites, Selection and design of foundation details (like bolts size, their number, etc.) code of practice for terminal plates, polarity and phase sequence, Oil tanks, drying of windings with & without oil, general inspection. Commissioning test such as volt ratio test, earth resistance oil strength, Buchholz & other relays, tap changing gear, fans & pumps, insulation test, impulse test, polarizing index, and load & temperature rise test. Determination of mechanical stress under normal & abnormal conditions, Maintenance Schedule.	**12**
Module – II Induction Motors: Specifications for different types of motors, duty, protection. Installation of the motors (including the foundation details) & its control apparatus, Shaft & alignment for various coupling, fitting of pulleys & couplings, Drying of windings, Commissioning test - mechanical tests for alignment, air gap symmetry, tests for bearings, vibrations & balancing. Electrical Tests - Insulation test, earth resistance, High voltage test, starting up failure to speed up to take the load type of test, routine test, factory test and site tests (in accordance with ISI code). Specific Tests-Performance & temperature rise tests, stray load losses, re-rating & special duty capability. Maintenance Schedule.	**12**
Module – III Synchronous Machines: Specifications, Installation- Physical inspection, Rating nameplate details, Foundation details, Alignments, Excitation systems, Cooling & control gear, drying out. Commissioning Tests- Insulation, Resistance measurement of armature & field wings, Wave from & telephone interference factors, Line charging capacity.	**8**
Module – IV Performance Tests: Various tests IP estimate the performance for generator & motor operations slip maximum lagging currents, Maximum reluctance power tests, sudden short circuit tests, transient & sub transient parameters, measurements of sequence impedances, capacitive reactance, Separation of losses, temperature rise tests, and Retardation tests. Factory Tests - Gap length, magnetic centricity balancing vibration, bearing performance.	**7**
Module – V Switchgear & Protective Devices: Standards, types, Specification, Installation, Commissioning tests, Maintenance schedule, Type & routine tests.	**6**

Textbooks:

1. S. Rao, Testing & Commissioning of electrical equipment, Khanna Publishers.
2. B.V.S. Rao, Testing & Commission of electrical equipment

Reference Books:

1. Relevant Bureau of Indian Standards.
2. Transformers – BHEL.
3. J & P transformer Handbook.
4. J & P Switchgear Handbook

Gaps in the Syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	0	0	0	0	2	1	3	2	1
CO2	3	3	2	3	2	0	0	0	0	1	1	3	3	2
CO3	2	3	2	3	2	1	1	0	0	1	2	2	3	2
CO4	2	3	2	2	2	1	1	0	1	1	1	2	3	2
CO5	2	2	2	2	2	2	2	1	2	3	2	2	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation – 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD5, CD7
CO3	CD1, CD2, CD5
CO4	CD1, CD3, CD4
CO5	CD1, CD7

COURSE INFORMATION SHEET

Course Code: EE24XXX

Course Title: Micro-Grid Operation and Control

Pre-requisite(s): Electrical Power System Transmission and Distribution, Control System and Power Electronics, Control System and Power Electronics

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VII/4

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions imparting the following objectives to the students:

A.	To enumerate the necessity of active distribution network and understand the principle of operation of microgrid.
B.	To expose the responsibility of controllers connected with DE Rs through IEEE standards 1547-2018.
C.	To feature the maximum power extraction from SPV system, the working procedure of SPV controllers and its integration with the main grid.
D.	To assess different controllers for voltage and frequency restoration in microgrid.
E.	To outline the basic principles of stability and protection of microgrids.

Course Outcomes

After the completion of this course, students will be able to:

CO1.	Describe the concept of microgrid and outline the significance of microgrid in big utility grid.
CO2.	Explain the control structure, its requirement and importance of controller in microgrid.
CO3.	Explain and design primary controllers MPPT controller, centralized, decentralized energy management system and modelling of PV system.
CO4.	Outline the steps and accordingly design and evaluate the performance of different controller.
CO5.	Explain the protection philosophy of islanding detection technique and the general microgrid protection.

SYLLABUS:

MODULE	(NO. OF LECTURE HOURS)
Module – I **Concept of Microgrid:** Distributed generation and Microgrid concept: Introduction, Conventional Power System Structure, Typical micro grid configuration, Microgrid definition and characteristics, Interconnection of renewable energy sources with microgrids, Technical and economic advantages of micro grid, Key challenges.	**6**
Module – II **Microgrid components and Modeling**: Introduction, PV model, Converter modeling, MPPT controller, Integration of solar sources: Complete modeling of the Entire PV Energy Conversion System, PV Controller, Energy storage system modeling, Control steps, Modeling of connection between main grid and microgrid, Overall representation of grid connected microgrid	**10**
Module – III **Hierarchical Microgrid Control** Introduction, Local or primary Control: Droop Control, Droop Control in Inverter-based Distributed Generators, performance of primary controller, Secondary Control and Tertiary Control. Centralized and decentralized Energy Management System (EMS) in microgrids.	**8**
Module – IV **Stability & dynamic performance of microgrid:** Introduction, Negative impacts due to low inertia, Modeling of Virtual Synchronous Generator (VSG), Emulation of VSG, Inertial droop control, Transient frequency response, Closed loop state-space modeling.	**8**
Module – V **Islanding & emergency control Islanding:** Non-detection zone, Anti-islanding techniques, different islanding scenarios. Emergency control: different load shedding algorithms, Under voltage- frequency load shedding, Voltage, and frequency performance. Basic concepts of hybrid AC-DC microgrids.	**8**

Textbooks

1. Microgrid Dynamics and Control, Hassan Bevrani, University of Kurdistan, Kurdistan, Iran, Bruno Francois, Centrale Lille, France, Toshifumi Ise, Osaka University, Osaka, Japan. First edition. Hoboken, NJ: John Wiley & Sons, 2017.
2. Microgrid: architectures and control / edited by professor Nikos Hatziargyriou. Wiley, IEEE Press, ISBN: 978-1-118-72068-4.
3. Microgrids and Active Distribution Networks, S. Chowdhury, S.P. Chowdhury and P. Crossley. The Institution of Engineering and Technology, London, United Kingdom, © 2009 The Institution of Engineering and Technology.

Gaps in the Syllabus (to meet Industry/Profession requirements):

More focus on secondary and tertiary control in decentralized environment.

Details in protection system for microgrid

POs met through Gaps in the Syllabus: PO3, PO4

Topics beyond syllabus/Advanced topics/Design:

The role of centralized and decentralized controllers.

Relay coordination.

POs met through Topics beyond syllabus/Advanced topics/Design: PO2

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	0	1	1	2	0	0	1	2	3	2	1
CO2	3	3	2	1	2	1	2	0	0	1	2	3	3	2
CO3	3	3	3	2	3	0	2	1	0	1	2	3	3	2
CO4	3	3	3	3	3	1	2	1	1	2	2	3	3	2
CO5	3	3	2	2	2	2	3	1	1	1	2	3	2	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3, CD6
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: EE24423

Course Title: Advanced Power System Analysis and Control

Pre-requisite(s): Power system analysis, basics of control system.

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VII/4

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions imparting the following objectives to the students:

A	To define single-phase modeling of power system components.
B	To describe steady state operation of large-scale power systems and to solve the power flow problems using efficient numerical methods suitable for computer simulation.
C	To analyze power systems under abnormal conditions (short circuit) utilizing bus impedance matrix for short circuit analysis
D	To analyze power system security using contingency analysis and assess the state estimation
E	To understand the nature of frequency change in Isolated and integrated system and thereby the control strategy for generator

Course Outcomes

After the completion of this course, students will be:

CO1	draw the impedance and reactance diagram and can explain different components modelling for load flow, short circuit, contingency analysis and harmonic analysis of power system
CO2	explain and solve load flow problems by different methods
CO3	identify and analyze the different abnormal (fault) conditions in power system utilizing efficient computer algorithm
CO4	explain different factors affecting the power system security for single and multiple contingencies, and assess state estimation of power system;
CO5	to utilize the knowledge of mathematics, physics, control system, and network analysis to evaluate the frequency change and calculate the primary and secondary parameter for Automatic generation control.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction: Modelling of power system component, Basic single-phase modeling, Generation, Transmission line, transformer, Shunt elements.	**8**
Module – II Load Flow Analysis: Introduction, Nature of load flow equations, Newton Raphson method: Formulation for load buses and voltage-controlled buses in rectangular and polar coordinates, Computational steps and flowchart, Computational Aspects of Large-Scale System-Introduction, Sparsity oriented technique for reducing storage requirements, Factorization.	**8**
Module – III Short Circuit Analysis: Introduction, Bus impedance matrix, and its building algorithm through modifications, Fault calculation uses Zbus and its computational steps. Symmetrical and Unsymmetrical faults.	**8**
Module – IV Contingency Analysis: Introduction to power system security, Factors affecting power system security, Analysis of single contingencies, Linear sensitivity factors, Analysis of multiple contingencies, Contingency ranking. State Estimation: Introduction, weighted least square technique, Statistics, Errors and estimates.	**8**
Module – V Load Frequency Control - Introduction, Types of speed governing system and modeling, Mechanical, Electro-hydraulic, Digital electro-hydraulic governing system, Turbine modeling, Generator-load modelling, Steady-state and dynamic response of ALFC loop, the secondary ALFC loop, Integral control.	**8**

Textbooks:

1. Power System Analysis - John J. Grainger, William D. Stevenson,Jr.
2. Power System Analysis - L. P.Singh
3. Power Generation Operation and Control - A.J. Wood, B.F. Wollenberg, John Wiley 7 Sons, 2nd Edition

Reference Books:

1. Electric Energy Systems Theory - An Introduction, O.L.Elgerd.
2. Computer Modelling of Electrical Power Systems - J. Arrillaga, N.R.Watson
3. Power System harmonic Analysis, J. Arrillage, B.C. Smith, etal.

