COURSES OFFERED

IN A.Y. 2025-26

FOR

B.E. (ELECTRICAL ENGINEERING)

IN ALIGNMENT WITH GAPC 4.0

THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

COURSE OUTCOMES AND PROGRAM OUTCOMES

Program Outcomes (POs) for UG Program

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

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

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

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

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

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

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

PO8: **Individual and Collaborative Team Work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams. (WK9)

PO9: **Communication:** Communicate effectively and inclusively within the engineering community and with 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. (WK9)

PO10: **Project Management and Finance:** Apply knowledge and understanding of the 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. (WK9)

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

Program Specific Outcomes (PSOs) for B.E. EE Program

PSO1: To design, analyse, and implement electrical systems by applying principles of mathematics, science, and engineering for industrial and societal solutions

PSO2: To apply modern tools and techniques to address challenges in electrical engineering, while actively engaging in lifelong learning with consideration of safety standards and sustainability goals

KNOWLEDGE AND ATTITUDE PROFILE (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

COURES OFFERED IN AY 2025-26

Rationale:

TIET has adopted the credit system in accordance with the latest National Board of Accreditation (NBA) guidelines, wherein one academic credit corresponds to 30 hours of student learning, including both direct faculty-led instruction and self-learning (student effort) hours.

Accordingly, the credit allocation for all courses in the B.E. Electrical Engineering programme has been computed based on the total student learning hours for a 15-week semester (excluding three weeks of examinations i.e. Mid semester & End semester Exams), taking into account both contact hours and self-learning hours. The semester-wise distribution of courses and their corresponding credits is presented in the following tables.

SEMESTER-I

S. No.	Course Code	Course Name	CODE	L	T	P	SL	Cr
1.	UPH013	PHYSICS	BSC	45	15	30	45	4.5
2.	UES101	ENGINEERING DRAWING	ESC	30	60	0	30	4.0
3.	UHU003	PROFESSIONAL COMMUNICATION	HSS	30	0	30	30	3.0
4.	UMA022	CALCULUS FOR ENGINEERS	BSC	45	15	0	45	3.5
5.	UES102	MANUFACTURING PROCESSES	ESC	30	0	30	30	3.0
6.	UTA032	BOOT CAMP		0	0	0	30	1.0
		TOTAL		**180**	**90**	**90**	**180**	**18.0**

SEMESTER-II

S. No.	Course Code	Course Name	CODE	L	T	P	SL	Cr
1.	UCB009	CHEMISTRY	BSC	45	0	30	45	4.0
2.	UES103	PROGRAMMING FOR PROBLEM SOLVING	ESC	45	0	30	45	4.0
3.	UES013	ELECTRICAL & ELECTRONICS ENGINEERING	ESC	45	15	30	45	4.5
4.	UEN008	ENERGY AND ENVIRONMENT	HSS	30	0	0	30	2.0
5.	UMA023	DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA	BSC	45	15	0	45	3.5
		TOTAL		**210**	**30**	**90**	**210**	**18.0**

SEMESTER-III

S. No.	Course Code	Course Name	CODE	L	T	P	SL	Cr
1.	UMA028	MATHEMATICS FOR DATA SCIENCE	BSC	45	0	30	45	4.0
2.	UEE307	TRANSMISSION AND DISTRIBUTION OF ELECTRIC POWER	PCC	30	15	0	30	2.5
3.	UEE301	DIRECT CURRENT MACHINES AND TRANSFORMERS	PCC	45	15	30	45	4.5
4.	UES302	INTRODUCTION TO MEASUREMENT SYSTEMS	ESC	30	0	30	30	3.0
5.	UTA030	ENGINEERING DESIGN PROJECT (BUGGY)	PRJ	15	0	60	15	3.0
6.	UTD003	APTITUDE SKILLS BUILDING	HSS	30	0	0	30	2.0
7.	UCS321	AI FOR ENGINEERS	ESC	30	0	30	30	3.0
		TOTAL		**225**	**30**	**180**	**225**	**22.0**

SEMESTER-IV

S. No.	Course Code	Course Name	CODE**	L	T	P	SL	Cr
1.	UEE401	ALTERNATING CURRENT MACHINES	PCC	45	15	30	45	4.5
2.	UTA018	OBJECT ORIENTED PROGRAMMING	ESC	45	0	30	45	4.0
3.	UEE409	NETWORK THEORY	PCC	45	15	30	45	4.5
4.	UES301	ANALOG CIRCUITS	ESC	30	0	30	30	3.0
5.	UMA035	OPTIMIZATION TECHNIQUES	BSC	45	0	30	45	4.0
6.	UHU052	THE EVOLUTIONARY BASIS OF HUMAN BEHAVIOUR FOR ENGINEERS (1 SELF EFFORT HOUR)	HSS	15*	0	0	15*	1.0
7.	UCS421	ETHICS AND RISK MITIGATIONS OF AI	ESC	45	0	0	0	3.0
		TOTAL		**255+ 15***	**30**	**150**	**210+15***	**24.0**

*Alternate Week

SEMESTER-V

S. No.	Course Code	Course Name	CODE	L	T	P	SL	Cr
1.	UEE509	POWER SYSTEM ANALYSIS	PCC	45	15	30	45	4.5
2.	UEE511	EMBEDDED SYSTEM DESIGN AND IOT	PCC	45	0	30	45	4.0
3.	UEE504	POWER ELECTRONICS	PCC	45	15	30	45	4.5
4.	UPH401	ELECTRICAL AND ELECTRONIC ENGINEERING MATERIALS	BSC	30	0	30	30	3.0
5.	UTA025	INNOVATION AND ENTREPRENEURSHIP	OTH	15	0	30*	45	3.0
6.	UEE410	DATA STRUCTURES AND ALGORITHMS	PCC	45	0	30	45	4.0
7.		ELECTIVE-I	PEC	30	0	30	30	3.0
		TOTAL		**255**	**30**	**180+30***	**255**	**26.5**

*Lab in alternate week

SEMESTER-VI

S. No.	Course Code	Course Name	CODE	L	T	P	SL	Cr
1.	UEE616	INDUSTRIAL DRIVES AND AUTOMATION	PCC	45	0	30	45	4.0
2.	UEE513	ELECTRICAL SYSTEM DESIGN	PRJ	15	0	30	15	2.0
3.	UEE610	POWER SYSTEM PROTECTION	PCC	45	0	30	45	4.0
4.	ULC601	MACHINE LEARNING TECHNIQUES	PCC	45	0	30	45	4.0
5.	UEE510	HIGH VOLTAGE ENGINEERING	PCC	30	0	30	30	3.0
6.	UHU005	HUMANITIES FOR ENGINEERS	HSS	30	0	30	30	3.0
7.		ELECTIVE-II	PEC	30	0	30	30	3.0
8.	UEE795	CAPSTONE PROJECT (START)	PRJ	0	0	30*	0	-
		TOTAL		**240**	**0**	**210**	**240**	**23.0**

*Not included in teaching load

SEMESTER-VII

S. No.	Course Code	Course Name	Code	L	T	P	SL	Cr.
1	UEE705	SUSTAINABLE ENERGY SYSTEMS	CP	30	0	30	30	3.0
2	UEE706	IoT AND REAL TIME SYSTEMS	CP	45	0	30	15	3.0
3		ELECTIVE-III	PE	30	0	30	30	3.0
4		GENERIC ELECTIVE	GE	30	0	0	30	2.0
5	UEE795	CAPSTONE PROJECT	PR	0	0	30	210	8.0
		TOTAL		**135**	**0**	**120**	**315**	**19**

SEMESTER-VIII

S. No.	Course Code	Course Name	Code	L	T	P	SL	Cr.
1	UEE894	PROJECT SEMESTER	PR	0	0	0	450	**15.0**
		OR						
1	UEE632	POWER GENERATION AND ECONOMICS	CP	45	15	0	45	3.5
2	UEE522	ENERGY AUDITING AND MANAGEMENT	CP	45	15	0	45	3.5
3	UEE895	DESIGN PROJECT	PR	0	0	30	210	8.0
		TOTAL		**90**	**30**	**30**	**300**	**15**
		OR						
1	UEE896	START- UP SEMESTER	PR	0	0	0	450	**15.0**

SEMESTER-I

UPH013: Physics

L	T	P	SL	Cr
45	15	30	45	4.5

Course Objective: To introduce the student to the basic physical laws of oscillators, acoustics of buildings, ultrasonics, electromagnetic waves, wave optics, lasers, and quantum mechanics and demonstrate their applications in technology. To introduce the student to measurement principles and their application to investigate physical phenomena

Syllabus

Oscillations and Waves: Oscillatory motion and damping, Applications - Electromagnetic damping – eddy current; ***Acoustics:*** Reverberation time, absorption coefficient, Sabine's and Eyring's formulae (Qualitative idea), Applications - Designing of hall for speech, concert, and opera; ***Ultrasonics:*** Production and Detection of Ultrasonic waves, Applications - green energy, sound signaling, dispersion of fog, remote sensing, Car's airbag sensor.

Electromagnetic Waves: Scalar and vector fields; Gradient, divergence, and curl; Stokes' and Green's theorems; Concept of Displacement current; Maxwell's equations; Electromagnetic wave equations in free space and conducting media, Application - skin depth.

Optics: ***Interference:*** Parallel and wedge-shaped thin films, Newton rings, Applications as Non-reflecting coatings, Measurement of wavelength and refractive index. ***Diffraction:*** Single and Double slit diffraction, and Diffraction grating, Applications - Dispersive and Resolving Powers. ***Polarization:*** Production, detection, Applications – Anti-glare automobile headlights, Adjustable tint windows. ***Lasers:*** Basic concepts, Laser properties, Ruby, HeNe, and Semiconductor lasers, Applications – Optical communication and Optical alignment.

Quantum Mechanics: Wave function, Steady State Schrodinger wave equation, Expectation value, Infinite potential well, Tunneling effect (Qualitative idea), Application - Quantum computing.

Laboratory Work

1. Determination of damping effect on oscillatory motion due to various media.
2. Determination of velocity of ultrasonic waves in liquids by stationary wave method.
3. Determination of wavelength of sodium light using Newton's rings method.
4. Determination of dispersive power of sodium-D lines using diffraction grating.
5. Determination of specific rotation of cane sugar solution.
6. Study and proof of Malus' law in polarization.
7. Determination of beam divergence and beam intensity of a given laser.
8. Determination of displacement and conducting currents through a dielectric.
9. Determination of Planck's constant.

Micro Project:
Students will be given physics-based projects/assignments using computer simulations, etc.

Course Outcomes (COs)
The students will be able to:

1. understand damped and simple harmonic motion, the role of reverberation in designing a hall and generation and detection of ultrasonic waves.
2. use Maxwell's equations to describe propagation of EM waves in a medium.
3. demonstrate interference, diffraction and polarization of light.
4. explain the working principle of Lasers.
5. use the concept of wave function to find probability of a particle confined in a box.
6. perform an experiment, collect data, tabulate and report them and interpret the results with error analysis.

Text Books
1. Beiser, A., Concept of Modern Physics, Tata McGraw Hill (2007) 6th ed.
2. Griffiths, D.J., Introduction to Electrodynamics, Prentice Hall of India (1999) 3rd ed.
3. Jenkins, F.A. and White, H.E., Fundamentals of Optics, McGraw Hill (2001) 4th ed.

Reference Books
1. Wehr, M.R, Richards, J.A., Adair, T.W., Physics of The Atom, Narosa Publishing House (1990) 4th ed.
2. Verma, N.K., Physics for Engineers, Prentice Hall of India (2014)1st ed.
3. Pedrotti, Frank L., Pedrotti, Leno S., and Pedrotti, Leno M., Introduction to Optics, Pearson Prentice HallTM (2008) 3rd ed.

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	✓	✓							
CO2	✓	✓							
CO3	✓	✓							
CO4	✓	✓							
CO5	✓	✓							
CO6	✓	✓	✓	✓		✓		✓	

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UES101: Engineering Drawing

L	T	P	SL	Cr
30	60	0	30	4.0

Course Objective: This module is dedicated to graphics and includes two sections: 2D drafting and 3D modelling of solid objects. This course is aimed at making the student understand the concepts of projection systems, learn how to create projections of solid objects using first and third angle orthographic projection as well as isometric and auxiliary projection, concept of sectioning, to interpret the meaning and intent of toleranced dimensions and to create/edit drawings using drafting software. In addition, this course shall
give an insight on the basic 3D modelling concepts like extrude, revolve, sweep, construction
of complex solids.

Syllabus

Engineering Drawing Concepts

1. Introduction to Engineering Drawing
2. Projection systems: First angle and third angle projection system
3. Orthographic Projection: Points, Lines, Solid objects
4. Isometric Projections
5. Auxiliary Projections
6. Development of surfaces
7. Section of solids
8. Limits, fits and tolerances

2D Drafting

1. Management of screen menus commands
2. Creating basic drawing entities
3. Co-ordinate systems: Cartesian, polar and relative coordinates
4. Drawing limits, units of measurement and scale
5. Layering: organizing and maintaining the integrity of drawings
6. Design of prototype drawings as templates.
7. Editing/modifying drawing entities: selection of objects, object snap modes, editing commands,
8. Dimensioning: use of annotations, dimension types, properties and placement, adding text to
drawing

3D Modelling

1. Management of screen menus commands
2. Introduction to basic 3D modelling commands such as extrude, revolve, sweep etc.
3. Creation of 2D drawings from a 3D model

Micro Projects /Assignments:

1. Completing the views - Identification and drawing of missing lines and views in the projection of objects

2. Projects related to orthographic and isometric projections Using wax blocks/soap bars/any soft material to develop three dimensional object from given orthographic projections

3. a. 3D modelling of complex machine components
   b. Development of production drawings of individual components from the model

Course Outcomes (COs)

The students will be able to:

1. creatively comprehend the geometrical details of common engineering objects
2. draw dimensioned orthographic and isometric projections of simple engineering objects
3. interpret the meaning and intent of limits, fits and tolerances in the drawing
4. create/edit the engineering drawings for simple engineering objects using 2D drafting software
5. create/edit 3D models of engineering components using 3D modelling software

Text Books

1. Jolhe, D.A., Engineering Drawing, Tata McGraw Hill, 2008
2. Davies, B. L., Yarwood, A., Engineering Drawing and Computer Graphics, Van Nostrand Reinhold (UK), 1986

Reference Books

1. Gill, P.S., Geometrical Drawings, S.K. Kataria & Sons, Delhi (2008).
2. Gill, P.S., Machine Drawings, S.K. Kataria & Sons, Delhi (2013).
3. Mohan, K.R., Engineering Graphics, Dhanpat Rai Publishing Company (P) Ltd, Delhi (2002).
4. French, T. E., Vierck, C. J. and Foster, R. J., Fundamental of Engineering Drawing & Graphics Technology, McGraw Hill Book Company, New Delhi (1986).
5. Rowan, J. and Sidwell , E. H., Graphics for Engineers, Edward Arnold, London (1968).
6. Mastering AutoCAD 2021 and AutoCAD LT 2021, Brian C. Benton, George Omura, Sybex - John Wiley and Sons, Indiana (2021).

CO MAPPING WITH PO and PSO

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

CO6	-	2	-	-	3	-	-	-	-	-	-	-	2

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1			✓						
CO2			✓						
CO3			✓						
CO4						✓			
CO5						✓			
CO6						✓			

Evaluation Scheme

Course Component	**Weightage**
AutoCAD tutorials/SolidWorks/Project work*	35
MST (1.5 hours-CAD based)**	20
EST (2 hours-CAD based)**	45

***Students are required to bring their personal computers for the** tutorial work.*
**Availability of institute server resources for sharing the software licences with the student*
community.
***Institute computational resources in collaboration with other academic units / departments for conducting the mid semester and end semester test.*

UHU003: Professional Communication

L	T	P	SL	Cr
30	0	30	30	3.0

Course Objective: The course is designed to develop the interpersonal, written, and oral as well as the non- verbal communication skills of the students. The course begins by building up on the theoretical concepts and then practicing on the applicability of the various elements. Since the course has very high applicability content, the students are advised to practice in class as well as off class. A very high level of interaction is expected of the students in the class.

Syllabus

Fundamentals of Communication: Meaning, Types and Characteristics of communication, Applicability of Transactional Analysis and Johari Window for enhancing interpersonal communication skills. Seven Cs of Effective Communication, Barriers to Effective Communication.

Effective Oral Communication: Understanding Principles of Oral communication, Formal and Informal Oral Communication, Oral Communication and Behavioral Patterns, Advantages and Disadvantages of Oral Communication.

Effective Listening: Listening vs Hearing, Active Listening techniques, Barriers to Listening.

Effective non-verbal communication: Meaning and Importance of Non-Verbal Communication, Different Types of Non-verbal Communication, Interpretation of Non-verbal Cues.

Effective written Communication: Characteristics of Good Writing, Choice of Words, Sentence Construction, Paragraph development, Forms of writing.

Business Communication: Technical Report Writing, Designing Resumes and Cover Letters for effective job application, E-mail writing and e-mail etiquette.

Organizational Communication: Directional communication: Downward, Upward and Horizontal Communication, Grapevine.

Reading: The following texts (one from each of the two categories listed below) are required to be read by the students in the semester:

Category 1: Animal Farm by George Orwell, Lord of the Flies by William Golding, Life of Pi by Yann Martel

Category 2: The Namesake by Jhumpa Lahiri, The God of Small Things by Arundhati Roy, Q&A by Vikas Swarup

Laboratory Work

1. Needs-assessment of spoken and written communication with feedback.
2. Training for Group Discussions through simulations and role plays.
3. Technical report writing on survey-based projects.
4. Project-based team presentations.

Course Outcomes (COs)

The students will be able to:

1. Apply communication concepts for effective interpersonal communication.
2. Speak assertively and effectively.
3. Interpret non-verbal cues in professional communication.

4. Write objectively, purposefully and effectively.
5. Design effective resumes and reports.

Text Books

1. Mukherjee H.S..Business Communication: Connecting at Work. Oxford University Press.(2013)
2. Lesikar R.V, and Flately M.E., Basic Business Communication Skills for empowering the internet generation.(2006)
3. Raman, M.,and Singh ,P, Business Communication . Oxford. University Press (2008).

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1									✓
CO2									✓
CO3									✓
CO4									✓
CO5									✓

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UMA022: CALCULUS FOR ENGINEERS

L	T	P	SL	Cr
45	15	0	45	3.5

Course Objective: To provide students with skills and knowledge in sequence and series, advanced calculus, calculus of several variables and complex analysis which would enable them to devise solutions for given situations they may encounter in their engineering profession.

Syllabus

Sequences and Series: Introduction to sequences and infinite series, Tests for convergence/divergence, Limit comparison test, Ratio test, Root test, Cauchy integral test, Alternating series, Absolute convergence, and conditional convergence.

Series Expansions: Power series, Taylor series, Convergence of Taylor series, Error estimates, Term by term differentiation and integration.

Partial Differentiation: Functions of several variables, Limits and continuity, Chain rule, Change of variables, Partial differentiation of implicit functions, Directional derivatives and its properties, Maxima and minima by using second order derivatives.

Multiple Integrals: Double integral (Cartesian), Change of order of integration in double integral, Polar coordinates, Graphing of polar curves, Change of variables (Cartesian to polar), Applications of double integrals to areas and volumes, Evaluation of triple integral (Cartesian).

Complex analysis: Introduction to complex numbers, Geometrical interpretation, Functions of complex variables, Examples of elementary functions like exponential, trigonometric and hyperbolic functions, Elementary calculus on the complex plane (limits, continuity, differentiability), Cauchy – Riemann equations, Analytic functions, Harmonic functions.

Course Outcomes (COs)

The students will be able to:

1. determine the convergence/divergence of infinite series, approximation of functions using power and Taylor's series expansion and error estimation.
2. examine functions of several variables, define and compute partial derivatives, directional derivatives, and their use in finding maxima and minima in some engineering problems.
3. evaluate multiple integrals in Cartesian and Polar coordinates, and their applications to engineering problems.
4. represent complex numbers in Cartesian and Polar forms and test the analyticity of complex functions by using Cauchy – Riemann equations.

Text Books

1. Thomas, G.B. and Finney, R.L., Calculus and Analytic Geometry, Pearson Education (2007), 9th ed.
2. Stewart James, Essential Calculus; Thomson Publishers (2007), 6th ed.
3. Kasana, H.S., Complex Variables: Theory and Applications, Prentice Hall India, 2005 (2nd edition).

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓							
CO2		✓							
CO3		✓							
CO4		✓							

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UES102: Manufacturing Processes

L	T	P	SL	Cr
30	0	30	30	3.0

Course Objective: This course introduces the basic concepts of manufacturing via machining, forming, casting and joining, enabling the students to develop a basic knowledge of the mechanics, operation and limitations of basic machining tools along with metrology and measurement of parts. The course also introduces the concept of smart manufacturing.

Syllabus

Machining Processes: Principles of metal cutting, Cutting tools, Cutting tool materials and applications, Geometry of single point cutting tool, Introduction to computerized numerical control (CNC) machines, G and M code programming for simple turning and milling operations, introduction of canned cycles.

Metal Casting: Introduction & Principles of sand casting, Requisites of a sound casting, Permanent mold casting processes, casting defects

Metal Forming: Hot & cold metal working, Forging, Rolling, Sheet Metal operations.

Joining Processes: Method of joining, type of electric arc welding processes, Methods of shielding, Power source characteristics, Resistance welding, Soldering, Brazing.

Smart Manufacturing: IoT and ML in manufacturing, Introduction to Additive Manufacturing, Robotics and Automation in manufacturing.

Laboratory Work

Relevant shop floor exercises involving practices in Sand casting, Machining, Welding, Sheet metal fabrication techniques, CNC turning and milling exercises, Experiments on basic engineering metrology and measurements to include measurements for circularity, ovality, linear dimensions, profiles, radius, angular measurements, measurement of threads, surface roughness.

Basic knowledge and derivations related to above measurements, uncertainties, statistical approaches to estimate uncertainties, Line fitting, static and dynamic characteristics of instruments will be discussed in laboratory classes.

Assignments: Assignments for this course will include the topics: Manufacturing of micro-chips used in IT and electronics industry and use of touch screens. Another assignment will be given to practice numerical exercises on topics listed in the syllabus. Case study related to smart manufacturing.

Micro Project: Fabrication of multi-operational jobs using the above processes as per requirement by teams consisting of 4 -6 members. Quality check should be using the equipment available in metrology lab.

Course Outcomes (COs)

The students will be able to:

1. identify & analyse various machining processes/operations for manufacturing of industrial components
2. apply the basic principle of bulk and sheet metal forming operations
3. apply the knowledge of metal casting for different requirements.
4. identify and analyse the requirements to for achieving a sound welded joint apply the concept of smart manufacturing

Text Books

1. Degarmo, E. P., Kohser, Ronald A. and Black, J. T., Materials and Processes in Manufacturing, Prentice Hall of India (2008) 8th ed.
2. Kalpakjian, S. and Schmid, S. R., Manufacturing Processes for Engineering Materials, Dorling Kingsley (2006) 4th ed.

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓					✓	
CO2		✓	✓					✓	
CO3		✓	✓					✓	
CO4		✓	✓					✓	

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following)	30

		Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	

SEMESTER-II

UCB009: Chemistry

L	T	P	SL	Cr
45	0	30	45	4.0

Course Objective: The course aims at elucidating principles of applied chemistry in industrial systems, water treatment, engineering materials, computational and analytical techniques.

Syllabus

Atomic and Molecular spectroscopy: Introduction to spectroscopy, principles of atomic absorption, flame emission spectrophotometry and ICP-AES (Inductively Coupled Plasma- Atomic Emission Spectroscopy), Quantification by calibration method, Jablonski diagram, fluorescence and phosphorescence, Beer-Lambert's Law, principle and applications of UV-Vis and IR spectroscopy.

Electrochemistry: Background of electrochemistry, Ionic mobility, Conductometric titrations, Modern Batteries: Pb-acid and Li ion battery, Corrosion and its protection.

Water Treatment and Analysis: Physiochemical parameters of water quality, External and internal methods of Softening of water: carbonate, phosphate, calgon and colloidal conditioning, Zeolite process, Ion exchange process, treatment of water for domestic use, Desalination of brackish water: Reverse osmosis & Electrodialysis.

Fuels: Classification of fuels, Calorific value, Cetane and Octane number, alternative fuels: biodiesel, Power alcohol, synthetic petrol, Fuel cells: H2 production and storage, Water splitting, Rocket propellant.

Chemistry of Polymers: Classification of polymers, tacticity of polymers, molecular weight calculations, Polymers in daily life, conducting, inorganic and biodegradable polymers.

Computers in Chemistry: Introduction to SMILES (Simplified Molecular Input Line-Entry System): Methodology and encoding rules, SMILES notation-chemical structure interconversions and its applications.

Laboratory Work

Electrochemical measurements: Experiments involving use of pH meter, conductivity meter, potentiometer, Spectroscopic technique, Volumetric titrations: Determination of mixture of bases, hardness, alkalinity, chloride and iron content, Application of polymers and SMILES Language.

Course Outcomes (COs)

The students will be able to:

1. recognize principles and applications of atomic and molecular spectroscopy.
2. explain the concepts of conductometric titrations, modern batteries and corrosion.

3. apply and execute water quality parameter and treatment methods.
4. discuss the concept of alternative fuels, application of polymers and SMILES.
5. execute laboratory techniques like pH metry, potentiometry, spectrophotometry, conductometry and volumetry.

Text Books

1. Engineering Chemistry, S. Vairam and S. Ramesh, Wiley India 1st ed, 2014.
2. Engineering Chemistry, K. S. Maheswaramma, and M. Chugh. Pearson, 2016.

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	✓								
CO2	✓				✓				
CO3	✓				✓				
CO4	✓				✓				
CO5	✓								

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UES103: Programming for Problem Solving

L	T	P	SL	Cr
45	0	30	45	4.0

Course Objectives: This course is designed to solve and explore the problems using the art of computer programming with the help of C Language. Students will be able to apply these problem solving concepts in real life applications.

Syllabus

Introduction to Computer Fundamentals- Computer Memory Hierarchy, Types of Software Binary number system, Algorithm, Flowchart, Formulate simple algorithms for logical and arithmetic problems.

Basics of C Programming: Structure and Life cycle of a C Program, Data types, Identifiers, Variables, Keywords, Constants, input/output statements, Operators, Type conversion and type casting. Translate the algorithms to code snippets.

Decision Making and Iterative Statements- Decision making- if, if-else, Nested if-else, Multiple if, else if, switch, Ternary Operator, **Loops-** (while, do-while, for), Nesting of Loops, break, continue and goto. Implement the switch () to solve the basic functions of scientific calculator.

Functions: Function prototype, Definition and Call, Type of Functions, Scope of variables in (Block, Function, Program, File), Storage classes (Auto, Register, Static and Extern), Recursion (with the introduction of Stack), Implementation of recursion to solve the problem of Tower of Hanoi.

Arrays and Strings- One-dimensional array its operations (Traversal, Linear Search, Insertion, Deletion, Bubble Sort), Two-dimensional and its operations (Addition, Transpose and Multiplication), Passing of array into a function (row and entire array), Input and output of a string, string inbuilt functions, 2-D Character array.

Pointers: Introduction to Pointers, Pointer arithmetic, Passing arguments to a function using pointer (understanding of call by value and call by reference), Accessing arrays using pointers Dynamic memory allocation (malloc(), calloc(), realloc() and free()), Pointer and Functions.

Structures and Union: Structure declaration, Initialization of structures, Structure variables, Accessing structure elements using (.) operator, Array of structure variables, Passing structure variable to a function (individual and entire structure), Structure pointer, Comparison of Structure and Union.

File Handling: Introduction of Files (streams in C), using File (Declaring, Opening and COsing), Operations on File (Reading, Writing and appending), and Random Access of a file, command line argument.

Laboratory Work

To implement programs for various kinds of real life applications in C Language.

Course Outcomes (COs)

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

1. Comprehend and analyze the concepts of number system, memory, compilation and debugging of the programs in C language.
2. Analyze the control & iterative statements to solve the problems with C language source codes.
3. Design and create programs for problem solving involving arrays, strings and pointers.
4. Evaluate and analyze the programming concepts based on user define data types and filehandling using C language.