Gaps in the Syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD3, CD5, CD6
CO2	CD1, CD3, CD5, CD6
CO3	CD1, CD3, CD5, CD6
CO4	CD1, CD3, CD5, CD6
CO5	CD1, CD3, CD5, CD6

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	2	3	0	0	2	0	0	0	3	2	0
CO2	3	3	2	3	3	0	0	2	0	0	0	3	3	0
CO3	3	3	2	3	3	0	0	2	0	0	0	3	3	0
CO4	3	3	2	3	3	2	2	2	0	0	0	2	3	2
CO5	3	3	2	3	3	0	0	2	0	0	0	3	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation – 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD3, CD5, CD6
CO2	CD1, CD3, CD5, CD6
CO3	CD1, CD3, CD5, CD6
CO4	CD1, CD3, CD5, CD6
CO5	CD1, CD3, CD5, CD6

COURSE INFORMATION SHEET

Course Code: EE24425

Course Title: Nonlinear and Adaptive Control

Pre-requisite(s): Control Theory

Co- requisite(s):

Credits: 04 L: 3 T: 1 P: 0

Class schedule per week: 04

Class: B. Tech

Semester/Level: VII/4

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions imparting the students to:

A.	State the basic concepts of nonlinear control and different methods for representing nonlinear systems.
B.	Recognize the common nonlinearities.
C.	Learn the tools for analysis of nonlinear systems and their different phenomena.
D.	Examine the methods of stability analysis of nonlinear systems.
E.	Illustrate the application of adaptive control to nonlinear systems.

Course Outcomes:

After completion of the course, the students will be able to:

CO1	Identify a nonlinear system and its characteristics.
CO2	Illustrate describing function and phase plane methods for modelling and analysis of nonlinear systems.
CO3	Interpret Lyapunov's method and apply it to stability analysis of nonlinear systems.
CO4	Describe adaptive control and analyze methods of parameter estimation.
CO5	Explain model reference adaptive control (MRAC) and classify its various laws.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction to nonlinear systems, Types of nonlinearities and their characteristics, nonlinear properties, Limit cycle, Singular points, Linear approximation of nonlinear systems.	**6**
Module – II Phase plane analysis: Phase plane representation, Phase portrait, graphical method to obtain phase trajectory, describing function analysis: Definition, Derivation of Describing functions for common nonlinear elements, Determination of amplitude and frequency of limit cycle using describing function technique.	**9**
Module – III Direct method of Lyapunov: Introduction, Basic concepts, Stability definitions, Stability theorems, Lyapunov functions for nonlinear systems, Feedback Linearization: Motivation, Input-output linearization, Full state linearization, State feedback control.	**9**
Module – IV Introduction to Adaptive Control, On-line Parameter Estimation, Spectral estimation, Optimum (Wiener and Kalman) linear estimation, Parameter Identifiers and Adaptive Observers	**8**
Module – V Model Reference Adaptive Control (MRAC): Direct MRAC Schemes, MRAC for SISO Plants, Direct MRAC with Unnormalized Adaptive Laws, Direct MRAC with Normalized Adaptive Laws.	**8**

Textbooks:

1. M. Gopal, "Digital Control & State Variable Method", TMH
2. B.C.Kuo, "Automatic Control System"7th Edition PHI

Reference books:

1. Slotine and Li, "Nonlinear Control Systems".
2. Hassan K.Khalil, "Non Linear Systems".
3. Shankar Sastry, Marc Bodson, "Adaptive Control", Prentice Hall Information and System Science Series.

Gaps in the Syllabus (to meet Industry/Profession requirements): Solving real-time problems related to industrial applications.

POs met through Gaps in the Syllabus: PO3, PO6

Topics beyond syllabus/Advanced topics/Design: Sliding Mode Control

POs met through Topics beyond syllabus/Advanced topics/Design: PO4, PO5

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	0	2	0	1	0	0	0	2	3	2	0
CO2	3	3	2	2	2	0	0	0	0	0	2	3	3	0
CO3	3	3	2	3	2	0	0	0	0	0	2	3	3	1
CO4	3	2	2	3	2	0	0	0	1	1	2	2	3	2
CO5	3	2	2	2	2	0	0	0	1	1	2	2	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3, CD6
CO4	CD1, CD2, CD3, CD6
CO5	CD1, CD2, CD3, CD6

COURSE INFORMATION SHEET

Course Code: EE24427

Course Title: Power Conversion Techniques

Pre-requisite(s): Power electronics

Co- requisite(s): Network Theory

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VII/4

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions to impart to students to:

1.	Identify different triggering circuits and protection schemes of power devices
2.	Explain importance of rectification and PWM techniques in AC-DC conversion
3.	Analyze the dynamic performance of DC-DC converters
4.	Design an inverter with minimization of harmonics for power quality improvement
5.	Evaluate design cost of power electronic conversion circuit for performance enhancement of a system and teamwork

Course Outcomes

After the completion of this course, students will be able to:

CO1	To describe working principle of power switching devices.
CO2	Apply the knowledge of rectification and PWM to enhance the performance parameters
CO3	Analyze the transient behavior of DC power conversion circuits.
CO4	Design an inverter to address power quality issues including mitigation of harmonics
CO5	Optimize the cost of power electronic conversion circuit

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction:** Basic concept of gate drivers (Triggering techniques, optical isolators, protection circuits, and isolation transformers), snubber design and protection schemes of power devices, Analysis of switched circuits- thyristor controlled half-wave rectifier – R, L, RL, RC load circuits, classification, and analysis of commutation	**10**
Module – II **AC-DC Conversion:** Single-phase and three-phase AC to DC converters- operating domains of three-phase full converters and semi-converters, Reactive power considerations, Pulse width modulation techniques for converters, PWM rectifiers, Design and control of front-end converter.	**8**
Module – III **DC-DC Conversion**: Analysis and design of DC-DC converters- Control of DC-DC converters, Steady-state analysis of Buck, Boost, Buck-Boost, and Cuk converter. Advanced DC-DC converter topologies.	**10**
Module – IV **DC-AC Conversion:** Single phase and three-phase inverters, Voltage source and current source inverters, Voltage control and harmonic minimization in inverters, Applications of voltage source converters, Improved power quality converters (non-isolated and isolated) for reduction of harmonics at AC mains.	**10**
Module – V AC-AC Conversion: AC to AC power conversion using voltage regulators, AC to AC Converters with a DC Link, Matrix Converters, and Different type of cyclo-converters, consideration of harmonics, Applications of AC-AC converters.	**7**

Textbooks (T):

1. Umanand, L., 2009. *Power Electronics: Essentials and Applications*. Wiley India Pvt. Limited.
2. Krein, P.T., 1998. *Elements of power electronics* (Vol. 126). New York: Oxford University Press.

Reference Books (R):

1. Batarseh, I., 2004. *Power electronic circuits*. John Wiley.
2. Wu, K.C., 2005. *Switch-mode power converters: Design and analysis*. Elsevier.

Gaps in the Syllabus (to meet Industry/Profession requirements): Closed loop control of power conversion circuits.

POs met through Gaps in the Syllabus: PO4

Topics beyond syllabus/Advanced topics/Design: Matrix converters

POs met through Topics beyond syllabus/Advanced topics/Design: PO4

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	2	2	1	1	1	3	2	1
CO2	3	3	3	3	3	3	2	2	2	2	1	3	2	2
CO3	3	3	3	3	3	3	3	3	2	2	2	3	3	2
CO4	3	3	3	3	3	3	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD5, CD6
CO4	CD1, CD2, CD5, CD6, CD7
CO5	CD1, CD2, CD5, CD6

COURSE INFORMATION SHEET

Course Code: EE24459

Course Title: Smart Power System

Pre-requisite(s): Power system courses, power electronics.

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VII/4

Branch: EEE

Name of Teacher:

Course Objectives

The course objectives are:

A.	To provide the basic concepts of a smart grid compared with traditional Grids, smart grid enablers, and challenges.
B.	To make the students understand the importance of proper control design of converters with RESs in satisfying the operation of an active distribution system.
C.	To discriminate the working principle of PMU and its application.
D.	To educate the students about communication protocol and demand response programs and their application and implementation in smart grids.

Course Outcomes

After the completion of this course, students will be able to:

CO1.	Interpret the fundamental elements of the smart grid and the challenges associated with implementing the Smart Grid Concept.
CO2.	Analysis the challenges involved with RESs based active distribution system and the role of controllers of grid-interactive and off-grid converters connected with RES.
CO3.	Demonstrate the DSP application to the function of PMUs and its application in WAMS and the function of PMUs.
CO4.	Relate the importance of cyber security in the smart grid.
CO5.	Apply the design concept involved with demand response Programmes.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction: Smart Grid: The Definitions, Characteristics of Smart Grid, Traditional Grid Versus Smart Grid, Evolution of Smart Grid, Components of Smart Grid, Smart Grid operation and control architecture, The key challenges, Case studies: 2012 blackout and requirement of new technology.	**10**
Module – II Smart Grid and Generation: Active Distribution network and Micro-grid, Micro-Grid Structure, Basic Concepts of Solar and Wind Generation, Different issues of Grid-tied inverter, Grid following and grid forming issues in islanding., Different disadvantages: Managing renewable intermittency in smart grid, Energy storage system for smart grid application, stability issues.	**10**
Module – III Smart Grid and transmission system: Introduction, Wide-area monitoring system, Phasor measurement units (PMUs) smart meters, multi-agent system technology, phasor measurement techniques: introduction, phasor estimation of nominal frequency signals, phasor updating using non-recursive and recursive updates, phasor estimation at off-nominal frequency input, hierarchy of phasor measurement systems, communication options for PMUs, functional requirements of PMUs and phasor data concentrators (PDCs).	**8**
Module – IV Smart Grid and Communication system: Introduction, Role of communication in smart grids, Bluetooth-IEEE 802.15.1, ZigBee Technology, Ultra-Wideband- IEEE 802.15.3a, TCP over wireless network: Overview of traditional TCP, Impact on the performance of TCP over wireless environment, Link Layer scheme (Snoop Protocol), The I-TCP protocol, The mobile TCP Protocol, IPv4 vs IPv6 : IPv4 and IPv6 addressing IPv4 and IPv6 header format, IPv4 option, IPv6 extension header, IPv5 routing architecture, QoS capabilities, IPv6 transition mechanism.	**10**
Module – V Smart Grid and Demand Response: Introduction, demand response, Types of demand Response Programmes, Benefits of demand response programs, Advanced metering infrastructure, quantification of financial benefit of generation utility and distribution utility, Basic concept of bigdata analysis.	**8**

Test Books

1. Smart Grids: opportunities, developments and trends by A.B.M Shawkat Ali, publisher : Springer, ISBN: 978-1-4471-5209-5
2. A.G. Phadke J.S. Thorp, "Synchronized Phasor Measurements and their Applications", springer 2008
3. Wireless Communication & Networking by Vijay K. Garg, Elsevier.