Text Books

1. C Programming Language, Brian W. Kernighan Dennis M. Ritchie, 2nd ed, 2012.
2. Programming in ANSI C, Balagurusamy G., 8th ed., 2019

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓			✓			
CO2		✓	✓			✓			
CO3		✓	✓			✓			
CO4		✓	✓			✓			

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45

3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UES013: **Electrical and Electronics Engineering**

L	T	P	SL	Cr
45	15	30	45	4.5

Course Objective: To introduce the basic concepts of electrical and electronics engineering.

Syllabus:

DC Circuits: Introduction to circuit elements; rms and average values for different wave shapes, independent and dependent current and voltage sources; Kirchhoff's laws; mesh and node analysis; source transformations; network theorems: Superposition theorem, Thevenin's and Norton's theorem, Maximum power transfer theorem; star-delta transformation; steady state and transient response of R-L and R-C and R-L-C circuits.

AC Circuits: Concept of phasor, phasor representation of circuit elements; analysis of series and parallel AC circuits; concept of real, reactive and apparent powers; resonance in RLC series and parallel circuits; balanced three phase circuits: voltage, current and power relations for star and delta arrangement; analysis of balanced and unbalanced circuits; three phase power measurement using two-wattmeter and one-wattmeter methods.

Magnetic circuits: analogy between electric and magnetic circuits; series and parallel magnetic circuits; operating principles of electrical appliances: single-phase transformer and rotating machines; tests and performance of single-phase transformer.

Digital Logic Design: Digital signals, Number systems, Positive and negative representation of numbers, Signed-number representation, Binary arithmetic, Postulates and theorems of Boolean Algebra**,** Algebraic simplification, Sum of products and product of sums formulations (SOP and POS), Gate primitives, Logic Gates and Universal Gates, Minimization of logic functions, Karnaugh Maps, Logic implementation using Gates, Decoder, MUX, Flip-Flops, Asynchronous up/down counters.

Electronic Devices: p- n junction diode: V-I characteristics of diode, Operation of Bipolar Junction Transistor, CB and CE configuration, Transistor as a switch, Operation of SCR, DIAC and TRIAC.

Operational Amplifier Circuits: The ideal operational amplifier, the inverting, non-inverting amplifiers, Op-Amp Characteristics, Applications of Op-amp: summing amplifier, differentiator and integrator.

Laboratory Work: Kirchhoff's laws, network theorems, ac series and parallel circuit, three phase power measurement, magnetic circuit, tests on transformer, resonance in AC circuit, combinational circuits, flip flops, shift register and binary counters, asynchronous and synchronous up/down counters, BJT characteristics.

Course Outcomes (COs)

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

1. Apply various networks laws and theorems to solve dc circuits
2. Compute different ac quantities with phasor representation
3. Comprehend the operation in magnetic circuits, single phase transformer and rotating machines
4. Recognize and apply the number systems and Boolean algebra.
5. Reduce and simplify Boolean expressions and implement them with logic gates.
6. Discuss and explain the working of diode, transistor and operational amplifier, their configurations and applications.

Text Books

1. Hughes, E., Smith, I.M., Hiley, J. and Brown, K., Electrical and Electronic Technology, Prentice Hall (2008) 10th ed.

2. Nagrath, I.J. and Kothari, D.P., Basic Electrical Engineering, Tata McGraw Hill (2002).
3. Boylestad, R.L. and Nashelsky, L., Electronic Devices & Circuit Theory, Perason (2009).
4. Mano M. M. and Ciletti, M.D., Digital Design, Pearson, Prentice Hall, (2013).

Reference Books

1. Chakraborti, A., Basic Electrical Engineering, Tata McGraw−Hill (2008).
2. Del Toro, V., Electrical Engineering Fundamentals, Prentice−Hall of India Private Limited (2004).
3. David Bell, Electronics Devices and Circuits, Oxford Publications (2009).

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓					
CO2		✓	✓	✓					
CO3		✓	✓	✓					
CO4		✓	✓	✓		✓			
CO5		✓	✓	✓		✓			
CO6		✓	✓	✓		✓			

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following)	30

	Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	

UEN008: Energy and Environment

L	T	P	SL	Cr
30	0	0	30	2.0

Course Objective: The exposure to this course would facilitate the students in understanding the terms, definitions and scope of environmental and energy issues pertaining to current global scenario; understanding the need of sustainability in addressing the current environmental & energy challenges.

Syllabus

Introduction: Concept of sustainability and sustainable use of natural resources, Climate Change & its related aspects.

Air Pollution: Origin, Sources and effects of air pollution; Primary and secondary meteorological parameters; wind roses; Atmospheric stability; Source reduction and Air Pollution Control Devices for particulates and gaseous pollutants in stationary sources.

Water Pollution: Origin, Sources of water pollution, Category of water pollutants, Physicochemical characteristics, Components of wastewater treatment systems.

Solid waste management: Introduction to solid waste management, Sources, characteristics of municipal solid waste, Solid waste management methods: Incineration, composting, landfilling.

Energy Resources: Classification of Energy Resources; Non-conventional energy resources-Biomass energy, Thermo-chemical conversion and biochemical conversion route; Solar energy-active and passive solar energy absorption systems; Type of collectors; Thermal and photo conversion applications.

Course Outcomes (COs)
The students will be able to:

1. comprehend the interdisciplinary context of environmental issues with reference to sustainability
2. assess the impact of anthropogenic activities on the various elements of environment and apply suitable techniques to mitigate their impact.
3. demonstrate the application of technology in real time assessment and control of pollutants.
4. correlate environmental concerns with the conventional energy sources associated and assess the uses and limitations of non-conventional energy technologies

Text Books

1. Moaveni, S., Energy, Environment and Sustainability, Cengage (2018)
2. Rajagopalan, R., Environmental Studies, Oxford University Press (2018)
3. O'Callagan, P.W., Energy Management, McGraw Hill Book Co. Ltd. (1993).

CO MAPPING WITH PO and PSO													
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	-	-	-	-	1	1	-	-	-	1	-	1
CO2	-	-	-	-	-	1	1	-	-	-	1	-	1
CO3	-	-	-	-	-	1	1	-	-	-	1	-	1
CO4	-	-	-	-	-	1	1	-	-	-	1	-	1

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1					✓		✓		✓
CO2					✓		✓		✓
CO3					✓		✓		✓
CO4					✓		✓		✓

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UMA023: DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA

L	T	P	SL	Cr
45	15	0	45	3.5

Course Objective: To introduce students the theory and concepts of differential equations, linear algebra, Laplace transformations and Fourier series which will equip them with adequate knowledge of mathematics to formulate and solve problems analytically.

Syllabus

Ordinary Differential Equations: Review of first order differential equations, Exact differential equations, Second and higher order differential equations, Solution techniques using one known solution, Cauchy - Euler equation, Method of undetermined coefficients, Variation of parameters method, Engineering applications of differential equations.

Laplace Transform: Definition and existence of Laplace transforms and its inverse, Properties of the Laplace transforms, Unit step function, Impulse function, Applications to solve initial and boundary value problems.

Fourier Series: Introduction, Fourier series on arbitrary intervals, Half range expansions, Applications of Fourier series to solve wave equation and heat equation.

Linear Algebra: Row reduced echelon form, Solution of system of linear equations, Matrix inversion, Linear spaces, Subspaces, Basis and dimension, Linear transformation and its matrix representation, Eigen-values, Eigen-vectors and Diagonalisation, Inner product spaces and Gram-Schmidt orthogonalisation process.

Course Outcomes (COs)
The students will be able to:

1. solve the differential equations of first and 2nd order and basic application problems described by these equations.
2. find the Laplace transformations and inverse Laplace transformations for various functions. Using the concept of Laplace transform students will be able to solve the initial value and boundary value problems.
3. find the Fourier series expansions of periodic functions and subsequently will be able to solve heat and wave equations.
4. solve systems of linear equations by using elementary row operations.
5. identify the vector spaces/subspaces and to compute their bases/orthonormal bases. Further, students will be able to express linear transformation in terms of matrix and find the eigenvalues and eigenvectors.

Text Books

1. Simmons, G.F., Differential Equations (With Applications and Historical Notes), Tata McGraw Hill (2009).
2. Krishnamurthy, V.K., Mainra, V.P. and Arora, J.L., An introduction to Linear Algebra, Affiliated East West Press (1976).

CO MAPPING WITH PO and PSO													
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	-	-	-	-	-	-	-	-	-	-	2	-
CO4	3	-	-	-	-	-	-	-	-	-	-	2	-
CO5	3	-	-	-	-	-	-	-	-	-	-	2	-

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓							
CO2		✓							
CO3		✓							
CO4		✓							
CO5		✓							

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

Semester III

UMA028: Mathematics for Data Science

L	T	P	SL	Cr
45	0	30	45	4.0

Course Objective: To introduce the student to the concept of Probability and Statistics that plays a vital role in computing and computational intelligence. Knowledge of these topics is critical to decision making and to the analysis of data. Using concepts of probability2 and statistics, individuals are able to predict the likelihood of an event occurring, organize and evaluate data.

Syllabus:

Mathematical Foundations of Data Sciences: Matrices, Vectors, Vector Spaces, Matrix Decomposition, Singular Value Decomposition, Eigenvalues and vectors, Sets and classes, Limit of a sequence of sets, rings, sigma-rings, sigma fields, monotone classes.

Probability: Classical, relative frequency and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem and independence, Random variable, some common discrete and continuous distributions (Binomial, Poisson, Negative binomial, Geometric, Rectangular, Exponential, Normal, Gamma).

Bi-variate Probability Distribution: Probability distribution of functions of a random variable, Joint and marginal distributions, Conditional distributions.

Correlation and Regression: Covariance, Karl-Pearson and rank Correlation coefficients; linear regression between two variables.

Estimation: Theory of Estimation, Properties of an estimator: Unbiasedness, consistency, Method of maximum likelihood, the method of moments, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for proportions.

Hypothesis: Introduction to Sampling Distribution (standard normal, chi-square, T& F distributions), Critical regions, Neyman-Pearson lemma (without proofs).

Parametric & Non-parametric tests: Tests for Goodness of fit: Based on Chi-square Test, one sample and paired sample tests; Sign Test, Signed-rank Test, Kolmogorov Smirnov Test.

Data Processing: Regression, Dimensionality Reduction, Linear Discriminant Analysis Principal Component Analysis.

Laboratory Work: Lab work based on the programming in MATLAB/ Python /SPSS/R language of various statistical techniques.

Course Outcomes (COs)

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

1. Compute probabilities of composite events along with an understanding of random variables and distribution functions.
2. Understand the convergence of sequence in probabilities

3. Analyse the correlated data and fit the linear regression models
4. Make statistical inferences using principles of hypothesis tests.

Text Books

1. Meyer P. L., Introduction to Probability and Statistical Applications, Oxford & IBH, (2007).
2. Hogg, R. V. and Craig, A.T., Introduction to Mathematical Statistics, Prentice Hall of India, (2004).
3. Ross, S.M., A First Course in Probability, 9th edition, Pearson (2012).
4. Peng, D., R., R Programming for Data Science, Lulu.com (2012).

Reference Books

1. Walpole, R. E., Myers, R. H., Myers, S. L. and Ye, K.,. Probability and statistics for engineers and scientists, Pearson, (2010).
2. 2. Hestie Trevor, Tibshirani R., Friedman J., the elements of statistical learning, SpringerVerlag New York Inc., 2nd Ed., (2001).

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓						
CO2		✓	✓						
CO3		✓	✓					✓	
CO4		✓	✓					✓	

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following)	30

	Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	

UEE307: **Transmission and Distribution of Electric Power**

L	T	P	SL	Cr
30	15	0	30	2.5

Course Objective: To introduce the concepts of transmission lines, line insulators, cables. To get familiarize with distribution, EHV and HVDC transmission system.

Syllabus:

Introduction: Structure of power systems–Indian perspective, Interconnections and their advantages, per unit system.

Transmission Line Parameters: Choice of voltage and frequency, computation of Resistance, Inductance and capacitance for different conductors, single phase and three phase transmission lines, effect of ground on capacitance, transposition and double circuit lines, Electrostatic and Electromagnetic interference with communication lines.

Insulators: Insulator types, String efficiency, Improvement of String Efficiency though insulation grading and usage of guard ring, Insulator Failure, Arcing horns, Armoured rods and Bushing.

Transmission Line Performance: Characteristics and performance of power transmission lines: Short, Medium, Long lines, π and T models, Generalized constants, Power flow, Regulation, Power circle diagrams, Series and shunt compensation

Corona : Corona visual and disruptive, Critical voltage, Phenomenon of Corona, Corona loss, Factors affecting Corona, Ferranti Effect

Insulated Cables: Constructional features, electric field intensity, dielectric strength, Grading of cables, Cable laying procedures, Fault location Methods, High voltage cables, Thermal characteristics, Ratings of Cables, Introduction to XLPE cables.

Mechanical design of overhead transmission lines: Tension and sag calculations, Effect of ice, wind and temperature, Sag template, Stringing charts, Vibrations and vibration damper.

Distribution Systems: Power supply systems and their comparison, Classification of distribution system, Primary and secondary distribution, Ring main and radial systems, Systematic design of distribution systems.

EHV transmission and HVDC transmission: Need of EHV transmission system, types of DC links, advantages of DC transmission, EHAV and HVDC systems in India and trends. Standards: Indian Electricity Rules.

Course Outcomes (COs)

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

1. Analyse the transmission line models and evaluate its performance parameters
2. Design the transmission lines under various working conditions
3. Select the configurations of different line insulators and evaluate their performance
4. Supervise the laying of cables and fault detection in cables
5. Design the distribution system network.

Text Books

1. Chakrabarti,A.,Soni,M.L.,Gupta,P.V.andBhatnagar,U.S.,ATextBookonPowerSystem Engineering, Dhanpat Rai(2008).
2. Wadhwa, C.L., Electrical Power Systems, New Age International (P) Limited, Publishers (2008).

Reference Books

1. Gupta, B.R., Power System Analysis and Design, S. Chand (2009).
2. Nagrath, I.J. and Kothari, D.P., Power System Engineering, Tata McGraw-Hill (2007).
3. Pabla, A.S., Electric Power Distribution, McGraw-Hill (2008).
4. Stevenson, W.D., Power System Analysis, McGraw-Hill (2007).

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓				✓	
CO2		✓	✓	✓	✓				
CO3		✓	✓	✓	✓				
CO4		✓	✓	✓	✓				
CO5		✓	✓	✓	✓				

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UEE301: **Direct Current Machines and Transformers**

L	T	P	SL	Cr
45	15	30	45	4.5

Course Objective: To introduce the fundamental concepts of dc machines and transformers.