Reference Books:

1. James Momoh**, "**SMART GRID: Fundamentals of Design and Analysis", IEEE (Power engineering series) – Wiley- Blackwell, April 2012

2. Janaka Ekanayake, KithsiriLiyanage, JianzhongWu, Akihiko Yokoyama, Nick Jenkins "Smart Grid Technology and Applications", Wiley, New- Delhi, August 2015

Gaps in the Syllabus (to meet Industry/Profession requirements):
POs met through Gaps in the Syllabus:
Topics beyond syllabus/Advanced topics/Design:
POs met through Topics beyond syllabus/Advanced topics/Design:
Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	2	2	1	0	1	2	3	2	1
CO2	3	3	2	2	3	2	2	1	0	0	2	3	3	2
CO3	2	2	2	3	3	1	1	2	0	1	2	2	3	2
CO4	1	2	1	2	2	3	3	2	1	2	2	2	2	3
CO5	2	2	3	2	3	2	2	1	1	2	2	3	2	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

COURSE INFORMATION SHEET

Course Code: EE24429

Course Title: Power Electronics Application

Pre-requisite(s): Power electronics.

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VII/4

Branch: EEE

Name of Teacher:

Course Objectives

This course enables the students to:

A.	Understand advanced concepts of various power electronics applications like HEV, HVDC and FACTS.
B.	Apply advanced concepts for analysis of existing power electronics-based systems.
C.	Analyze power electronics topology of advance power electronics applications.
D.	Evaluate performance parameters of modern industrial chips for power electronics.
E.	Design methods for development and execution of new power electronics-based installation

Course Outcomes:

After the completion of this course, students will be

CO1.	Describe working principles of advanced power converters.
CO2.	Solve problems in existing power electronics-based system using advanced concepts.
CO3.	Analyze performance parameters of state of art of power electronic technology.
CO4.	Evaluate the cost and efficiency of power electronics-based systems for maximum utilization of sustainable energy resources.
CO5.	Design novel power management systems and aspire for pursuing a carrier in power electronics, recognize the need to learn, to engage and to adapt in a world of constantly changing technology and play role of team leader or supporter of team.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction:** Scope of Power electronics on modern world, Overview of Triac High Power Switches, GTO, Power BJT , Power MOSFET , IGBT , MCT and IGCT, Feature of Converter of Power Electronics Electric Vehicles: Introductions, Advantages ,types of electrical vehicle, Energy management in electrical vehicles, features various subsystem in electrical vehicles. Limitations of EV, Future scopes.	**8**
Module – II **Hybrid Electrical Vehicles:** Introduction, Types of hybrid electrical vehicle, series, parallel, series-parallel and complex According to hybridization, Micro, mild and heavy HEV, Road load, DAB based battery charging, permanent magnet based AC motor Drive, Energy Storage system.	**8**
Module – III **Power Electronics for Green Energy:** Solar and Wind Energy, Buck-boost Converter, CUK converter, Single and Three phase boost inverter, Power Factor Correction devices: Extinction angle control, symmetrical angle control, PWM control, single and Three phase sinusoidal PWM control, Series and Parallel conversion of rectifiers	**8**
Module – IV **Flexible AC transmission systems (FACTS):** Introduction, principle of Power transmission series and shunt power compensation, Description of: TCR, TSC, SVC, STATCOM, TSSC, Comparison of Compensators.	**8**
Module – V **HVDC Transmission and Power Quality Management:** Introduction, advantages-Disadvantage of HVDC, type of HVDC Links, Monopolar, Bipolar, Homopolar Configuration,12-pulse converter in HVDC, Series and Parallel Converter.	**8**

Textbooks:

1. Understanding FACTS**:** concepts and technology of flexible AC transmission systems Narain G. Hingorani, Laszlo Gyugyi ,IEEE Press, 2000
2. Muhammad H. Rashid, "Power Electronics - Circuits, Devices and Applications", Prentice-Hall of India Private Ltd. New Delhi
3. Rao, S.,"EHVAC and HVDC Transmission", Khanna Publishers, 1991.

Reference books:

1. Rai, G.D.,"Solar Energy Utilisation", Khanna Publishers, New Delhi, 1991.
2. Gray.L.Johnson, "Wind energy systems", Prentice Hall Inc., 1985.

Gaps in the Syllabus (to meet Industry/Profession requirements): Practical design of converters using power electronics converter.

POs met through Gaps in the Syllabus: PO3

Topics beyond syllabus/Advanced topics/Design: Three phase grid connection.

POs met through Topics beyond syllabus/Advanced topics/Design: PO4

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	2	2	1	1	1	3	2	1
CO2	3	3	3	3	3	3	2	2	2	2	1	3	2	2
CO3	3	3	3	3	3	3	3	3	2	2	2	3	3	2
CO4	3	3	3	3	3	3	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD3
CO2	CD1, CD2
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD5, CD6
CO5	CD1, CD5, CD6

COURSE INFORMATION SHEET

Course Code: EE24431

Course Title: Electric Vehicles

Pre-requisite(s): Power electronics, Microcontrollers

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VII/4

Branch: EEE

Name of Teacher:

Course Objectives

This course enables the students to:

A	Understand working of Electric Vehicles.
B	Able to choose components for a given electrical vehicle design and dimension according to the specification.
C	To integrate electrical vehicle components into a system and design for necessary controls.
D	To estimate and understand the requirement for the infrastructure, including various charging and power distribution solutions, required for electrical vehicles
E	To evaluate electrical vehicle design and infrastructure using modern tools.

Course Outcomes

After the completion of this course, students will be able to:

CO1.	List the different types of EV's
CO2.	Explain different architecture of EV's. Show suitability of a power converter in the EV's.
CO3.	Analyze dynamic Response of power train using different motors
CO4.	Evaluate the cost of practical design incorporating converters and drives
CO5.	Develop a strategy for the development of coordinated charging-based EVCI for inculcating leadership quality in order to carry out large scale projects of socio-economic importance.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction to Electric Vehicles:** Evolution of Electric Vehicles, Electric Vehicles and the Environment, EV classification and comparison with internal combustion engine: Technology, Advantages and Disadvantages of EV, EV configurations, Parameters of EV systems.	**9**
Module – II **Electric Machines in EV:** Working principle of DC machines, characteristics and types of DC machines, Overview of (speed torque characteristics) permanent magnet motor, BLDC motor, Electrical motor topologies and operations principles: radial, axial and transversal flux motors. Torque production and characteristics of induction, permanent magnet and reluctance motors, comparison of all motor's performance in EV	**15**
Module – III **Converters in Electric vehicles (Wireless Power Transfer):**Introduction to wireless power transfer, Analysis of power converter for WPT, Analysis of various configuration of inductively coupled WPT, Challenges in Wireless Power Transfer, Available solution to Challenges in WPT, Frequency Analysis of WPT power converters, Evaluation of maximum efficiency and optimal load for WPT.	**7**
Module – IV **Embedded Systems for EV:** Introduction to VCU, Different types of VCU and their function, Embedded architecture of a generalized VCU, SPI communication protocol between VCU microcontrollers, I2C communication between VCU microcontrollers, CAN communication between VCU microcontrollers, Study of an Example of STM microcontroller based VCU	**7**
Module – V **Charging Infrastructures:** Brief Introduction to Energy Storage for EV, Understanding charging economics, commercial charging and pricing models, Load managements for large scale EV integration	**4**

Textbooks (T):

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley , 2003.
2. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001
3. "Serial Port Complete" by Jan Axelson
4. "The I2C Bus: From Theory to Practice" by Dominique Paret
5. "CAN System Engineering: From Theory to Practical Applications" by Wolfhard Lawrenz
6. "In-Vehicle Automotive Gateway ECU", by Shamin Dudu T S

Reference Books (R):

1. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design M. Ehsani, Y. Gao, S. Gay and Ali Emadi CRC Press 2005
2. Electric and Hybrid Vehicles: Design Fundamentals Iqbal Husain CRC Press 2003

Gaps in the Syllabus (to meet Industry/Profession requirements): Controller implementation using fixed point arithmetic.

POs met through Gaps in the Syllabus: PO5

Topics beyond syllabus/Advanced topics/Design: Design of battery charging infrastructure

POs met through Topics beyond syllabus/Advanced topics/Design: PO3, PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	2	2	1	1	1	3	2	1
CO2	3	3	3	3	3	3	2	2	2	2	1	3	2	2
CO3	3	3	3	3	3	3	3	3	2	2	2	3	3	2
CO4	3	3	3	3	3	3	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD5, CD6
CO5	CD1, CD2, CD5, CD6

COURSE INFORMATION SHEET

Course Code: EE24433

Course Title: Blockchain Applications in Power Systems

Pre-requisite(s): Basic knowledge of power systems, electrical networks, digital systems and basic programming.

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VII/4

Branch: EEE

Name of Teacher:

Course Objectives

1	To introduce the fundamentals of **blockchain technology** and its role in power systems.
2	To explore **peer-to-peer (P2P) energy trading, smart contracts**, and **secure transactions** in the energy sector.
3	To understand **blockchain-enabled microgrids** and decentralized renewable energy systems.
4	To examine **cybersecurity challenges** and **regulatory aspects** of blockchain in power systems.

Course Outcomes

Upon successful completion, students will be able to:

CO1	Understand the fundamental principles of blockchain and its role in the power sector.
CO2	Analyze blockchain applications in energy trading, microgrids, and renewable integration.
CO3	Evaluate the cybersecurity, privacy, and regulatory challenges in blockchain-based power systems.
CO4	Design a conceptual framework for blockchain-based smart grid transactions.
CO5	Apply blockchain concepts to develop decentralized energy management solutions.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction to Blockchain & Distributed Ledgers** Fundamentals of Blockchain Technology, Key Components: Blocks, Hashing, Consensus Mechanisms, Types of Blockchain: Public, Private, Consortium Blockchains, Smart Contracts: Concept, Execution, and Applications.	**6**
Module – II **Blockchain in Power Systems** Challenges in conventional power grids and need for decentralization, Peer-to-Peer (P2P) Energy Trading using blockchain, Decentralized Energy Markets: Real-time energy settlements, Case Study: Brooklyn Microgrid and other real-world projects.	**8**
Module – III **Blockchain for Renewable Energy & Microgrids** Blockchain-Enabled Microgrids: Secure and autonomous operation, Integration with Renewable Energy Sources: Solar, Wind and other DERs, Energy Tokenization: Digital energy credits, carbon trading **and automated billing** for peer-to-peer (P2P) energy exchange.	**8**
Module – IV **Security & Challenges in Blockchain-Based Energy Systems** Cybersecurity in Power Systems: Threats and Blockchain-based Security, Data Privacy and Energy Transactions, Regulatory and Policy Challenges: Legal and market barriers, Scalability & Interoperability Issues in blockchain networks	**8**
Module – V **Future Trends & Practical Applications** Integration with AI & IoT for Smart Grids, Blockchain in Smart Metering & Demand Response, Emerging Technologies: Quantum-safe blockchain, Hands-on Project: Simulation of a blockchain-based energy trading system	**6**

Textbooks & Reference Books

1. Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S. – Bitcoin and Cryptocurrency Technologies, Princeton University Press, 2016.
2. Tushar, W., Yuen, C., Mohsenian-Rad, H., & Poor, H. V. – Blockchain for Smart Energy Systems, Springer, 2020.
3. Gupta, M. – Blockchain for Dummies, Wiley, 2021.
4. **J. J. Grainger & W. D. Stevenson –***Power System Analysis*, McGraw-Hill, 1994.
5. **Hadi Saadat –***Power System Analysis*, McGraw-Hill, 2010.

Gaps in the Syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	0	1	2	1	0	0	1	2	3	2	1
CO2	2	3	2	1	2	2	2	0	0	1	2	3	3	2
CO3	1	2	2	2	2	3	3	0	0	2	3	2	2	3
CO4	2	2	3	2	3	2	2	1	2	2	2	3	3	2
CO5	2	3	3	2	3	2	2	1	2	2	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD5, CD6

COURSE INFORMATION SHEET

Course Code: EE24437

Course Title: Embedded Control of Switching Power Converters

Pre-requisite(s): Power electronics.

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VII/4

Branch: EEE

Name of Teacher:

Course Objectives

This course enables the students to:

A	Understand modeling and control power converters.
B	Explaining PWM techniques the need for digital control
C	Analyses of DPWM techniques and its implementation.
D	Perform evaluation of close loop power converter
	Plan and design procedure for a complex power converter- based drives system.

Course Outcomes

After the completion of this course, students will be:

CO1	List the different techniques for control of power converters using embedded systems.
CO2	Apply discrete mathematical modeling techniques to obtain the dynamic response of a converter in discrete time samples.
CO3	Analyze the role of different embedded system architectures for digital controller design for a specific application.
CO4	Estimatethe cost and long-term impact of embedded system-based control of power converters on a large-scale project of socio-economic importance on account of scalability and expandability.
CO5	Designnew adaptive controller topologies using embedded systems for the control of power converters having superior performance, therefore taking a leadership role towards enhancing state of art technologies in the field of energy management for social welfare.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction to power converters:** Introduction to switching power converters and emerging applications, such as dynamic voltage scaling, power amplifiers, energy harvesting, etc.	**2**
Module – II **Modelling and Control in PWM Switching Converters:** Introduction to basic DC-DC converter topologies, such as buck converter, boost converter, buck/boost converters, etc., PWM control techniques such as voltage mode control (VMC), current mode control (CMC); CCM and DCM operating modes, Modelling of PWM DC-DC converters, State-space averaging technique, small-signal modelling, Control challenges, limitations of analog control techniques and need for digital control in DC-DC converters	**10**
Module – III **Digital Pulse Width Modulator (DPWM) Architecture and analysis:** DPWM architectures in DC-DC converters: Counter-based DPWM, tapped-delay line based DPWM, hybrid DPWM, segmented DPWM, Frequency domain analysis of digitally controlled DC-DC converters, special emphasis on effects of finite sampling and quantization, such as limit cycle oscillations, Discrete-time modelling and analysis for existence of sub-harmonic oscillations in DPWM DC-DC converters.	**10**
Module – IV **DSP Processor based digital control of DC-DC converters:** C2000 series TI DSP processors: Texas Instruments Delfino F28379D architecture, Introduction to CCS Studio, ADC interface and sampling program for motor speed feedback, PWM Generation program for inverter control, Timer Counter program, interrupt subroutine handling.	**10**
Module – V **FPGA Based Embedded System Design for Power Converters:** Introduction to Verilog Hardware Description Language -VHDL, FPGA devices, FPGA based embedded processor, FPGA-based Signal Interfacing and Conditioning, Motor control using FPGA, Prototyping Using FPGA.	**8**

Textbooks

1. Rahul Dubey, Introduction to Embedded System Design Using Field Programmable Gate Arrays, Springer, 2009
2. Atanu Banerjee, Fpga controlled three phase inverters based bldc motor drive, Lambert, 2015
3. TI, LAUNCHXL-F28379D Overview- User's Guide, 2019
4. Gautam Iyer, An Introduction to Texas Instruments C2000 Real-time Control Microcontrollers: Covering LAUNCHXL-F28027 Launchpad in detail with Step-by-Step LAB Sessions with TI-CCS and Mathworks Simulink

5. P.T. Krein, Elements of Power Electronics. New York: Oxford Univ. Press, 1998.
6. R.W.Erickson and D. Maksimovic, Fundamentals of Power Electronics, 2nd ed. Dordrecht, The Netherlands: Kluwer, 2001.
7. S. Banerjee and G. C. Verghese, Eds., Nonlinear Phenomenon Power Electronics: Attractors, Bifurcations, Chaos, and Nonlinear Control, New York: IEEE Press, 2001.
8. F. Maloberti, "Data Converters", Springer, 2007
9. Michael D. Ciletti, "Modeling, synthesis, and rapid prototyping with the Verilog HDL", Prentice Hall, 1999.
10. V.Bobal, J.Bohm, and J.Fessl,"Digital Self-Tuning Controllers: Algorithms, Implementation and Applications"1 st Ed.,Springer,2005.
11. Francesco Vasca, Luigi Iannell i,Eds,"Dynamics and Control of Switched Electronic Systems:Advanced Perspectives for Modeling, Simulation and Control of Power Converters", Springer,1st Ed.,2012

Reference Books (R):

1. Fundamental of Electrical Drives: G K Dubey
2. Electric Motor Drives, modelling analysis and control: R Krishnan
3. Power Electronics: Circuits, Devices, and Applications: MH. Rashid https://www.ti.com/video/library.html

Gaps in the Syllabus (to meet Industry/Profession requirements): Controller implementation using fixed point arithmetic.

POs met through Gaps in the Syllabus: PO4, PO5

Topics beyond syllabus/Advanced topics/Design: VHDL programming and FPGA based Prototyping

POs met through Topics beyond syllabus/Advanced topics/Design: PO3, PO5

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	
CO2	
CO3	
CO4	
CO5	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	2	2	1	1	1	3	2	1
CO2	3	3	3	3	3	3	2	2	2	2	1	3	2	2
CO3	3	3	3	3	3	3	3	3	2	2	2	3	3	2
CO4	3	3	3	3	3	3	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

COURSE INFORMATION SHEET

Course Code: EE24439

Course Title: Introduction to Autonomous Vehicles

Pre-requisite(s): Engineering Mathematics, Control Theory, Signals and Systems

Co- requisite(s): Estimation and Identification Techniques, Image Processing

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VII/4

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions to impart to students to:

A	Describe both the hardware and software architectures commonly used for autonomous vehicle design.
B	Explain the mathematical modelling of an autonomous vehicle necessary for both longitudinal and lateral control.
C	Explain state estimation and localization of autonomous vehicles.
D	Describe the perception and motion planning of autonomous vehicles.
E	Demonstrate the implementation of the concepts using suitable software.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Differentiate between the levels of autonomy and identify the various sensors needed for self-driving vehicles along with necessary safety considerations and ethics.
CO2	Develop the mathematical model of autonomous vehicles and design a controller for desired control objectives.
CO3	Estimate the pose of the ego vehicle using a suitable estimation algorithm.
CO4	Employ camera and sensor data to develop the environment perception and motion planning of the ego vehicle.
CO5	Implement autonomous vehicle control through simulation platforms