Syllabus:

General Concepts of Rotating Electrical Machines: Electromagnetic torque, Reluctance torque, Constructional features of rotating electrical machines, Classifications of rotating electrical machines, Construction of DC machines.

DC Generators: Classification of DC generator, Armature reaction, Compensating windings, Commutation, Methods of improving commutation, Characteristic of DC generators, Voltage buildup of shunt generators, Voltage regulation, Parallel operation of DC generators, Condition for maximum efficiency, Applications of DC generators.

DC Motors: Characteristic of DC motors, Speed control of DC motors, Ward–Leonard control (Voltage control), Three-point starter, four-point starter, DC shunt motor starter design, Electric breakings of DC shunt and series motors, Condition for maximum mechanical power.

Testing of DC machines: Brake test, Swinburne's test, Hopkinson's test or back to back test, Retardation test or Running test, Field's test, Applications of DC motors.

Single Phase Transformers: Introduction, Basic principle, Types of transformer, Construction, Equivalent circuit, Open circuit and short circuit, Separation of core losses, Per unit representation, Voltage regulation of a transformer, Losses in a transformer, Efficiency of a transformer, Condition for maximum efficiency, All day efficiency, Polarity test of a single–phase transformer, Sumpner's test, Parallel operation, Auto transformer.

Three-Phase Transformer: Advantages of three phase transformer, Principle of operation, Construction, Three–phase transformer connections, Open delta or V–V connection, Scott connection or T–T connection, Three–phase to two–phase conversion, Three–phase to six–phase conversion, Three–winding transformer, Parallel operation of transformers.

Special Purpose Transformers: Instrument transformers (CT and PT), Earthing transformer, Pulse transformer, High frequency transformer, Converter transformer.

Laboratory Work: DC Machines: Characteristics of generators and motors, Speed control, Efficiency, DC generators in parallel. Transformers: Open and short circuit tests, Parallel operation, Harmonics in no-load current, Three-phase connections, 3–phase to 2–phase and 6–phase conversions.

Course Outcomes (COs)

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

1. Analyse the performance characteristics of DC motors and DC generators
2. Use different methods for starting and speed control of DC motors
3. Analyse the performance of transformers under various operating conditions
4. Use and analyse special purpose transformer (s) for measurement and protection
5. Elucidate the advantages of parallel operation of generators/transformers.

Text Books

1. Bimbhra, P.S., Electrical Machinery, Khanna Publishers (2008).
2. Mukherjee, P.K. and Chakravorty, S., Electrical Machines, DhanpatRai(2004).
3. Nagrath, I.J. and Kothari, D.P., Electric Machines, Tata McGraw Hill(2004).

Reference Books

1. Bimbhra, P.S., Generalized Theory of Electrical Machines, Khanna Publishers (2007).
2. Fitzgerald, A.E., Kingsley, C. Jr. and Umans, Stephen, Electric Machinery, McGraw Hill (2002).

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓				✓	
CO2		✓	✓	✓					
CO3		✓	✓	✓				✓	
CO4		✓	✓	✓				✓	
CO5		✓	✓	✓					

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UES302: **Introduction to Measurement Systems**

L	T	P	SL	Cr
30	0	30	30	3.0

Course Objective: To introduce the classification of standards, to get familiar with principle, operation and comparison of electromechanical indicating instruments. To get familiarize with power and energy measurement systems, working and applications of various type of bridges and transducer.

Syllabus:

Introduction: Types of measurements, Instrument classification, Elements of an instrument, Input-output configuration of measuring instruments, Methods of correction for interfering and modifying inputs, Calibration, Static and Dynamic characteristics, measurement errors and error analysis, Classification of standards, Time and frequency standards, Electrical standards.

Electromechanical Indicating Instruments: PMMC galvanometer, Ohmmeter, Electrodynamometer, Moving iron meter, Rectifier and thermo-instruments, Comparison of various types of indicating instruments.

Power and Energy Measurement: Electrodynamometer type of wattmeter and power factor meter, Single-phase induction and Electronic energy meters. Amplitude and phase comparator, Phasor extraction and Introduction to PMU and its Applications.

Bridges for Measurement: Kelvin double bridge, AC bridges: Maxwell's bridge, Hay's bridge, Schering bridge, Wien's bridge, Low and High resistance measurement.

Electronic Instruments: Electronic multi-meter, Quantization error, Digital frequency meter, Q meter, Spectrum Analyzer, Digital Storage Oscilloscopes.

Sensors and Transducers: Basic principle and applications of Resistive, Inductive, Capacitive and, Piezoelectric sensors, Synchros and Resolvers, Fiber optic sensors, Hall-Effect, Photo transducer, Photovoltaic, Digital transducers, Tacho-generators, shaft parameters measurement in rotating shafts.

Laboratory Work: To measure sensitivity of Wheat Stone Bridge, Comparison of various types of indicating instruments, Single phase induction type energy meter, AC bridge measurement, Familiarization with storage type digital oscilloscopes.

Course Outcomes (COs)

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

1. Select various types of instruments for measurement of variables.
2. Select and use various types of sensors in different conditions.
3. Select and use various types of bridge circuits with different sensors.
4. Demonstrate the working of electronic instruments, working of sensors and transducers

Text Books

1. Golding, E.W., and Widdis, F.C., Electrical Measurements and Measuring Instruments, Pitman (2003).
2. Sawhney, A.K., A Course in Electrical and Electronic Measurements and Instrumentation, DhanpatRai and Co. (P) Ltd.(2007).
3. Nakra, B. C. and Chaudhry, K. K., Instrumentation Measurement and Analysis, Tata McGraw–Hill (2003).

Reference Books

1. Murthy, D.V.S., Transducers and Instrumentation, Prentice–Hall of India Private Limited(2003).
2. Doeblin, E.O., Measurement systems, Applications and Design, McGraw–Hill(1982).

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓	✓				
CO2		✓	✓	✓	✓				
CO3		✓	✓	✓	✓				
CO4		✓	✓	✓					

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UTA030: Engineering Design Project (Buggy)

L	T	P	SL	Cr
15	0	60	15	3.0

Course Objective: The project will introduce students to the challenge of electronic systems design & integration. The project is an example of 'hardware and software co-design' and the scale of the task is such that it will require teamwork as a co-ordinated effort.

Syllabus:

Hardware overview of Arduino:

- Introduction to Arduino Board: Technical specifications, accessories and applications.
- Introduction to Eagle (PCB layout tool) software.

Sensors and selection criterion:

- Concepts of sensors, their technical specifications, selection criterion, working principle and applications such as IR sensors, ultrasonic sensors.

Active and passive components:

- Familiarization with hardware components, input and output devices, their technical specifications, selection criterion, working principle and applications such as-
  - Active and passive components: Transistor (MOSFET), diode (LED), LCD, potentiometer, capacitors, DC motor, Breadboard, general PCB etc.
  - Instruments: CRO, multimeter, Logic probe, solder iron, desolder iron
  - Serial communication: Concept of RS232 communication, Xbee
- Introduction of ATtiny microcontroller based PWM circuit programming.

Programming of Arduino:

- Introduction to Arduino: Setting up the programming environment and basic introduction to the Arduinomicro-controller
- Programming Concepts: Understanding and Using Variables, If-Else Statement, Comparison Operators and Conditions, For Loop Iteration, Arrays, Switch Case Statement and Using a Keyboard for Data Collection, While Statement, Using Buttons, Reading Analog and Digital Pins, Serial Port Communication, Introduction programming of different type of sensors and communication modules, DC Motors controlling.

Basics of C#:

- Introduction: MS.NET Framework Introduction, Visual Studio Overview and Installation
- Programming Basics: Console Programming, Variables and Expressions, Arithmetic Operators, Relational Operators, Logical Operators, Bitwise Operators, Assignment Operators, Expressions, Control Structures, Characters, Strings, String Input, serial port communication: Read and write data using serial port.
- Software code optimization, software version control.

Laboratory Work:

Schematic circuit drawing and PCB layout design on CAD tools, implementing hardware module of IR sensor, Transmitter and Receiver circuit on PCB.

Bronze Challenge: Single buggy around track twice in Clockwise direction, under full supervisory control. Able to detect an obstacle. Parks safely. Able to communicate state of the track and buggy at each gantry stop to the console.

Silver Challenge: Two buggies, both one loop around, track in opposite directions under full supervisory, control. Able to detect an obstacle. Both park safely. Able to communicate state of the track and buggy at each gantry stop with console.

Gold Challenge: Same as silver but user must be able to enter the number of loops around the track beforehand to make the code generalized.

Course Outcomes (COs)

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

1. Recognize issues to be addressed in a combined hardware and software system design
2. Draw the schematic diagram of an electronic circuit and design its PCB layout using CAD Tools
3. Apply hands-on experience in electronic circuit implementation and its testing
4. Demonstrate programming skills by integrating coding, optimization and debugging for different challenges
5. Develop group working, including task sub-division and integration of individual contributions from the team.

Text Books

1. Michael McRoberts, Beginning Arduino, Technology in Action Publications, 2nd Edition.
2. Alan G. Smith, Introduction to Arduino: A piece of cake, Create Space Independent Publishing Platform (2011).

Reference Books

1. John Boxall, Arduino Workshop - a Hands-On Introduction with 65 Projects, No Starch Press; 1st edition (2013).

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓				✓			
CO2		✓	✓			✓			
CO3		✓	✓	✓		✓			
CO4		✓				✓			
CO5									✓

UTD 003: APTITUDE SKILLS BUILDING

L	T	P	SL	Cr
30	0	0	30	2.0

Course Objective:

- The course aims to equip students with a comprehensive understanding of quantitative, verbal, and logical reasoning concepts, enhancing their ability to solve numerical problems, interpret written information, and evaluate arguments effectively. It provides exposure to various aptitude test formats, and time-management strategies, and offers practice opportunities with personalized feedback to build confidence and prepare students for aptitude tests, increasing their job market competitiveness and career advancement opportunities.

- **Verbal Ability & Reading Comprehension:** Introduction to Reading Comprehension: Strategies for approaching different types of passages, identifying main ideas, and understanding structure, Advanced reading techniques, dealing with inferences, tone, and author's purpose, Introduction to Verbal Ability: Grammar Fundamentals, sentence structure, common errors, Sentence Correction and Completion, Review and Test-Taking Strategies: Consolidate knowledge from all areas, focusing on test-taking strategies, time management, and practice tests.
- **Quantitative & Logical Reasoning:** Introduction to Quantitative Ability - Arithmetic Basics: arithmetic concepts (numbers, operations, percentages, ratios, averages), Advanced Arithmetic & Introduction to Algebra: more complex arithmetic (interest, partnerships, mixtures, ratios, variation) and basics of algebra (equations, inequalities, speed, time and distance), Algebra Continued & Introduction to Modern Math: quadratic equations, sequences and introduce concepts of modern math set theory, probability, permutations, combinations, and more complex probability problems, Introduction to Data Interpretation: Basics of data interpretation, understanding and interpreting bar charts and pie charts, Data Interpretation - Line Charts and Tables, interpreting trends, and comparing data, practice session with mixed problems from quantitative ability and data interpretation, Introduction to Logical Reasoning: Number Series and Sequences, Family Relationships and Directions.

Course Outcomes (Cos)

CO 1: Ability to identify and provide solutions for complex problems and apply the basics of mathematics

CO 2: Able to analyze and interpret data from various sources to identify trends and make data-driven comparisons.

CO 3: Able to evaluate logical reasoning scenarios to identify patterns, solve sequences, and make accurate inferences.

CO 4: Able to improve communication skills, including correcting errors, refining structure, and enhancing verbal proficiency.

CO 5: Able to analyze various types of information to identify key points, infer meaning, and understand underlying tones and purposes.

Text Books

1. *Aggarwal, R.S., Quantitative Aptitude for Competitive Examinations; S Chand (2017)*
2. *Agarwal, A., An expert guide to problem-solving: with practical examples; CreateSpace Independent Publishing Platform (2016)*

3. *Other supplemental materials: Instructor prepared material disseminated through social media tools & apps*
4. *M. Tyra, Magical Book on Quicker Maths, Fifth Edition, BSC Publishing Co Pvt Ltd, 2018*
5. *K Kundan, Advanced Verbal Reasoning, Tyrasons Publications, 2021*
6. *Wren and Martin, English Grammar Book, S. Chand Publication, 2024*

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓	✓				
CO2		✓	✓	✓				✓	✓
CO3		✓	✓	✓				✓	
CO4								✓	✓
CO5		✓	✓	✓				✓	

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	EST	50
2	Sessional	40
3	Assignment	10

UCS321: AI FOR ENGINEERS					
	L	T	P	SL	Cr
	30	0	30	30	3.0

Course Objective: Develop foundational AI knowledge while equipping participants with practical problem-solving skills using data relevant to engineering applications.

1.Introduction to AI for Engineers: Definitions: Artificial Intelligence (AI), Machine Learning (ML), Deep Learning (DL), Reinforcement Learning (RL) • Understanding AI's role in engineering decision-making • Illustrative examples from engineering fields (e.g., predictive maintenance, process control)

2. Data and Preprocessing: Types of data: sensor data, image data, text data, and time-series data • Techniques for cleaning, normalization, and handling missing values • Introduction to feature selection methods

3. Supervised Learning: Core algorithms: Linear Regression, Logistic Regression, Decision Trees, Random Forest • Applications: Predicting equipment failure or component lifespan

4. Unsupervised Learning: Clustering techniques: K-Means, DBSCAN • Dimensionality reduction methods: Principal Component Analysis (PCA), t-SNE • Applications: Process classification and anomaly detection

5. Neural Networks & Deep Learning (Intro): Fundamentals of Neural Networks: Multilayer Perceptron (MLP), Convolutional Neural Networks (CNN) • Use cases: Image recognition (e.g., detecting cracks in structures)

6. Time-Series Analysis • Forecasting techniques: ARIMA and introductory Long Short-Term Memory (LSTM) models • Applications: Load prediction and vibration analysis

7. Toolchain for Engineers • Programming tools: Python, Jupyter Notebook • Libraries: pandas, scikit-learn, TensorFlow/Keras • Version control: Using Git effectively

8. Mini Project: Choose an engineering-specific dataset • Apply preprocessing, modeling, and evaluation techniques

Laboratory Work:

- Build a regression model to predict temperature rise in a motor
- Use K-Means clustering to group materials based on properties
- Create a neural network to detect faulty circuits

Case Studies

• Siemens: AI applications in industrial automation

• General Electric (GE): AI-driven turbine health monitoring

• Honeywell: Predictive maintenance in smart factories

Semester IV

UEE401: Alternating Current Machines

L	T	P	SL	Cr
45	15	30	45	4.5

Course Objective: To introduce the concept of single phase and three phase AC machines, their construction and performance parameters.