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction, Why Autonomous Vehicle, History of Autonomous Vehicles, Taxonomy of driving, requirements for autonomy, Levels of autonomy, Driving decisions and Actions, Sensors and Computing Hardware necessary for vehicle autonomy, Software architecture, Environment representation, Safety considerations and Ethics.	**9**
Module – II Vehicle dynamic modelling, kinematic model in 2D, bicycle model, longitudinal vehicle modelling, Lateral Dynamics of Bicycle Model, vehicle actuation, Tyre Slip and modelling, vehicle longitudinal control with PID control, lateral vehicle control, Lane Keeping, Geometric Lateral control for path tracking: Pure Pursuit and Stanley control, advanced steering control: Model Predictive Control (MPC), Industry challenges, Case Study: Zoox.	**9**
Module – III State estimation and localization, Importance of State Estimation, Method of Least Squares, Recursive Least Squares, Method of Maximum Likelihood, Kalman Filter, Extended Kalman Filter, Error State Extended Kalman Filter, Unscented Kalman Filter, 3D Geometry and Reference Frames, Inertial Measurement Unit (IMU), Global Navigation Satellite Systems (GNSS), Light Detection and Ranging Sensors, Pose Estimation from LIDAR Data, Optimizing State Estimation, Challenges of State Estimation.	**9**
Module – IV Perception, Camera Sensor and Projective Geometry, Camera Calibration, Visual Depth Perception, Image Filtering, Image features and Feature Detectors, Feature Descriptors, Feature Matching, Outlier Rejection, Visual Odometry, Motion planning, Driving Missions, Scenarios and Behaviour, Motion Planning Constraints, Objective Functions for Autonomous Driving.	**9**
Module – V Occupancy Grids, Populating Occupancy Grids from LIDAR Scan Data, Creating a Road Network Graph, Dijkstra's Shortest Path Search, A* Shortest Path Search, Map-Aware Motion Prediction, Behaviour Planning, Introduction to software platforms: CARLA and CarSim.	**9**

Textbooks

1. Rajesh Rajamani, “Vehicle Dynamics and Control”, Springer
2. Shaoshan Liu, Liyun Li, Jie Tang, Shuang Wu, Jean-Luc Gaudiot, “Creating Autonomous Vehicle Systems” Morgan and Claypool Publisher, 2nd edition

Reference Books

1. Hanky Sjafrie, “Introduction to Self-Driving Technology” CRC Press
2. Q, Zhou, Z. Shen, B. Yong, R Zhaor, “Theories and Practices of Self-Driving Vehicles”, Elsevier publisher

Gaps in the Syllabus (to meet Industry/Profession requirements): Application of AI/ML based techniques such as Reinforcement learning.

POs met through Gaps in the Syllabus: PO3**,** PO5

Topics beyond syllabus/Advanced topics/Design: Hardware fabrication of vehicle

POs met through Topics beyond syllabus/Advanced topics/Design: PO3

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher’s assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher’s assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	0	2	2	3	0	1	1	0	2	2	1
CO2	3	3	3	2	2	0	0	2	0	0	0	2	3	1
CO3	3	3	3	3	2	3	3	0	0	2	0	0	0	2
CO4	3	3	3	2	3	2	2	2	1	1	0	3	3	2
CO5	3	2	3	2	3	0	0	2	1	1	1	2	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD3
CO3	CD1, CD3
CO4	CD1, CD2, CD5, CD6
CO5	CD1, CD2, CD5, CD6

COURSE INFORMATION SHEET

Course Code: EE24441

Course Title: Introduction to Demand Side Management

Pre-requisite(s): Basics of Power Systems, Power System Analysis

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VII/4

Branch: EEE

Name of Teacher:

Course Objectives

The course objective is to provide students with an ability to:

1	To introduce the concept, need, and importance of Demand Side Management (DSM) in modern power systems
2	To analyze load forecasting, demand response (DR), and energy efficiency techniques.
3	To explore DSM's role in smart grids, renewable energy integration.
4	To evaluate the economic, policy, and sustainability aspects of DSM for a reliable and resilient power system.

Course Outcomes (COs)

Upon completion, students will be able to:

CO1	Understand the fundamentals of DSM and its impact on modern power systems.
CO2	Analyze different DSM strategies and demand response mechanisms.
CO3	Evaluate DSM's role in smart grids, renewables, and grid stability.
CO4	Apply energy efficiency techniques and demand response models in real-world scenarios.
CO5	Develop DSM-based solutions for energy conservation and cost savings.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Fundamentals of Demand Side Management Introduction to Demand Side Management (DSM): Definition, objectives, and scope of DSM. Need for DSM in modern power grids. DSM vs. Supply Side Management. Types of DSM Strategies: Peak Clipping, Valley Filling, Load Shifting, Energy Conservation. Strategic Load Growth & Strategic Load Reduction. Benefits of DSM Case study: DSM initiatives in different countries.	**8**
Module – II Load Forecasting & Demand Response Mechanisms Load Forecasting Techniques; Short-term, medium-term, and long-term forecasting, AI/ML-based load forecasting models, Demand Response (DR) Mechanisms, Time-of-Use (TOU) Pricing, Real-Time Pricing (RTP), Critical Peak Pricing (CPP), Incentive-Based Response, Smart Meters & Automated Load Control, Role of smart metering in DSM, Home and industrial automation for demand response.	**8**
Module – III DSM in Smart Grids & Renewable Energy Integration DSM in Smart Grids; Integration of DSM with smart grid technology, Role of AI, IoT, and Blockchain in DSM, Renewable Energy & DSM, Managing solar and wind energy intermittency through DSM, Energy storage solutions for demand-side flexibility, Reducing grid congestion using DSM.	**8**
Module – IV Energy Efficiency & Conservation Techniques Energy Efficiency in DSM, Power factor correction and voltage optimization, Energy-efficient appliances and building design, Industrial DSM Strategies, Home Energy Management Systems (HEMS), Demand-side control in residential buildings, Role of automation in reducing electricity costs, Case Studies on Energy Conservation Techniques, Successful energy management programs in different sectors.	**8**
Module – V Economic, Policy & Future Trends in DSM Economic Analysis of DSM, Cost-benefit analysis of DSM programs, Utility incentives and pricing mechanisms, Regulatory Policies for DSM, Global DSM policies, Government initiatives and legal framework, DSM's Role in Carbon Emission Reduction & Sustainability Goals, DSM's impact on climate change and energy sustainability, Future Trends in DSM	**8**

Textbooks:

1. C. W. Gellings**,** Demand-Side Management Planning, The Fairmont Press, 1996.
2. A. K. Mehta**,** Demand Side Management & Energy Efficiency, Springer, 2016.

3. J. N. Sheen, Demand Side Management: Theory and Practice, CRC Press, 2019.
4. H. Lee Willis, Distributed Power Generation: Planning and Evaluation, CRC Press, 2000.

Reference Books:

1. P. S. Pabla, Electric Power Distribution, McGraw-Hill, 2012.
2. Clark W. Gellings & John H. Chamberlin, Demand Side Management: Concepts and Methods, The Fairmont Press, 1993.

James Momoh, Smart Grid: Fundamentals of Design and Analysis, Wiley, 2012.

Gaps in the Syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	0	0	2	2	0	0	0	0	3	0	0
CO2	3	3	2	2	0	0	0	2	0	0	0	3	2	0
CO3	3	3	3	3	2	2	2	0	0	0	0	3	2	0
CO4	3	3	3	3	3	0	2	2	2	2	0	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2
CO3	CD1, CD2
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD5, CD6

COURSE INFORMATION SHEET

Course Code: EE24451

Course Title: Electrical Machine Design

Pre-requisite(s): Electrical Machines

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VI/3

Branch: EEE

Name of Teacher:

Course Objectives

This course envisions to impart students to:

A	Understand the philosophy behind the machine design.
B	Develop the understanding of machine specification selection for particular application.
C	Design the electric and magnetic circuit based on output specification requirement.
D	Develop the structural dimension of machine according to output requirement.
E	Evaluate and analyze the performance characteristics of machines.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Understand concept behind the electrical machine design.
CO2	Understand the design and analyze the rotatory DC and AC machines.
CO3	Understand the design concept of static electrical machine.
CO4	Design magnetic circuit, electrical circuit, and overall structure of electrical rotatory and static machine.
CO5	Analyze the performance, cost effectiveness, and design constraints of the machines within the acceptable limits.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I Fundamental Aspects of Electrical Machine Design: Design of Machines, Design Factors, Limitations in design, Modern Trends in design, manufacturing Techniques. Electrical Engineering Materials: Electrical Conducting Materials, Magnetic Materials, Types of Magnetic Material, Insulating Materials. Thermal design: Conduction, Radiation, Convection, Thermal state in Electrical Machines, Cooling of rotating machines.	**8**
Module – II Design of DC Machines: Output Equation, Choice of Specific Loadings and Choice of Number of Poles, Main Dimensions of armature, Design of Armature Slot Dimensions, Commutator and Brushes. Estimation of Ampere Turns for the Magnetic Circuit. Dimensions of Yoke, Main Pole and Air Gap. Design of Shunt and Series Field Windings.	**8**
Module – III Design of Transformers: Output Equations of Single Phase and Three Phase Transformers, Choice of Specific Loadings, Expression for Volts/Turn, Determination of Main Dimensions of the Core, Estimation of Number of Turns and Conductor Cross Sectional area of Primary and Secondary Windings, No Load Current. Expression for the Leakage Reactance of core type transformer with concentric coils, and calculation of Voltage Regulation. Design of Tank and Cooling (Round and Rectangular) Tubes.	**8**
Module – IV Design of Three Phase Induction Motors: Output Equation, Choice of Specific Loadings, Main Dimensions of Stator. Design of stator slots and Winding, Choice of Length Air Gap, Estimation of Number of Slots for Squirrel Cage Rotor. Design of Rotor Bars and End Ring. Design of Slip Ring rotor. Estimation of No-Load Current and Leakage Reactance.	**8**
Module – V Design of Three Phase Synchronous Machines: Output Equation, Choice of Specific Loadings, Short Circuit Ratio, Main Dimensions of Stator. Design of stator slots and Winding. Design of Salient and non-salient Pole Rotors. Magnetic Circuit and Field Winding.	**8**

Textbooks:

1. K. Sawhney, “A Course in Electrical Machine Design”, Dhanpat Rai & Sons
2. M.G. Say, “The Performance and Design of Alternating Current Machines”, CBS Publishers & Distributors.

Gaps in the Syllabus (to meet Industry/Profession requirements): Design of special electrical machines.

POs met through Gaps in the Syllabus: PO3, PO6

Topics beyond syllabus/Advanced topics/Design: Vibrational and thermal analysis of electrical machines

POs met through Topics beyond syllabus/Advanced topics/Design: PO4, PO5

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	0	1	1	0	0	0	0	2	3	2	1
CO2	3	3	2	2	2	1	1	0	0	0	2	3	3	2
CO3	3	2	2	2	2	1	0	0	0	0	2	3	3	2
CO4	3	3	3	2	3	1	1	0	0	0	2	3	3	2
CO5	3	3	3	2	3	2	2	1	1	1	2	2	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD3
CO2	CD1, CD3
CO3	CD1, CD3
CO4	CD1, CD2, CD5, CD6
CO5	CD1, CD2. CD5, CD6

COURSE INFORMATION SHEET

Course Code: EE24457

Course Title: Hybrid Electric Vehicle

Pre-requisite(s): Electrical Machines, Power Electronics and Electric drives

Co- requisite(s): Induction Motor, BLDC Motor, Battery, Power Converters

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VII/4

Branch: EEE

Name of Teacher:

Course Objectives:

The course objective is to provide students with an ability to:

A.	Understand basic working principle of IC engine and special electrical motors used in EV applications
B.	Apply the theory of vehicle dynamics to obtain dynamic and steady state performances of any vehicle
C.	Analyze the combined effect of IC engine, motors and transmission on output characteristics in HEV
D.	Design a suitable power train for HEV application as per requirements

Course Outcomes:

At the end of the course, the student will be able to:

CO1.	Describe fundamental working principle of IC engine and Electric motors used in vehicle application
CO2.	Apply the theory of vehicle dynamics to obtain performance of any vehicle
CO3.	Analyze mutual effect of power converter fed electric motor, IC engine and different transmission options on the characteristics of HEV.
CO4.	Evaluate and optimize hybrid power train architecture and components to achieve dynamic traction requirements in HEV applications
CO5.	Design an HEV for a particular application with help of interdisciplinary teamwork

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction** Hybrid and Electric Vehicles (HEV): History Overview and Modern Applications, Ground vehicles with mechanical powertrain and reasons for HEV development, HEV configurations and ground vehicle applications, Advantages and challenges in HEV design.	**8**
Module – II **Power Flow and Power Management Strategies in HEV** Mechanical power: generation, storage and transmission to the wheels, Vehicle motion and the dynamic equations for the vehicle., Vehicle power plant and transmission characteristics and vehicle performance including braking performance., Fuel economy characteristics of internal combustion engine, Basic architecture of hybrid drive train and analysis series drive train., Analysis of parallel, series parallel and complex drive trains and power flow in each case., Drive cycle implications and fuel efficiency estimations.	**8**
Module – III **Electric Vehicles** Traction Motor Characteristics, Tractive Effort and Transmission Requirement, Vehicle Performance, Tractive Effort in Normal Driving, Energy Consumption.	**8**
Module – IV **Hybrid Electric Vehicle** Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel Hybrid Electric Drive Trains, Torque-Coupling Parallel Hybrid Electric Drive Trains, Speed-Coupling Parallel Hybrid Electric Drive Trains, Torque Coupling and Speed-Coupling Parallel Hybrid Electric Drives.	**8**
Module – V **Design of Hybrid Electric** Vehicles Design of Series Hybrid Electric Vehicle, Design of Parallel Hybrid Electric Vehicle, Design of Electric Vehicle, Impact on Environment.	**8**

Textbook:

1. Modern Electric, Hybrid Electric and Fuel Cell Vehicles. Mehrdad Ehsani, CRC Press
2. Modern Electric Vehicle Technology, C. C. Chanand K. T. Chau, Oxford University Press

Reference Book:

1. R. Krishnan, 'Electric motor drives', Prentice Hall of India,2002
2. T.J.E.Miller, Brushless magnet and Reluctance motor drives

Gaps in the Syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design: Regenerative Braking, Self-Driven HEV

POs met through Topics beyond syllabus/Advanced topics/Design: PO2, PO4

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	2	2	1	1	1	3	2	1
CO2	3	3	3	3	3	3	2	2	2	2	1	3	2	2
CO3	3	3	3	3	3	3	3	3	2	2	2	3	3	2
CO4	3	3	3	3	3	3	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD3
CO2	CD1, CD3
CO3	CD1, CD3, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD5, CD6

COURSE INFORMATION SHEET

Course Code: EE24453

Course Title: Computer-Aided Power System Analysis

Pre-requisite(s): Knowledge of basic principles of power system and its analysis

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VII/4

Branch: EEE

Name of Teacher:

Course Objectives:

This course envisions imparting the following objectives to the students:

A.	Understanding of single-phase modelling of power system components and their input parameters for computer programming.
B.	Understanding and use of efficient mathematical/numerical methods suitable for computer simulation for the solution of power system planning.
C.	Comprehending the power flow problem, fault analysis, optimal system operation, contingency analysis and state estimation in context of a large integrated power system network.
D.	Ability to apply mathematical/numerical techniques for solving power flow problems, optimal system operation, fault analysis, contingency analysis and state estimation problem.
E.	Understanding of small-signal and transient stability analysis of a interconnected power system network.

Course Outcomes:

After completion of the course, the learners will be able to:

CO1.	Define and describe models of power system components to be used in software tools. identify and list input parameters to start with software-based solution.
CO2.	List and apply various mathematical techniques for solving power system planning problems.
CO3.	Identify and analyse the different abnormal (fault) conditions in power system utilizing efficient computer algorithm.
CO4.	To solve economic load dispatch problems with and without transmission losses and also to solve unit commitment problem by Dynamic programming method.
CO5.	Evaluate small signal stability and transient stability of a power system network.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction** Basic single-phase modelling- Generator, Transmission lines, electrical load Transformer- Off nominal transfer tap representation, Phase shifting representation, 3-winding transformer connection and equivalent circuit. Convention for power flow, concept of power/current injection, shunt connected element. Bus admittance matrix, mutual inductance, dimension and sparsity.	**6**
Module – II Nature of load flow equations, Computational steps and flow chart of Gauss-Seidel Techniques, Newton-Raphson method: Formulation for load buses and voltage-controlled buses in rectangular and polar co-ordinates, Computational steps and flow chart. Decoupled power flow algorithm, Fast Decoupled load flow. Gaussian Elimination method, Gaussian Elimination and optimal ordering, triangular factorization, LU decomposition for sparsity-oriented programming.	**10**
Module – III **Optimal System Operation:** Equal incremental cost operation, Computational steps, Transmission loss and incremental transmission loss (ITL), Computational aspects. Introduction to contingency analysis, linear sensitivity factor, line outage sensitivity factor	**8**
Module – IV **State estimation techniques,** weighted least square method, error analysis, bad data detection, power system state estimation. **Power System Stability:** Stability problem, small signal stability and transient stability analysis using differential and numerical methods. Improvement of stability.	**8**
Module – V **Short Circuit Analysis:** Bus impedance matrix and its building algorithm through modifications, Symmetrical and unsymmetrical fault calculation using Zbus and its computational steps.	**8**

TEXTBOOKS:

1. Power system Analysis—Grainger and Stevension—Tata-McGraw Hill, New Delhi.
2. Advanced Power System Analysis and Dynamics-L. P. Singh, New Age International, 4th edition, 2006.

Reference Books:

1. Computer Modelling of Electrical Power Systems - J. Arrillaga, N.R. Watson, Wiley, 2nd edition, 2001.
2. Power Generation Operation and Control - A.J. Wood, B.F. Wollenberg, 2nd edition Wiley Inderscience publication.
3. Computer Techniques in Power System Analysis –M. A. Pai, Mc Graw Hill, New Delhi,

2nd edition, 2003.

Gaps in the Syllabus (to meet Industry/Profession requirements):

Impact of Deregulation in Power Industry

Computer Simulation incorporating impact of Renewable Sources in Power System.

POs met through Gaps in the Syllabus: PO6

Topics beyond syllabus/Advanced topics/Design: Load flow considering RES, MATLAB Simulation of power system network.

POs met through Topics beyond syllabus/Advanced topics/Design: PO4

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	3	2	2	3	2	0	0	3	1	1	2	2	1
CO2	3	3	2	3	3	2	0	1	3	1	1	3	2	2
CO3	3	3	3	3	3	2	1	1	3	1	3	3	2	2
CO4	3	3	3	3	3	2	1	1	3	1	3	3	2	2
CO5	3	3	3	3	3	2	0	1	3	1	2	3	2	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6
CO3	CD1, CD2, CD3, CD6
CO4	CD1, CD2, CD5, CD6
CO5	CD1, CD2, CD3, CD5, CD6

COURSE INFORMATION SHEET

Course Code: EE24455

Course Title: Advanced Power Electronics

Pre-requisite(s): Operating Principle of Semiconductor Devices

Co- requisite(s):

Credits: 03 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech

Semester/Level: VII/4

Branch: EEE

Name of Teacher:

Course Objectives: This course enables the students to:

A	Remember classifications of power converters based on different criteria such as soft switching/ hard switching and isolated/non-isolated configuration etc.
B	Explain the working principle of different classes of power converters and relate them with different areas of application
C	Analyse shortcomings of different types of power converters.
D	Evaluate cost of power converter-based topology terms of dynamic parameters of system, overall efficiency and cost.
E	Design power converter-based topologies for energy management.