Syllabus:

Three–Phase Induction Motors: Construction, working principle, Sip and its effect on rotor parameters: rotor frequency, Torque–slip characteristics, Power flow diagram, Efficiency, Synchronous watt, Measurement of slip, Equivalent circuit, No–load test, Blocked rotor test, Circle diagram, Starting methods, Speed control methods, Crawling, Cogging, Deep cage and Double cage rotors, Applications, self-excited and grid connected Induction generator.

Fractional kW Motors and Special Machines: Classification, Production of rotating field, Double revolving field theory, Equivalent circuit, Determination of equivalent circuit parameters, Split phase induction motor, Capacitor motor, Permanent split capacitor motor; Shaded pole motor, Universal motor, Stepper motor.

Synchronous Generators/Alternators: Introduction, Comparison with DC generator, Advantages of rotating field over rotating armature, Constructional features, Excitation systems, Armature windings, EMF equation, Winding factor, Harmonics, Armature resistance, Armature reaction: Unity power factor, Zero lagging and Zero leading power factor, Armature reaction reactance, Equivalent circuit of an alternator, Voltage equation, Phasor diagram of a loaded alternator for various types of loads, Voltage regulation and methods of estimation of voltage regulation, Load characteristic of alternators, power equation, Two reaction theory and Torque angle characteristic of a salient pole alternator, Maximum reactive power for a salient pole alternator, Losses and efficiency, Determination of Xd and Xq, Parallel operation of alternators, Synchronising procedures, Synchronising power and Torque coefficient, Damper Windings, Hunting.

Synchronous Motors: Voltage equation, Phasor diagram, Operation at constant load with variable excitation, Power equations, salient pole Synchronous motor, Starting of synchronous motors, Applications, Synchronous condensers.

Laboratory Work: Reactances of cylindrical and salient-pole synchronous machines, Voltage regulation, Operating characteristics, Synchronizing, Parallel operation and load division, determination of sub-transient, transient and steady state reactances and various time constants, Determination of positive, negative and zero sequence reactances, Synchronous motor starting, Efficiency. Three phase induction motors: starting methods, Equivalent circuit parameters, Load test, Polarity test, Single phasing, Efficiency, Schrage motor, Single-phase induction motors: Equivalent circuit parameters.

Course Outcomes (COs)

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

1. Comprehend the operation, test and performance and speed control of three-phase induction motor
2. Analyse the performance of fractional kW motors
3. Comprehend the performance, test and control of synchronous machines.

4. Elucidate the advantages of alternators connected in parallel.

Text Books

1. Bimbhra, P.S., Electrical Machinery, Khanna Publishers (2008).
2. Mukherjee, P.K. and Chakravorty, S., Electrical Machines, Dhanpat Rai and Co. (P) Ltd. (2004).
3. Nagrath, I.J. and Kothari, D.P., Electric Machines, Tata McGraw Hill (2004).
4. Sawhney, A. K., and Chakrabarti, A. Course in electrical machine design. Dhanpat Rai (2006).

Reference Books

1. Bimbhra, P.S., Electrical Machinery, Khanna Publishers (2008).
2. Mukherjee, P.K. and Chakravorty, S., Electrical Machines, Dhanpat Rai and Co. (P) Ltd. (2004).
3. Nagrath, I.J. and Kothari, D.P., Electric Machines, Tata McGraw Hill (2004).

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓					
CO2		✓	✓	✓				✓	
CO3		✓	✓	✓					
CO4		✓	✓	✓					

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UTA018: **Object Oriented Programming**

L	T	P	SL	Cr
45	0	30	45	4.0

Course Objective: To become familiar with object oriented programming concepts and be able to apply these concepts in solving diverse range of applications.

Syllabus:

Objects and Classes: Structure in C and C++, Class specification, Objects, Namespaces, Overview of pillars of OOPS (Data Encapsulation, Data Abstraction, Inheritance, Polymorphism), Inline functions, Passing objects as arguments, Returning object from a function, Array of objects, Static keyword with data member, member function and object, Friend function, and Friend classes, Pointer to objects, this pointer, Dynamic Initialization, Dynamic memory allocation.

Constructor and Destructor: Constructors and its types, Constructor Overloading, Constructors in array of objects, Constructors with default arguments, Dynamic Constructor, Destructor, 'const' keyword with data member, member function and object.

Inheritance: Introduction to Inheritance, Forms of Inheritance (Single, Multiple, Multilevel, Hierarchical and Hybrid) with various modes (Public, Private and Protected), Inheritance with Constructor and Destructor, Benefits and Limitations of Inheritance.

Polymorphism: Classification of Polymorphism (Compile-time and Run-time), Compile Time-Function Overloading, Operator Overloading (Unary operator and Binary operator with member function and friend function), Data Conversion (Basic to user-defined, user-defined to basic, one user-defined to another user-defined). Run-time- Pointers to derived class object, Overriding member function, Virtual functions, pure virtual functions, Abstract class.

Exception Handling, Templates and Standard Template Library: Exception handling mechanism, Usage of template, Function templates, Overloading of Function templates, Class templates, Introduction to Standard Template Library and its components. Algorithms, Containers (Array, Vector, Stack, List and Queue) and Iterators.

Laboratory Work: To implement object oriented constructs using C++programming language

Course Outcomes (COs)

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

1. To recall the knowledge of structure and its variables to comprehend the concept of classes, objects, constructors and destructors for implementing the object oriented paradigms.
2. To apply and analyze the inheritance on real life case studies via coding competences.
3. To design and develop code snippets for polymorphism to proclaim coding potential; and management of run-time exceptions.
4. To assess and interpret the knowledge of templates to appraise the standard template libraries.

Text Books

1. C++:The Complete Reference , Schildt H., Tata McGraw Hill, 4thed, 2003
2. C++Primer, Lippman B.S., Lajoie J., and MooE.B., , Addison-Wesley Professional, 5th ed, 2013

Reference Books

1. Object-Oriented Programming in C++, Lafore R., Pearson Education, 4thed, 2002
2. Object Oriented Programming with C++, E Balagurusamy, 8th ed,2017
3. The C++programming language, Stroustrup B., Pearson Education India, 4thed, 2013

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓				✓			
CO2		✓				✓			
CO3		✓				✓			
CO4		✓				✓			
CO5		✓				✓			

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UEE409: Network Theory

L	T	P	SL	Cr
45	15	30	45	4.5

Course Objective: To make the students understand the concepts of graph theory, two port networks, filter and attenuators.

Syllabus:

Graph Theory: Graph, Tree and link branches, Network matrices and their relations, Choice of linearly independent network variables, Topological equations for loop current and for nodal voltage, Duality.

Network Theorems: Source transformation, Superposition theorem, Thevenin's theorem, Norton's theorem, Millman's theorem, Reciprocity theorem and Maximum power transfer theorem as applied to ac circuits, Compensation theorem, Tellegen's theorem and their applications.

Two Port Networks: Two port network description in terms of open circuits impedance, Short circuit admittance, Hybrid and inverse hybrid, ABCD and inverse ABCD parameters, Inter- connection of two port network, Indefinites admittance matrix and its applications.

Network Functions: Concepts of complex frequency, Transform impedance, Networks function of one port and two port network, concepts of poles and zeros, property of driving point and transfer function.

Passive Network Synthesis: Introduction, Positive Real Functions: Definition, Necessary and sufficient conditions for a function to be positive real, Synthesis vs. analysis, Elements of circuit synthesis, Foster and Cauer forms of LC Networks, Synthesis of RC and RL networks.

Filters and Attenuators: Classification of Filters, Analysis of a prototype low pass, high pass, band pass, band stop and m-derived filters, Attenuation, Types of attenuators: symmetrical and asymmetrical.

Active Filters: Introduction to Active filters, first and second order low pass Butterworth filter, First and second order high pass Butterworth filter, Band pass filter.

Laboratory Work: Verification of Network Theorems, Determination of Z, Y, hybrid and ABCD parameters of two port network, Inter-connection of two port networks, Implementation of different types of filter and attenuator configurations.

Course Outcomes (COs)

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

1. Apply various laws and theorems to solve electric networks
2. Analyse the behaviour of two port networks
3. Apply graph theory concept to solve electrical networks
4. Realise one-port network parameters
5. Design different filter and attenuator configurations.

Text Books

1. Hayt, W., Engineering Circuit Analysis, Tata McGraw–Hill (2006).
2. Hussain, A., Networks and Systems, CBS Publications (2004).

3. Valkenberg, Van, Network Analysis, Prentice–Hall of India Private Limited(2007).
4. Gayakwad, A. Op-Amps and Linear Integrated Circuits, Prentice–Hall of India(2006).

Reference Books

1. Chakarbarti,A., Circuit Theory, Dhanpat Rai and Co. (P) Ltd.(2006).
2. Roy Chowdhury, D. Network and Systems, New Age International (P) Limited (2007).
3. Suresh Kumar, K.S. Electrical circuits and Networks, Pearson Education,(2009).

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓					
CO2		✓	✓	✓				✓	
CO3		✓	✓	✓					
CO4		✓	✓	✓					
CO5		✓	✓	✓	✓			✓	

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UES301: ANALOG CIRCUITS

L	T	P	SL	Cr
30	0	30	30	3.0

Course Objective: To analyse working of BJT and MOSFET, understand multi-stage and power amplifications, working of operational amplifiers, active filters and oscillators.

Syllabus:

Biasing and Thermal Stabilization: Transistor biasing and load line analysis, structure, working and applications of MOSFET, output and transfer characteristics, Thermal Runaway, Thermal Stability, biasing schemes,

Amplifiers: low and high frequency analysis of single stage amplifiers, h-parameter models, variation of parameters, short-circuit current gain, gain-bandwidth product frequency compensation, current mirrors, multistage amplifiers

Differential and operational amplifiers: Basic operations, negative and positive feedback, distortion and frequency response of an amplifier, applications of amplifiers for multi-stage and power amplifications, CMOS Operational Amplifier: Structure, Analysis and Design, Frequency Response and Compensation Techniques. Switched Capacitor Circuits: Principles of operation, Filter and non-filter applications.

Active filters and Oscillators: Design of Butterworth filters using op amp, condition for sustained oscillation, R-C phase shift, Hartley, Colpitts, Crystal and Wien Bridge Oscillators, Negative Resistance oscillator; Multi-vibrators (Astable, Mono-stable, Bi-Stable).

Laboratory Work: RC coupled amplifier in CE mode, application of bistable, astable and monostable multivibrators, Hartley and Colpitts oscillator.
Minor Project: Automatic intensity control of street lights, auto night lamp with high power LED, water level alarm, panic alarm, dc motor control using L298N motor driver module and Arduino.

Course Outcomes (COs)

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

1. Design different types of transistor biasing circuits
2. Analyse the applications of amplifiers for multi-stage and power amplifications
3. Design Butterworth active filters and oscillator circuits

Text Books

1. Boylestad R. L., Electronic Devices and Circuit Theory, Pearson Education(2007).
2. Millman, J. and Halkias, C.C., Integrated Electronics, Tata McGraw Hill(2006).

Reference Books

1. Neamen, Donald A., Electronic Circuit Analysis and Design, McGraw Hill(2006).
2. Sedra A. S. and Smith K. C., Microelectronic Circuits, Oxford University Press(2006).

CO MAPPING WITH PO and PSO												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	-	2	-	-	-	-	-	-	3	1
CO2	3	3	-	2	-	-	-	-	-	-	-	3	-
CO3	3	3	3	-	2	-	-	-	-	-	-	3	2

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓	✓	✓			
CO2		✓	✓	✓				✓	
CO3		✓	✓	✓	✓	✓			

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following) Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	30

UMA035: Optimization Techniques

L	T	P	SL	Cr
45	0	30	45	4.0

Course Objective: The main objective of the course is to formulate mathematical models and to understand solution methods for real life optimal decision problems. The emphasis will be on basic study of linear and non-linear programming problems, Integer programming problem, Transportation problem, Two person zero sum games with economic applications and project management techniques using CPM.

Syllabus:

Scope of Operations Research: Introduction to linear and non-linear programming formulation of different models.

Linear Programming: Geometry of linear programming, Graphical method, Linear programming (LP) in standard form, Solution of LP by simplex method, Exceptional cases in LP, Duality theory, Dual simplex method, Sensitivity analysis.

Integer Programming: Branch and bound technique, Gomory's Cutting plane method. Network Models: Construction of networks, Network computations, Free Floats, Critical path method (CPM), optimal scheduling (crashing). Initial basic feasible solutions of balanced and unbalanced transportation problems, optimal solutions, assignment problem.

Multiobjective Programming: Introduction to multiobjective programming, efficient solution, efficient frontier.

Nonlinear Programming: Unconstrained Optimization: unimodal functions, Fibonacci search method, Steepest Descent method, Conjugate Gradient method

Constrained Optimization: Concept of convexity and concavity, Maxima and minima of functions of n-variables, Lagrange multipliers, Karush-Kuhn-Tucker conditions for constrained optimization.

Laboratory Work: Lab experiments will be set in consonance with materials covered in the theory using Matlab.

Course Outcomes (COs)

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

1. formulate the linear and nonlinear programming problems
2. solve linear programming problems using Simplex method and its variants
3. construct and optimize various network models
4. construct and classify multiobjective linear programming problems
5. solve nonlinear programming problems.

Text Books

1. Chandra,S.,Jayadeva,Mehra,A.,NumericalOptimizationandApplications,Narosa Publishing House,(2013)
2. Taha H.A., Operations Research-An Introduction, PHI (2007).

Reference Books

1. Pant J. C., Introduction to optimization: Operations Research, Jain Brothers(2004)

2. BazaarraMokhtar S., Jarvis John J. and Shirali Hanif D., Linear Programming and Network flows, John Wiley and Sons(1990)
3. Swarup, K., Gupta, P. K., Mammohan, Operations Research, Sultan Chand & Sons, (2010).
4. H.S. Kasana and K.D. Kumar, Introductory Operations Research, Springer publication,(2004)
5. Ravindran, D. T. Phillips and James J.Solberg: Operations Research-Principles and Practice, John Wiley & Sons, Second edn.(2005).

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	✓	✓				✓			
CO2	✓	✓				✓			
CO3	✓	✓				✓			
CO4	✓	✓				✓			
CO5	✓	✓				✓			

Evaluation Scheme

Sr. No.	**Evaluation elements**	**Weightage (%)**
1	MST	25-30
2	EST	40-45
3	Sessional: (May include the following)	30

		Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	

	UCS421: ETHICS AND RISK MITIGATION IN AI					
		L	T	P	SL	Cr
		45	0	0	45	3.0
	Course Objective: Empowering engineers to navigate ethical and societal implications of AI in safety-critical domains					
	1. Introduction to AI Ethics Understanding the distinction between ethics and compliance is foundational for AI engineers. While compliance ensures adherence to regulations and standards, ethics delves deeper into principles guiding the responsible use of AI. Engineers will explore the core principles of fairness, accountability, transparency, and privacy, emphasizing their relevance in decision-making processes. 2. Bias in Engineering AI Models Bias in engineering applications can manifest in various forms, such as calibration bias in sensors or the use of biased datasets during model training. Engineers will study real-world examples to understand how biases can lead to safety system failures or discrimination in access to services. This module equips participants to recognize, mitigate, and manage biases effectively. 3. Data Privacy & Governance With the increasing integration of AI into sensitive domains like smart grids and health sensors, data privacy and governance are crucial. Participants will examine the Indian DPDP Act and GDPR, focusing on their relevance to engineering IoT systems. The goal is to understand how to handle sensitive data responsibly while maintaining compliance with global standards. 4. Explainable AI (XAI) Explainable AI bridges the gap between black-box models and interpretable systems. Engineers will learn about tools such as SHAP and LIME, which provide insights into AI decision-making processes. Practical applications will include explaining AI-based decisions in process control systems, ensuring transparency and trust in high-stakes engineering environments. 5. AI in Critical Systems Critical systems such as autonomous vehicles, robotics, and power grids demand rigorous risk management. Engineers will explore risk categories specific to these applications, emphasizing redundancy and fallback mechanisms. The module highlights the necessity of robust systems capable of mitigating risks and maintaining operational safety. 6. Safety-by-Design Safety-by-design principles entail proactive measures to ensure the reliability of AI systems. Engineers will investigate fail-safe models and strategies to combat adversarial attacks on control systems. Furthermore, the module will underscore the importance of engineering responsibility in deploying AI, ensuring that safety remains the highest priority. 7. Governance and Standards AI governance frameworks, such as IEEE AI ethics and NIST standards, provide a structured approach to ethical deployment. Engineers will study these frameworks and learn how to create AI audit templates tailored to engineering applications. This module fosters a systematic approach to maintaining accountability and compliance. 8. AI Policy & Case Resolution Real-world simulations will challenge participants to create AI policies for smart plant operations, addressing ethical dilemmas and practical constraints. Engineers will evaluate case studies of ethical failures to understand lessons learned and apply them to future engineering scenarios.					

	Laboratory Work: Hands-on exercises are integral to this course, enabling engineers to apply theoretical knowledge in practical settings: • Bias detection using SHAP: Participants will analyze sensor data to identify and mitigate biases effectively. • Privacy impact assessment: Engineers will use templates to evaluate privacy implications in smart home data. • AI audit checklist creation: Developing comprehensive checklists for AI-driven drone navigation to ensure safety and compliance.
	Case Studies • The course incorporates comprehensive case studies to illustrate the real-world implications of ethics and risk mitigation in AI: • Boeing 737 MAX: Analyzing software bias and identifying gaps in risk mitigation strategies. • Tesla autopilot: Exploring failures in AI systems and the importance of robust data governance. • AI in nuclear reactor control: Insights from IAEA on the role of ethical AI in maintaining safety in critical applications.
	Evaluation The assessment framework is designed to evaluate both theoretical understanding and practical application: • Scenario-based short answers: Accounting for 30%, this segment tests engineers' ability to respond to ethical dilemmas in AI contexts. • Ethics audit: Another 30% focuses on evaluating engineers' capacity to critically assess and audit AI systems. • Final case report and group discussion: Constituting 40%, this segment promotes collaborative learning and comprehensive evaluation of case studies. By the end of this course, engineers will be equipped with the knowledge and tools necessary to implement AI systems that prioritize ethics, mitigate risks, and uphold societal trust in safety-critical applications.

SEMESTER-V

UEE509: **Power Systems Analysis**

L	T	P	SL	Cr
45	15	30	45	4.5

Course Objective: To explain concepts of power flow analysis, rotor angle and voltage, economic operation, load-frequency control and power system security

Syllabus:

Representation of Power System: Structure of Power System and related concept, Modelling of power system components: Regulating Transformers (Tap changing & Phase Shifting), Generators, Transmission line and loads, Y-Bus Formulation using node analysis and graphical method, Sparsity handling and optimal ordering techniques, Triangular Factorisation method.

Load Flow Analysis: Power flow equations, load flow solution using Gauss Seidal and Newton Raphson methods, decoupled and fast decoupled methods, comparison of load flow methods.

Power System Stability: Concepts of types of stability limits, steady state stability analysis, transient stability analysis, Swing equation and its solution by point-by-point method, Equal area criterion, critical clearing angle and improvement of transient stability.

Economic Operation: Characteristics of thermal and hydro units, Incremental fuel rate and their approximation, Minimum and maximum power generation limits; Economic dispatch with and without transmission line losses, Unit Commitment, Hydrothermal scheduling problems

Voltage Stability: Basic concepts, Voltage collapse, P-V and Q-V curves, Impact of load, Static and dynamic analysis of voltage stability, Prevention of voltage collapse.

.**Laboratory Work:** Simulate power flow solutions using NR method, stability studies using point by point integration method, economic load dispatch with and without losses and draw PV curve for single-machine infinite bus system, Use of ETAPS/DigSilent Factory Tool

Course Outcomes (COs)

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

1. Analyse power flow of balanced power system.
2. Analyse the stability of single machine-infinite bus system.
3. Decide the scheduling units for overall economy.
4. Execute voltage stability analysis.

Text Books

1. Das D., Electrical Power Systems, second Ed., New Age International Pvt. Ltd., (2023)
2. Nagrath, I.J. and Kothari, D.P., Power System Engineering, 3rd ed., McGraw-Hill (2019).
3. Grainger John J. and Stevenson, W.D., Power System Analysis, McGraw-Hill (2017).

Reference Books

1.Kothari, D.P., Dhillon, J.S., Power System Optimization, PHI Learning(2010).

2. Allen J. Wood, Bruce F. Wollenberg and Gerald B. Sheble, Power Generation, Operation and Control, Wiley-Interscience(2013).

3. Kimbark, E. W., Power System Stability, Volumes-I, II,III, „Jan. 2007

4. Jizhong Z., Optimization of power system operation, 2nd Edition Wiley -January 2015

5. Elgerd, O. Electric Energy Systems Theory: An Introduction,, McGraw Hill Education Private Limited, July 2017

CO MAPPING WITH PO and PSO													
CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2
CO1	3	3	-	3	-	-	-	-	-	-	1	3	2
CO2	3	3	-	3	-	2	-	-	-	-	1	3	2
CO3	3	3	3	-	-	-	-	-	-	-	1	3	2
CO4	3	3	-	-	-	-	-	-	-	-	1	3	2

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓				✓	
CO2		✓	✓	✓				✓	
CO3		✓	✓	✓	✓				
CO4		✓	✓	✓					

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEE511: **Embedded System Design and IoT**

L	T	P	SL	Cr
45	0	30	45	4.0

Course Objective: To understand the hardware and software concepts of embedded systems. To understand the development of embedded systems for Day-to-day applications and to handle IoT systems.

Syllabus:

Introduction to Embedded system: Single purpose hardware and software, Characteristics of embedded system applications. Architectural Issues: CISC, RISC, RISC-V, DSP Architectures. Component Interfacing: interrupt, DMA, I/O Bus Structure, I/O devices.
Software for Embedded Systems: Program Design and Optimization techniques, Operating system for Embedded Systems, Real-time Issues. Designing Embedded Systems. Design Issues, Hardware-Software Co-design, Use of UML

ARM embedded application development: ARM Architecture, ARM programmer's model, Hardware and Software Requirements, Embedded Control Application Development Case study: Open Loop and Closed Loop Control and Coding of PID Controller for different applications

Embedded application with programmable digital signal processors: Commercial digital signal processing devices, data addressing modes, memory space, program control, on chip peripherals, interrupts and pipeline operations of TMS320C54XX DSPs. Networked Embedded Systems: Distributed Embedded Architectures, Protocol Design issues, wireless network.

Internet of Things (IoT) and enabling Technologies: Introduction to Internet of Things (IoT), vision and challenges for realizing the Internet of Things, IoT architecture, design. IoT and Interoperability: Communication Protocol, Physical/Link Layer, IEEE 802.3 (Ethernet), Network Layer, Transport Layer, Application Layer, Interoperability in IoT, Interoperable communication standards: IEC 61850. Green Wireless Networking Standards (IEEE 802.15.4).

IoT Sensors modules and Actuators: Introduction to IoT based measurements, Smart sensors, MEMS etc., Green IoT Application Development, Resource Optimization in IoT,Case Study: Solid state relay, Sensor and Motor application.
RISC-V for Edge Computing and AI in IoT, Security Aspects in RISC-V for IoT.

Laboratory Work: Programming examples of ARM based processors, Programming and Application development around ARM, Interfacing with peripherals, actuators, sensors, etc., IoT application programs.

Minor Project: Development of IoT based application such as: Home and Building Automation, Smart Grid, Smart City, Smart Farming, Smart Healthcare. Temperature Monitoring over the Internet, Smart Lighting, Voice-Controlled Door Access, RFID Reader, Cloud Example with IBM Watson Bluemix.

Course Outcomes (COs)

After completion of the course, the students will be able to:
1. Elucidate the architecture of ARM processors and write embedded program.
2. Interface peripherals and develop applications based on ARM processors.
3. Elucidate the IoT communication, protocols and platform properties.
4. Plan IoT applications for electrical and electronics systems.

Text Books

1. Steve Furber, ARM System-on-Chip Architecture", Second Edition, Pearson Education, (2013).
2. Hanes, David, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, and Jerome Henry. IoT fundamentals: Networking technologies, protocols, and use cases for the internet of things. First ed., Cisco Press, (2017).
3. Xiao, Perry, Designing Embedded Systems and the Internet of Things (IoT) with the ARMmbed., John Wiley & Sons, (2018).

Reference Books

1. Stephen Welsh, Peter Knaggs, ARM: Assembly Language Programming, Bourne Mouth University Publication, (2003).
2. Andrew N. Sloss, Dominic Symes, Chris Wright "ARM System Developers Guide, Designing and Optimizing System Software", Elsevier Publication. (2004)
3. Internet of Things, Abhishek S Nagarajan, RMD Sundaram Shriram K Vasudevan, Wiley India (2019)

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓		✓			
CO2		✓	✓	✓		✓			
CO3		✓	✓	✓		✓			
CO4		✓	✓	✓	✓	✓			

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEE504: **Power Electronics**

L	T	P	SL	Cr
45	15	30	45	4.5

Course Objective: To review the operational aspects of power electronic devices and principle of conversion and control of AC and DC voltages for high power applications.

Syllabus:

Introduction: Introduction to Thyristors and its family, static and dynamic characteristics, turn-on and turn-off methods and firing circuits, Ratings and protection of SCRs, Series and parallel operation, Power electronics and linear electronics, Types of power switches

Phase Controlled Converters: Principle of phase control, Single phase and three phase converter circuits with different types of loads, continuous and discontinuous conduction, effect of source inductance, Dual converters and their operation.

DC Choppers: Principle of chopper operation, control strategies, types of choppers, step up and step down choppers , steady state time domain analysis with R.L and E type loads, voltage, current and load commutated choppers.

Inverters: Single phase voltage source bridge inverters and their steady state analysis, series inverters, three phase bridge inverters with 180^0 and 120^0 modes. single-phase PWM inverters, current source inverters, CSI with R load (qualitative approach).

AC Voltage Controllers: Types of single-phase voltage controllers, single-phase voltage controller with R and RL type of loads.

Cycloconverters: Principles of operation, single phase to single phase step up and step down cycloconverters, three phase to single phase cycloconverters, output voltage equation for a cycloconverter.

Laboratory Work: SCR V-I characteristics, Gate firing circuit, DC -DC chopper, Semi converter and Full converter with R , RL and RLE type of loads, DC shunt motor speed control, Single phase AC voltage controller with R load, Inverters, Simulation of power electronics converters.

Course Outcomes (COs)

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

1. Illustrate thyristor characteristics, operation methods and protection for efficient circuit design.
2. Analyse single-phase and three-phase converters with varied loads and phase control techniques.
3. Design DC chopper circuits using control strategies for step-up and step-down operations.
4. Implement single-phase and three-phase inverters for steady state and PWM based applications.
5. Demonstrate AC voltage controllers and cycloconverters for single-phase and three-phase load operations.

Text Books

1. *Dubey, G.K., Doradla, S.R., Joshi, A. and Sinha, R.M.K., Thyristorised Power Controllers, New Age International (P) Limited, Publishers (2004).*
2. *Rashid, M., Power Electronics, Prentice Hall of India 4th ed.2017.*
3. *Bimbhra,P.S., Power Electronics, Khanna Publishers 7th ed.2022.*

CO MAPPING WITH PO and PSO													
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	-	-	-	-	-	-	-	-	2	2
CO2	3	3	2	3	-	-	-	-	-	-	-	2	2
CO3	3	3	-	1	-	-	-	-	-	-	-	2	1
CO4	3	3	3	-	-	-	-	-	-	-	-	2	3
CO5	3	3	-	-	-	-	-	-	-	-	-	2	2

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓	✓				
CO2		✓	✓	✓	✓	✓		✓	
CO3		✓	✓	✓				✓	
CO4		✓	✓	✓	✓				
CO5		✓	✓	✓					

Evaluation Scheme		
S. No.	**Evaluation Elements**	**Weightage (%)**
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UPH401: **Electrical and Electronic Engineering Materials**

L	T	P	SL	Cr
30	0	30	30	3.0

Course Objective: To provide students with a firm understanding of electrical and electronics engineering materials, and their applications. The course will cover a wide range of topics, including electron transport in conductors/semiconductors, properties of dielectric materials, magnetic materials, superconductors, etc.