Course Outcomes: At the end of the course, a student should be able to:

CO1	List different types of semiconductor devices and remember their operating characteristics. Explain the working principle of different semiconductor devices.
CO2	Classify different types of power converters. Show suitability of a power converter for a particular application. Solve power management related problems with application of power electronics-based topologies.
CO3	Outline shortcomings of each class of power converters and solve those using proper modifications. Identify potential areas for power electronics applications.
CO4	Estimate the cost and long-term impact of power electronics technology on a large scale project of socio-economic importance.
CO5	Design new power converter topologies and plan to develop energy management unit for industrial and domestic applications as well as to motivate for continuous learning in order to play lead role in the field of technology development for energy management.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I **Power Electronic Devices:** (Diodes, Thyristor), Transistors, MOSFET, IGBT, IGCT, etc. - operating principle, Static & dynamic characteristics, Data sheet ratings; Thermal characteristics of power devices; Sample Gate drive circuits.	**8**
Module – II **Switched Mode Power Supply:** **Forward and flyback converter circuits:** operation of flyback converter and waveforms analysis, operation of forward converter and waveforms analysis, Double ended forward converter, Push Pull converter, Half Bridge isolated converter, Full bridge isolated converter, Bidirectional power supplies, small signal analysis of DC-DC converters and closed loop control.	**8**
Module – III **PWM inverter modulation strategies & dual bridge:** Sine wave with third harmonic, space vector modulation and predictive current control techniques; PWM rectifier; Input side bidirectional power flow requirement for regeneration & Dual Thyristor Bridge. Multi- level inverter: Basic topology and waveform, Diode clamped multilevel inverter, Flying capacitor multilevel inverter, cascaded multilevel inverter improvement in harmonics and high voltage application, comparison of different multilevel inverters, application of multilevel inverters.	**8**
Module – IV **Resonant Inverters:** Operating principle of series resonant inverter, waveforms analysis, switching trajectory, losses and control, Operating principle of series resonant inverter with bidirectional switches, Frequency response of resonant series loaded, parallel loaded, and series parallel- loaded inverter, Parallel resonant inverter, ZCS resonant converter, ZVS resonant converter.	**8**
Module – V **Introduction to application-oriented chips:** Industrial PWM driver chips for power supplies such as UC 3843, 3825 or equivalent; Industrial gate driver chips for PWM voltage source inverters with isolation and protection circuits. Intelligent power modules.	**8**

TEXTBOOK

1. M.H. Rashid,"Power Electronics: Circuits, Device and Applications",2nd Ed.n, PHI, New Jersey, 1993
2. Mohan, Underland, Robbins; Power Electronics Converters, Applications and Design, 3rd Edn., 2003, John Wiley & Sons Pte. Ltd.
3. M. D. Singh, K. B. Khanchandani, "Power Electronics", 2nd Edn., Tata McGraw- Hill, 2007.

REFERENCE BOOK

1. R. Krishnan, "Electric Motor Drives: Modeling, Analysis and Control ", 1st Edn., Prentice Hall,2001

2. B. K. Bose, “Modern Power Electronics & AC Drives” , 1st Edn., Prentice Hall, 2001
3. L. Umanand, “Power Electronics: Essentials & Applications”, 1st Edn. Wiley India Private Limited, 2009
4. Jeremy Rifkin, “Third Industrial Revolution: How Lateral Power is Transforming Energy, the Economy, and the World”, 1st Edn., St. Martin‟s, Press, 2011

Gaps in the Syllabus (to meet Industry/Profession requirements):

Cost Evaluation of Power Electronics based installation based on reliability.

Application of artificial intelligence in power electronics.

Study of impact of power electronics on society and environment.

POs met through Gaps in the Syllabus: PO4, PO5, PO6

Topics beyond syllabus/Advanced topics/Design:

Reliability analysis in power electronics topologies

Application of adaptive algorithms in power electronics-based systems.

POs met through Topics beyond syllabus/Advanced topics/Design: PO3, PO5

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher’s assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher’s assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	2	2	1	1	1	3	2	1
CO2	3	3	3	3	3	3	2	2	2	2	1	3	2	2
CO3	3	3	3	3	3	3	3	3	2	2	2	3	3	2
CO4	3	3	3	3	3	3	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD3
CO2	CD1, CD3
CO3	CD1, CD3
CO4	CD1, CD2, CD3, CD5
CO5	CD1, CD2, CD5, CD6

Course information sheet for Skill- Based Vocational courses, Level 1 (After completion of B.Tech. 1st Year)

Course Code: EE24151

Course Title: Electrical System Installation, Maintenance and Troubleshooting

Credits: 04 L: 3 T: 1 P: 0

Class schedule per week: 04

Class: Skill-based vocational course

Semester / Level:

Branch: EEE

Course Objectives

This course envisions imparting the following objectives to the students:

A	Detail information about instruments, tools, techniques, and accessories used in electrical system installation, repair and maintenance.
B	Knowledge of safety devices and measures used in electrical installation.
C	Skill to repair and maintenance of home appliances.
D	Ability to carryout domestic and commercial wiring with preparation of drawing and design of wiring system.
E	Knowledge of costing and estimation of wiring system.

Course Outcome

After completion of this course the student will be able to:

CO1.	List and define the instruments, devices, tools, accessories along their application used in electrical wiring, installation, and troubleshooting.
CO2.	Describe the electrical symbols, diagrams, and circuits and use these for developing wiring layout.
CO3.	Install and repair domestic appliances and prepare plate and pipe earthing installations.
CO4.	Plan, draw, assemble and perform various domestic wiring. Carry out Testing, maintenance and repair/ replacement of domestic wiring.
CO5.	Plan, draw, assemble and perform various domestic wiring. Carry out Testing, maintenance and repair/ replacement of commercial wiring up to 11kV voltage rating.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module I Instruments and devices for preliminary testing of any electrical circuit: Multimeter: Analog Multi-meter, Digital Multi-meter, Tong Tester, Energy-meter, Tester, Line tester, electric line tester, series test lamp for single phase parallel test lamp for single phase, series test lamp for three phase, parallel lamp for three phases, thermocouple, Insulation tester, earth resistance tester. Types of electrical joints and connections. Electric circuit diagram, schematic diagram, single line diagram. Thermostat, bimetallic relay, overload switch, electromagnetic relay, MCB, MCCB, ELCB. Electrical joints.	**6**
Module II Commercial Appliances: Principle, working, various parts, their uses, types, specifications, maintenance & trouble shooting of electric lights, electric iron, water heater & geyser, room heater, washing machine, electric fans, air conditioner, microwave oven, hair dryer, table lamp, torch, electric doorbell, electric kettle, tandoor maker, bread toast maker, electric induction cooker and stove, air frier and other such appliances.	**8**
Module III Conductors and Insulators used for domestic and commercial wiring: Conductors, Gauges of conductor, Insulator, types of wires used in wiring system PVC, CTS, TRS, Lead Sheath, Flexible Wire, Flexible wire, overhead and underground cable, ACSR Cable, Al. Cable, Belted cable, H type cable, oil fill cable, earthing conductor. Semi-Conductor and high resistance heating elements. Types of Accessories used in wiring system: Plug, Screwdriver, hammer, cutter, hacksaw, tester, punch, file, chisel, line and thread pliers, different types of pliers (combination pliers, side cutting pliers, long nose pliers) Screw drivers (light duty screwdriver) Lamp, Holders, Switches power sockets two pin, 3 pin, fuse types of fuses, ceiling rose two plates, ceiling rose three plate. Adaptors, connectors, distribution board, neutral line. Earthing system: Earthing and its importance: Basic considerations of earthing, Measurement of soil resistivity; Types of ground connections, Pipe Earthing, Plate Earthing; Ground Testing.	**8**
Module IV Types of residential and commercial wiring systems, specifications, general rules and guidelines for installation, electrical symbols and outlets, load calculation and sizing of wire, determining the required number of branch circuits, wiring methods, rating of main switch, distribution board and protection devices, voltage drop, and neutral conductor sizing, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing for commercial installations. Selection and sizing of components. Industrial loads, motors, starting of motors, Lightning Protection, UPS System, Electrical Systems for the elevators, Battery banks, Selection of UPS and Battery Banks.	**12**
Module V	**8**

Estimating and Costing Fundamentals; Estimation of Single and Three Phase Wiring: Steps for Estimation and Costing of Electrical Installations, costing calculations and Schedule of Rates; Estimation and Costing of House Wiring and Electrical Installations.	

TEXTBOOKS

1. Electrical Appliances: The Complete Guide to the Maintenance and Repair of Domestic Electrical Appliances (Haynes for Home DIY S.) Paperback - Import, 1 July 1995
2. Handbook of Repair and Maintenance of Domestic Electronics Appliances Paperback - 1 January 2016.
3. Troubleshooting and Repairing Major Appliances Hardcover - Illustrated, 16 December 2012.
4. Practical Electrical Wiring: Residential, Farm and Industrial Hardcover - Import, 1 March 1993.
5. N.V. Suryanarayana, "Utilization of Electrical Power including Electric drives and Electric traction", New Age International (P) Limited Publishers, 1st Edition, 1994.
6. E. Open Shaw Taylor, "Utilization of Electric Energy", Orient Longman,1st Edition,1937

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars

CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	0	2	1	0	0	1	1	2	3	2	1
CO2	3	2	2	1	2	1	0	0	1	1	2	3	3	1
CO3	3	2	2	1	3	1	1	0	2	1	2	3	3	2
CO4	3	2	3	2	3	2	1	1	2	2	2	3	3	2
CO5	3	2	3	2	3	2	1	1	2	2	2	3	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD5, CD6
CO4	CD1, CD2, CD5, CD6
CO5	CD1, CD2, CD5, CD6

Course information sheet for Skill- Based Vocational courses, Level 1 (After completion of B.Tech. 1st Year)

Course Code: EE24152

Course Title: Laboratory on Electrical System Installation, Maintenance and Troubleshooting

Credits: 02 L: 0 T: 0 P: 2

Class schedule per week: 01

Class: Skill-based vocational course

Semester / Level:

Branch: EEE

Course Objectives

This course envisions imparting the following objectives to the students:

A	Detail information about instruments, tools, techniques, and accessories used in electrical system installation, repair and maintenance.
B	Knowledge of safety devices and measures used in electrical installation.
C	Skill in repairing and maintenance of home appliances.
D	Ability to carry out domestic and commercial wiring with preparation of drawing and design of wiring system.
E	Knowledge of costing and estimation of wiring system.

Course Outcome

After completion of this course the student will be able to:

1.	List and define the instruments, devices, tools, accessories along their application used in electrical wiring, installation, and troubleshooting.
2.	Describe the electrical symbols, diagrams, and circuits and use these for developing wiring layout.
3.	Install and repair domestic appliances and prepare plate and pipe earthing installations.
4.	Plan, draw, assemble and perform various domestic wiring. Carry out Testing, maintenance and repair/ replacement of domestic wiring.
5.	Plan, draw, assemble and perform various domestic wiring. Carry out Testing, maintenance and repair/ replacement of commercial wiring up to 11kV voltage rating.

List of experiments

1. Introduction to

   (a) Tools and Measuring instruments

   (b) Symbols of Electrical Components and devices.

   (c) Cables, Conductors and Insulators

   (d) Electrical Supply

   Introduction to Indian Electricity Rule pertaining to

   (a) Domestic (House) wiring

   (b) Industrial wiring

   (c) Earthing

2. Introduction to Safety precautions, Elementary first aid and treatment of Electrical shocks.
3. Testing of Underground cable with the help of Megger and verification of size of cable.
4. Draw a neat sketch of the meter board and the distribution board showing clearly how the cables enter the meter and leave the distribution board and carry out the actual work.
5. Draw a schematic diagram and wiring diagram to switch on and off, a lamp, a fan with regulator and a three-pin socket with necessary safety device and carry out the actual work.
6. Draw a schematic diagram and wiring diagram and carry out actual work to control one light point by two-way switches placed at two different places.
7. Draw the wiring diagram of single tube light and double tube light controlled by a switch and construct the circuit.
8. Draw the circuit diagram and construct an automatic DOL starter to run a 5HP, 3phase induction motor. Make arrangement to start and stop motor from two different places.
9. In a workshop one 5HP, 400V & 50Hz induction motor has to be installed and need to run in forward and reverse direction with the help of DOL starter. Direction of the motor can be changed either manually or by limit switches. Draw the circuit diagram and construct the actual starter.
10. Testing of the motor with the help of Megger and multimeter

    (a) Continuity test; (b) Insulation resistance test; (c) Earth test; (d) Polarity test

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quiz	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	0	0	1	1	2	3	2	1
CO2	3	2	2	1	2	1	1	0	1	1	2	3	3	1
CO3	2	1	1	0	1	1	3	1	2	1	2	2	1	2
CO4	3	2	3	2	3	2	1	1	2	2	2	3	3	2
CO5	3	2	2	2	3	2	1	1	2	1	2	3	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2
CO2	CD1, CD2
CO3	CD1, CD2
CO4	CD1, CD2
CO5	CD1, CD2

Course information sheet for Skill- Based Vocational courses, Level 1 (After completion of B.Tech. 2nd Year)

Course Code: EE24275

Course Title: Electrical Power Equipment and Protection

Credits: 04 L: 3 T: 1 P: 0

Class schedule per week: 04

Class: Skill-based vocational course

Semester / Level:

Branch: EEE

Course Objectives

This course envisions imparting the following objectives to the students:

A	Basic knowledge of electrical AC rotating machines.
B	Introduce the students to power system structure and its operation and protection.
C	Ability to apply switching components for control of electrical machines.
D	Imparts analytical capability for repair and maintenance of electrical equipment.
E	Evaluate and create design architectures for electrical systems.

Course Outcome

After completion of this course the student will be able to:

CO1.	Remember operating characteristics of switching devices and electrical machines
CO2.	Understand operating principle of power system operation and protection
CO3.	Apply fundamental principles of electrical machines and protection systems
CO4.	Analyse performance of machines and power converters
CO5.	Design the electrical systems encapsulating converters, machines and power system units.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module I **Synchronous Machines:** Production of rotating magnetic field, EMF and torque equations Construction, types: Cylindrical rotor and salient pole rotor, Principle of operation, Excitation system, Circuit model, Phasor diagram, Determination of voltage regulation by synchronous impedance method of cylindrical rotor machines. Two reaction theory, Phasor diagram, Power-angle characteristic of salient pole machines.	**8**
Module II **3-phase Induction Motor:** Introduction, Construction, Types-comparison, Principle of operation, Slip and rotor frequency, Equivalent circuit model, Losses and efficiency, Torque-slip characteristics, Effect of rotor resistance, starting torque and maximum torque, Starting and speed control methods, applications. **1-phase Induction and AC Motors:** Introduction, Double revolving field theory, Equivalent circuit model, Starting methods, Applications. Universal motor: Working principle and applications	**8**
Module III Structure of a power system, Effect of transmission voltage, Load demand curve, Inductance and capacitance of single-phase transmission line, Performance of transmission line, Types of overhead line insulators, DC and AC distribution systems, Voltage control and reactive power. Brief introduction to power system protection systems.	**8**
Module IV Introduction Power Electronics based applications, construction and switching principle of Power Diode, POWER MOSFET, IGBT, Thyristor, DIAC, and TRIAC. Static and Dynamic Characteristics of Switching Devices.	**8**
Module V Introduction to power converters, Brief introduction to DC-DC Power Converter, AC-DC power converter, DC-AC power Converter, AC-AC power converter.	**8**

Textbooks:

2. D.P.Kothari and I.J.Nagrath; Electric Machines, TMH New Delhi, 4th Edition, 2010
3. A.E. Fitzraul, Charles Kinsley, Stephen D. Umansd ; Electric Machinery , McGraw Hill Education (India) Pvt. Ltd , Noida, Indian 6th Edition 2003
4. E.H. Langsdrof; Theory of Alternating Current Machinery, McGraw-Hill New York 1955

5. M.D. Singh, K. B. Khanchandani, Power Electronics, TMH, New Delhi 2008.
6. P. S. Bimbhra, Power Electronics, Khanna Publications, 5th Edition, New Delhi, 2012.
7. Modern Power System Analysis – D. P. Kothari, I. J. Nagrath, Tata-McGraw Hill.
8. Electric Energy Systems Theory - An Introduction – O. I. Elgerd, TMH Edition.
9. Electric Power System – C. L. Wadhwa, New Age International Publishing

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars
CD5	Mini projects/Projects
CD6	Simulation
CD7	Laboratory experiments/teaching aids

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	0	0	0	0	0	0	3	2	0
CO2	2	3	2	1	1	2	0	0	0	0	2	3	1	0
CO3	3	3	2	2	2	0	0	0	0	0	0	1	3	0
CO4	3	2	1	3	3	0	0	0	0	0	2	1	3	0
CO5	3	1	3	1	3	2	0	0	0	2	3	1	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD5, CD6

Course information sheet for Skill- Based Vocational courses, Level 1 (After completion of B.Tech. 2nd Year)

Course Code: EE24276

Course Title: Laboratory on Electrical Power Equipment and Protection

Credits: 04 L: 3 T: 1 P: 0

Class schedule per week: 04

Class: Skill-based vocational course

Semester / Level:

Branch: EEE

Course Objectives

The course aims to:

1	Familiarize students with the practical aspects of power semiconductor devices, converters, and machines.
2	Provide hands-on experience in the operation and testing of electrical machines and power electronic circuits.
3	Develop analytical skills to evaluate performance characteristics of machines and power electronic converters.
4	Impart knowledge on protection, regulation, and efficiency improvement of electrical systems.
5	Enable students to simulate and analyze power system components and transmission behavior.

Course Outcomes (COs)

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

CO1	Demonstrate the operation of thyristor and IGBT based controlled rectifiers and evaluate the relation between firing angle and output voltage and compare different commutation techniques experimentally.
CO2	Perform and verify different types of tests on AC electrical equipment like transformer, IM, and synchronous generator for evaluation of performance parameters of the equipment
CO3	Assess relay operation using test benches and understand protection mechanisms.
CO4	Apply power factor correction techniques for inductive loads.
CO5	Simulate transmission line performance and analyze voltage regulation, efficiency, and line parameters.

List of experiments

1. IGBT Characterisation for obtaining Output characteristics and Transfer characteristics.
2. Operation of Single Phase fully controlled rectifier to verify the relation between firing angle and average output voltage.
3. Experimentation with different classes of thyristor commutation circuit.
4. Connections of 3-phase transformer windings for different phasor groups.
5. Load test on a 3-phase induction motor to calculate torque, power, efficiency slip, etc.
6. Voltage regulation of a 3-phase alternator by direct loading and synchronous impedance method.
7. Starting and load test of 1-phase induction motor.
8. Testing of relay unit using relay test bench.
9. Power factor correction of RL load.
10. Transmission line simulation.

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

INDIRECT ASSESSMENT

Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	0	0	2	0	1	2	3	3	2
CO2	3	3	2	3	3	0	0	2	0	1	2	3	3	2
CO3	2	2	2	2	2	2	2	1	0	1	1	3	2	2
CO4	2	2	2	2	2	2	2	1	0	1	1	3	2	2
CO5	3	3	2	3	3	1	2	2	0	1	2	3	3	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2
CO2	CD1, CD2
CO3	CD1, CD2
CO4	CD1, CD2
CO5	CD1, CD2