Introduction: Brief review of bonding, PE well curve, Crystal structure, Concept of lattice and basis, types of Bravis lattices, Crystallographic directions and planes. Classification of crystal defects and defect induced properties.

Electrons in a Crystal: Fermi distribution function, Free electron theory for solids, Fermi energy and Fermi surface, Density of states, Population density, Band model and its consequences, Concept of effective mass.

Electrical Conduction in Solids: Temperature dependence of resistivity, Matthiessen's rule, Temperature coefficient of resistivity, Solid solutions, Nordheim's rule, Mixture rules for heterogeneous mixtures, Resistivity of some silver alloys used as electrical contact materials, Hall effect and Hall devices.

Semiconductor Materials: Energy band diagrams, Fermi level, Conduction in semiconductors, Temperature dependence of conductivity, Carrier concentration, Drift mobility, Recombination and minority carrier injection.

Dielectric Properties: Polarization, Polarization vector, Polarization mechanisms in solids, Local field, Clausius–Mossotti equation, Frequency dependence of dielectric constant and dielectric losses, Dielectric strength and insulation breakdown in solids.

Magnetic Properties: Magnetic materials: Diamagnetism, Paramagnetism, Ferromagnetism, Antiferromagnitism, Ferrimagnnetism, Exchange interactions, Saturation magnetization, Curie temperature, Soft and hard magnetic materials, Application of magnetic materials in electrical and electronic industries.

Superconducting Materials: Zero resistance and Meissner effect, Type I and type II superconductors, Critical current density, High temperature superconductors, Applications of superconductors. London theory and BCS (qualitative).

Laboratory Work:

1. To Determine the Curie Temperature of a ferrite sample.
2. To determine the dielectric constant of different insulating samples.
3. To prepare the two metallic specimens for metallographic examination and measure their grain size.
4. Estimation of Band-Gap energy of Germanium using four-probe setup.
5. To determine the light intensity response of a Silicon Solar cell.
6. To determine the resistivity of a given sample using four probe method.
7. To determine the Hall coefficient, carrier concentration and mobility in Ge crystal using Hall Effect.
8. To study the response of a LDR and VDR.
9. Determine Critical temperature and Meissner effect for the given Superconducting sample.

10. Comparison of temperature dependent resistivity of metallic and semiconductor samples

Course Outcomes (COs)

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

1. Recall common crystal structures and their characteristics. (Bloom's Taxonomy level -1: Remembering)
2. Summarize the basics of semiconductor physics, including energy bands, charge carriers, and doping. (Bloom's Taxonomy level -2: Understanding)
3. Explain the behavior of dielectric materials in electric fields and their applications. (Bloom's Taxonomy level -2: Understanding)
4. Describe the different types of magnetic materials and their properties. (Bloom's Taxonomy level -2: Understanding)
5. Explain the phenomenon of superconductivity and the properties of superconducting materials. (Bloom's Taxonomy level -2: Understanding)
6. Justify the selection of a particular material for a given electrical and electronic engineering application based on its properties. (Bloom's Taxonomy level -5: Evaluating)
7. Analyze and interpret experimental data to determine material properties. (Bloom's Taxonomy level -4: Analyzing)

Text Books

1 Kasap, S. O., Principles of Electronic Engineering Materials, Tata-Mc-Graw Hill (2007).
2 Raghvan, V., Material Science and Engineering Prentice Hall India (2005).
3 Kittle, C., Introduction to Solid State Physics, John Wiley & Sons (2008).
4 Omar, M. A., Elementary Solid State Physics, Pearson (2008).

CO MAPPING WITH PO and PSO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	2	-
CO2	2	2	-	-	-	-	-	-	-	-	-	2	-
CO3	2	2	-	-	-	-	-	-	-	-	-	2	-
CO4	2	2	-	-	-	-	-	-	-	-	-	2	-
CO5	2	2	-	-	-	-	-	-	-	-	-	2	-
CO6	3	3	-	1	-	-	-	-	-	-	-	2	-
CO7	3	3	-	1	-	-	-	-	-	-	-	2	-

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	✓		✓						
CO2	✓		✓						
CO3	✓		✓						

CO4	✓		✓						
CO5	✓		✓						
CO6	✓	✓	✓						
CO7	✓	✓	✓						

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UTA025: **Innovation and Entrepreneurship**

L	T	P	SL	Cr
15	0	30*	45	3.0

Course Objective: This course aims to provide the students with a basic understanding in the field of entrepreneurship, entrepreneurial perspectives, concepts and frameworks useful for analyzing entrepreneurial opportunities, understanding eco-system stakeholders and comprehending entrepreneurial decision making. It also intends to build competence with respect business model canvas and build understanding with respect to the domain of startup venture finance.

Introduction:

Introduction to Entrepreneurship: Entrepreneurs; entrepreneurial personality and intentions - characteristics, traits and behavioral; entrepreneurial challenges.

Entrepreneurial Opportunities: Opportunities- discovery/ creation, Pattern identification and recognition for venture creation: prototype and exemplar model, reverse engineering.

Entrepreneurial Process and Decision Making: Entrepreneurial ecosystem, Ideation, development and exploitation of opportunities; Negotiation, decision making process and approaches, - Effectuation and Causation.

Crafting business models and Lean Start-ups: Introduction to business models; Creating value propositions - conventional industry logic, value innovation logic; customer focused innovation; building and analyzing business models; Business model canvas, Introduction to lean startups, Business Pitching.

Organizing Business and Entrepreneurial Finance: Forms of business organizations; organizational structures; Evolution of organization, sources and selection of venture finance options and its managerial implications. Policy Initiatives and focus; role of institutions in promoting entrepreneurship.

Course Outcomes (COs)

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

1. Explain the fundamentals behind the entrepreneurial personality and their intentions
2. Discover/create and evaluate opportunities.
3. Identify various stakeholders for the idea and develop value proposition for the same.
4. Describe various Business Models and design a business model canvas.
5. Analyse and select suitable finance and revenue models for start-up venture.

Text Books

1. *Ries, Eric(2011), The lean Start-up: How constant innovation creates radically successful businesses, Penguin Books Limited.*
2. *Blank, Steve (2013), The Startup Owner's Manual: The Step by Step Guide for Building a Great Company, K&S Ranch.*
3. *S.Carter and D.Jones-Evans,Enterprise and small business-Principal Practice and Policy, Pearson Education(2006)*

Reference Books

1. *T. H. Byers, R. C. Dorf, A. Nelson, Technology Ventures: From Idea to Enterprise,McGraw Hill (2013)*
2. *Osterwalder, Alex and Pigneur, Yves (2010) Business Model Generation.*
3. *Kachru, Upendra, India Land of a Billion Entrepreneurs,Pearson*

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1							✓		✓
CO2					✓	✓		✓	
CO3					✓		✓		✓
CO4					✓		✓		✓
CO5					✓		✓	✓	✓

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEE410: **Data Structures and Algorithms**

L	T	P	SL	Cr
45	0	30	45	4.0

Course Objective: To become familiar with different types of data structures and their applications and learn different types of algorithmic techniques and strategies.

Syllabus:

Introduction and Overview: Basic Terminology, Elementary Data Organization, Data Structures, Control Structures, Asymptotic Notations for Algorithms, Big O notation: formal definition and use, Little o, big omega and big theta notation, Arithmetic Expressions, Polish Notations, Arrays, Records, Pointers, Storing Strings, String Operations, Pattern Matching Algorithms, Stacks, Queues, Recursion, Towers of Hanoi.

Searching and Sorting: Linear Arrays, Traversing and Searching in Linear Arrays, Inserting and Deleting, Bubble Sort, Linear Search, Binary Search, Insertion Sort, and Selection Sort.

Non-Linear Data Structures: Trees, Binary Trees, Traversing Binary Trees, Binary Search Trees, Searching and Inserting in Binary Search Trees, Deleting in a Binary Search Tree, Preorder, Postorder and Inorder Traversal, Heaps, Graph, Graph Algorithms, Breadth First Search, Depth First Search.

Linked List: Introduction, Insertion into a linked list, Deletion into a linked list. Stack, Queues, trees using linked list, Hashing, Hash Functions.

Laboratory Work: Implementation of Arrays, Recursion, Stacks, Queues, Lists, Binary trees, Sorting techniques, Searching techniques. Implementation of all the algorithmic techniques.

Course Outcomes (COs)

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

1. Implement the basic data structures and solve problems using fundamental algorithms.
2. Implement appropriate searching & sorting techniques for Problem solving
3. Apply tree and graph data structures and algorithms for specific applications.
4. Analyze, evaluate and choose appropriate data structure and algorithmic technique to solve real-world problems.

Text Books

.1. Seymour Lipschutz Data Structures, TATA McGraw Hill (2016).

2. Corman, Leiserson&Rivest, Introduction to Algorithms, MIT Press (2009).

3. Narasimha Karumanchi, Data Structures and Algorithms Made Easy (2014).

Reference Books

1. Sahni, Sartaj, Data Structures, Algorithms and Applications in C++, Universities Press (2005)

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓		✓		✓		✓	
CO2		✓		✓		✓		✓	
CO3		✓		✓		✓		✓	
CO4		✓		✓		✓		✓	

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEE514: **Introduction to Database Management System (Elective-I)**

L	T	P	SL	Cr
30	0	30	30	3.0

Course Objective: Emphasis is on the need of database systems. Main focus is on E-R diagrams, relational database, concepts of normalization and de-normalization and SQL commands.

Syllabus:

Introduction: Data, data processing requirement, desirable characteristics of an ideal data processing system, traditional file based system, its drawback, concept of data dependency, Definition of database, database management system, 3-schema architecture, database terminology, benefits of DBMS.

Relational Database: Relational data model: Introduction to relational database theory: definition of relation, keys, relational model integrity rules.

Database Analysis: Conceptual data modeling using E-R data model -entities, attributes, relationships, generalization, specialization, specifying constraints, Conversion of ER Models to Tables, Practical problems based on E-R data model.

Relational Database Design: Normalization- 1NF, 2NF, 3NF, BCNF, 4NF and 5NF. Concept of De-normalization and practical problems based on these forms.

Transaction Management and Concurrency control: Concept of Transaction, States of Transaction and its properties, Need of Concurrency control, concept of Lock, Two phase locking protocol.

Recovery Management: Need of Recovery Management, Concept of Stable Storage, Log Based Recovery Mechanism, Checkpoint.

Database Implementation: Introduction to SQL, DDL,DML and DCC including all aspects for database definition, manipulation and control, PL/SQL - cursor, stored function, stored procedure, triggers, error handling, and package.

Laboratory Work: Students will perform SQL commands to demonstrate the usage of DDL and DML, joining of tables, grouping of data and will implement PL/SQL constructs. They will also implement one project

Project:

It will contain database designing & implementation, should be given to group of 2-4 students. While doing projects emphasis should be more on back-end programming like use of SQL, concept of stored procedure, function, triggers, cursors, package etc. Project should have continuous evaluation and should be spread over different components.

Course Outcomes (COs)

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

1. Analyze the Information Systems as socio-technical systems, its need and advantages as compared to traditional file-based systems.
2.. Modeling of real world problems using E-R diagrams
3. Design and create relational databases with normalization and de-normalization processes.
4. Organize the transaction management, concurrence control and recovery management.
5. Demonstrate use of SQL and PL/SQL to implementation database applications.

Text Books

1. Silverschatz A., Korth F. H. and Sudarshan S., Database System Concepts, Tata McGraw Hill (2010) 6th ed.

2. Elmasri R. and Navathe B. S., Fundamentals of Database Systems, Pearson (2016) 7th ed.

CO MAPPING WITH PO and PSO													
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	-	3	2	-	-	-	-	-	-	3	-
CO2	1	1	3	3	2	-	-	-	-	-	-	3	-
CO3	1	1	-	-	2	-	-	-	-	-	-	3	3
CO4	1	1	-	-	2	-	-	-	-	-	-	3	3
CO5	1	1	-	-	2	-	-	-	-	-	-	3	3

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓				✓		✓	
CO2		✓			✓	✓		✓	
CO3		✓				✓			
CO4		✓				✓			
CO5		✓				✓			

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEE515: **Data communication and Computer Networks (Elective-I)**

L	T	P	SL	Cr
30	0	30	30	3.0

Course Objective: To introduce basic concepts of Data communication with different models. Enumerate the physical layer, Data Link Layer, Network Layer, Transport Layer and Application Layer, explanation of the function(s) of each layer. Understanding of switching concept and different types of switching techniques.

Syllabus:

Overview of Data Communication and Networking: Data communications, Networks, The Internet, Protocols and standards, Layered tasks, OSI model, TCP/IP protocol Architecture.

Physical layer: Analog and digital, Analog signals, Digital signals, Analog versus digital, Data rate limit, Transmission impairments, Line coding, Block coding, Sampling, Transmission mode, Modulation of digital data, Telephone modems, Modulation of analog signal, FDM, WDM, TDM, Guided media, Unguided media, Circuit switching, Telephone networks, DSL technology, Cable modem, SONET

Data link layer: Types of errors, Detection, Error correction, Flow and error control, Stop and wait ARQ, go back n ARQ, Selective repeat ARQ, HDLC, Point to point protocol, PPP stack, Random access, Controlled access, Channelization, Traditional Ethernet, Fast Ethernet, Gigabit Ethernet, IEEE802.11, Bluetooth, Connecting devices, Backbone network, Virtual LAN, Cellular telephony, Satellite networks, Virtual circuit switching, Frame relay, ATM.

Network layer: Internetworks, Addressing, Routing, ARP, IP, ICMP, IPV6, Unicast routing, Unicast routing protocol, Multicast routing, Multicast routing protocols.

Transport layer: Process to process delivery, User datagram protocol (UDP), Transmission control protocol (TCP), Data traffic, Congestion, Congestion control, Quality of service, Techniques to improve QOS, Integrated services, Differentiated services, QOS in switched networks.

Application layer: Client server model, Socket interface, Name space, Domain name space, Distribution of name space, DNS in the internet, Resolution, DNS messages, DDNS, Encapsulation, Electronic mail, File transfer, HTTP, World wide web (WWW), Digitizing audio and video, Audio and video compression, Streaming stored audio/video, Streaming live audio/video, Real time interactive audio/video, Voice over IP.

Switching: Circuit Switching Networks, Concepts, Control Signaling, Soft switch Architecture, Packet switching, Packet size, X.25, Frame Relay, ATM, Message Switching

Laboratory Work: The laboratory work includes the open source simulator GNS3. GNS3 is a graphical network simulator that allows emulation of complex networks.Different networking commands such as hostname, ipconfig, getmac, arp, ping, netstat, tracert, nslookup, nbstat, route. How to configure router and telnet in GNS3 simulator. Design of general topology in GNS3 simulator. Design of network topology such as Bus, Ring, Star and Tree in GNS3 simulator. How to classify the network on the basis of classful and classless IP addressing scheme. Demonstrate RIP routing protocol in GNS3 simulator.

Course Outcomes (COs)

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

1. Design the various network models
2. Propose the protocol layer specific communication between two trusted entities.
3. Analyse the possible attacks on a network to interrupt the transmission
4. Analyse the shortest path for data transmission and design a routing protocol of security mechanisms for secured data transmission
5. Design a network topology with the available networking elements ensuring the error free data transmission data.

Text Books

1. 1. Ferouzan, Behrouz A., Data Communications and Networking, TATA McGraw Hill (2002) 2nd ed.

2. Stallings William, Data and Computer Communication, Pearson Education (2000) 7th ed.

Reference Books

1. Black, Ulylers D., Data Communication and Distributed Networks, PHI (1999) 3rded.
2. Tanenbaum, Andrew S., Computer Networks, PHI (2000) 2nd ed.

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓	✓			✓	
CO2		✓	✓	✓	✓				
CO3			✓	✓	✓	✓			
CO4			✓	✓	✓	✓		✓	
CO5			✓	✓	✓	✓		✓	

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEE406: Power System Practices (Elective-I)

L	T	P	SL	Cr
45	0	0	45	3.0

Course Objective: To make the students understand the concepts of energy scenario, energy conservation, auditing and various stages of financial management. To introduces the concept of restructuring and deregulation of power industry.

Syllabus:

Energy Scenario: Energy needs of growing economy, Long term energy scenario, Energy pricing, Energy sector reforms, Energy and environment: Air pollution ,Climate change, Energy security, Energy conservation and its importance, Energy strategy for the future, Energy conservation Act-2001 and its features.

Energy Management and Audit: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments

Financial Management: Investment-need, Appraisal and criteria, Financial analysis techniques-Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis, Financing options, Energy performance contracts and role of ESCOs.

Introduction to Deregulation: Introduction, Reasons for restructuring / deregulation of power industry, Understanding the restructuring process: Entities involved, The levels of competition, The market place mechanisms, Sector-wise major changes required, Reasons and objectives of deregulation of various power systems across the world: The US, The UK and India. Market models based on contractual arrangements: Monopoly model, Single buyer model, Wholesale competition model, Retail competition model.

Electricity vis-à-vis Other Commodities: Distinguishing features of electricity as a commodity, Four pillars of market design: Imbalance, Scheduling and Dispatch, Congestion Management, Ancillary Services. Framework of Indian power sector and introduction to the availability based tariff (ABT)

Course Outcomes (COs)

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

1. Analyze energy scenario nationwide and worldwide
2. Decide about energy management strategies in more effective way.
3. Implement financial management for energy auditing.
4. Adapt deregulation of power industry.
5. Identify various pillars of electricity market design.

Text Books

1. Shahedepour M., Yamin H.,Zuyi Li.,Market operations in power systems: Forecasting, Scheduling, and Risk Management, John Wiely & Sons, New York.

2. Abbi, Y.P. and Jain, S., Handbook on Energy Audit and Environment Management, Teri Bookstore (2006).

3. Diwan, P., Energy Conservation, Pentagon Press (2008).

Reference Books

1. Bhattacharya K., Bollen M.,Daalder, Jaap E., Power System Restructuring: Springer(2001).

2. Younger, W., Handbook of Energy Audits, CRC Press(2008).

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓				✓		✓	
CO2		✓			✓	✓		✓	
CO3		✓				✓			
CO4		✓				✓			
CO5		✓				✓			

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

Semester VI

UEE616: **Industrial Drives and Automation**

L	T	P	SL	Cr
45	0	30	45	4.0

Course Objective: To introduce the concept of electric drives and it features. To get familiarize with power converter-controlled drives and automation.

Syllabus:

Electric Drives: Concept of electric drive and its classifications, Types of loads, Quadrant diagram, Dependence of load torque on various factors, Dynamics of motor-load combination, Steady state stability of an electric drive system, Load Equalization.

Estimation of Motor Rating: Thermal modeling of motors, Types of duty cycles, Calculation of motor rating for duty cycles, Overload factor calculation for short and intermittent duty cycle, Use of load diagrams.

DC Motor Drives: Control of DC drives fed through single-phase and three-phase semi converter and full-converter phase-controlled configurations, their analysis, Regeneration and braking through static power converters.

Induction Motor Drives: Control of three phase induction motors by stator voltage and frequency control for speeds below and above synchronous speed, Static rotor resistance control, Static Kramer and Scherbius drives, V/f and Vector control, Field oriented control.

Drives for Electric Vehicles: Synchronous motor drives, servo drives, PM drive , , axial-flux drives and BLDC motor drives

Introduction to automation: Architecture of industrial automation systems and operations, Industrial control Systems-Process. Measurement of industrial parameters, signal conditioning and processing, estimation of errors and calibration.

Sequence control: Introduction, power and control circuit layout, structured design approach, Relay ladder logic (RLL) programming, hardware environment, Networking of Sensors, Actuators and Controllers: The Fieldbus, The Fieldbus communication protocols,

Laboratory Work: Starting and running characteristics of converter fed AC and DC motor control, Harmonic analysis of AC and DC Drives, V/f based drive, Microprocessor based Drive, PLC based drive, Project on drives using standard software.

Minor Project

Course Outcomes (COs)

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

1.Conceptualize the basic drive system and analyze it for different types of loads while ensuring energy efficiency.

2.Analyze the motor situation during starting and braking with a focus on regenerative braking and energy recovery.

3. Develop control circuitry for motor control, integrating energy-saving techniques.

4. Estimate the motor rating for different load conditions, considering sustainable energy consumption.

5.Analyze converter circuits for electric vehicles used for sustainable development

Text Books

1. *Dubey, G.K., Power Semiconductor Controlled Drives, Prentice Hall Inc. (1989).*

2. *Pillai, S.K.,* A First Course on Electric Drive*s New Age International (P) Limited, Publishers (1989), Reprint 2004..*

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓				✓		✓	
CO2		✓			✓	✓		✓	
CO3		✓				✓			
CO4		✓				✓			
CO5		✓				✓			

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEE513: **Electrical System Design**

L	T	P	SL	Cr
15	0	30	15	2.0

Course Objective: To design transformer and power conditioning unit for application in electric power utility.

Syllabus:

Design of Inductor: Conductor size, size and shape of magnetic core, consideration of peak flux and material constraints, application specific design, loss calculation and heat dissipation, Incorporation of sustainable materials and eco-friendly cooling techniques to minimize environmental impact.

Design of Transformer: Output equation, Types of transformer windings, design of core and windings, tank design with cooling tubes, performance calculations for power and distribution transformers, optimized and sustainable approaches to transformer design, including energy efficiency measures and recyclability of components, implementation of computer programs for transformer design to enhance precision and reduce resource wastage.

Design of Rotating Machines: Calculation of D and L for dc, induction and synchronous machines, length of air gap, design of field coils for DC and synchronous machines, selection of rotor slots of squirrel cage induction motors, design of bars and ends, design of rotor for wound rotor for induction motors, design of commutator and inter poles for DC machines, windings for DC and AC machines and their layout, Sustainable design principles, including energy-efficient motors and use of renewable materials.

Power Conditioning Unit Design : Modelling and design of converter and control circuit, PWM techniques, Power line disturbances and UPS, selection of capacitor and inductor for power converter, voltage and current filters, design of DC and AC side filters with a focus on reducing power losses and ensuring grid stability for renewable energy integration.

Laboratory Work:

Perform design calculations and prepare design sheets and drawings, develop algorithms for computer-aided design (CAD) and realize power conditioning units, analyse and optimize designs for energy efficiency, sustainability, and resilience.

Course Outcomes (COs)

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

1. Design inductors with reduced losses, utilizing sustainable materials and methods.
2. Develop and implement optimized, eco-friendly designs for power and distribution transformers.
3. Design energy-efficient rotating machines and evaluate their lifecycle impacts.
4. Develop sustainable power converters and filters for power conditioning units to support renewable energy systems.
5. Apply SDG principles to electrical system design, contributing to clean energy solutions and infrastructure development.

Text Books

1. Sawhney, A.K. A Course in Electrical Machine Design, Dhanpat Rai & CO. (2013)
2. Say, M.G., Design and Performance of Machines, CBS Publications (1981).
3. Smith, S.P. and Say, M.G., Electrical Engineering Design Manual, Chapman and Hall (1984).

Reference Books

1. Ramamoorty, M., Computer Aided Design of Electrical Equipment, Eastern Press Private Limited (1989).
2. Hamdi, E.S., Design of Small Electrical Machine, John Wiley and Sons (1994).
3. Walker, J.H., Large AC Machines: Performance and Operation, BHEL (1997).
4. Erickson, R.W. Fundamentals of Power Electronics, Springer (2020).

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓				✓		✓	
CO2		✓			✓	✓		✓	
CO3		✓				✓			
CO4		✓				✓			
CO5		✓				✓			

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEE610: **Power System Protection**

L	T	P	SL	Cr
45	0	30	45	4.0

Course Objective: To introduce the concept of power system protection, circuit breakers, earthing, relays, protection schemes and analysis of symmetrical and unsymmetrical faults.

Syllabus:

Introduction: General Background, Functions of a Substation, Substation Layouts, Types of Substations, Components of Substation, Bus-bar Schemes, Preventive and predictive maintenance of substation, concept of live line maintenance.

Fault Analysis: Symmetrical component Transformation Technique, Sequence modelling of power system components, Analysis of Symmetrical and unsymmetrical shunt and series faults, Bus impedance matrix, short circuit algorithm, Fault Diagnostics in substation.

Fuses and Circuit Breakers: LV and MV fuses and their characteristics, Circuit breakers as a switch: Arc formation and its extinction (AC and DC), re-striking and recovery voltage, Current chopping, specifications of circuit breakers, types of circuit breakers like oil, Air, Vacuum and SF6, comparative merits and demerits, HVDC circuit breaker system.

Substation Earthing practices: Earthing requirements and practices, Neutral grounding and neutral shift, Earth resistivity, Step, Touch and mesh potential, Substation Earthing Mat, Fencing, Procedure of Laying Earthing-Mat, Earthing bonding, earthing materials, Dimensioning of Earth Conductors, Measurement of Earthing Resistance.

Protective Relays: Functions, Constructional and operating principles of electromagnetic type like over-current, directional, differential and distance relays, their characteristics, General equation. Basic principles of static relaying, Phase and amplitude comparator, Microprocessor based relays, Digital relaying and protection, relay coordination.

Protection, Control and Automation in Substations: Control Panels, Protective Relaying in Substations, Power Transformer Protection, Bus Zone Protection, Protection of Transmission Lines, Protection of Generators, Carrier Assisted Distance Protection, Control and Automation.

Laboratory Work: Symmetrical and unsymmetrical fault level measurement, analysis of various types of faults, Measurement of ground resistivity and resistance of a ground electrode, obtain characteristics of different types of relays, generator and transmission line protections, short circuit simulation studies and relay coordination.

Course Outcomes (COs)

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

1 Analyze various protection strategies applied for resilient power system.

2. Design the basic earthing requirement for residential and other purposes.

3.Select required protection measures against overcurrent, overvoltage in transmission lines and other power system equipment.

4. Analyse balanced and unbalanced faults and decide circuit breaker ratings.

Text Books

1. Pathinkar, Y.G. and Bhide, S.R., Fundamentals of Power System Protection, PHI Learning Pvt. Limited (2008).

2. Nagrath, I.J. and Kothari, D.P., Power System Engineering, Tata McGraw Hill (2007).

3. Rao, S.S., Switchgear and Protection, Khanna Publishers (2007).

4. Chakraborti, A., Soni, M.L., Gupta, P.V. and Bhatnagar, U.S., A Text Book on Power System Engineering, Dhanpat Rai and Co. (P) Ltd. (2008).

Reference Books

1. *Deshpande, M.V., Switchgear and Protection, Tata McGraw Hill (2005).*

2. Elmore, W.A., Protective Relaying Theory and Applications, ABB Power T and D Company Inc. (2003).

3. John D. McDonald, Electric Power Substations Engineering, Second Edition, CRC Press, (2007)

CO MAPPING WITH PO and PSO												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	-	3	2	-	-	-	-	-	-	3	-
CO2	1	1	3	3	2	-	-	-	-	-	-	3	-
CO3	1	1	-	-	2	-	-	-	-	-	-	3	3
CO4	1	1	-	-	2	-	-	-	-	-	-	3	3
CO5	1	1	-	-	2	-	-	-	-	-	-	3	3

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓				✓		✓	
CO2		✓			✓	✓		✓	
CO3		✓				✓			
CO4		✓				✓			
CO5		✓				✓			

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

ULC601: **Machine Learning Techniques**

L	T	P	SL	Cr
45	0	30	45	4.0

Course Objective: To understand the need, latest trends and design appropriate machine learning algorithms for problem solving

Syllabus:

Introduction: Definitions of learning systems, machine learning, supervised vs. unsupervised vs. reinforcement learning, training and test data, concept representation, function approximation for learning system; Objective functions and evaluation metrices (MSE, MAE, $R2$, AUC-ROC) for classification, and regression.

Concept of Optimization: Convex function, gradients and sub-gradients, ADAM, RMSProp optimizers, gradient descent, Constrained optimization, Stochastic gradient descent, Mini batch training, Hyperparameter tuning: Grid search.

Data Pre-processing: Methods for Data cleaning, Data integration, Data transformation, Data Reduction; Feature Scaling (Normalization and Standardization), Splitting dataset into Training and Testing set, Principle Component Analysis (PCA), Linear Discriminant Analysis (LDA), t-SNE, UMAP, Correlation based feature selection.

Regression and Supervised learning: Linear regression and LMS algorithm, Perceptron and logistic regression, Nonlinear function estimation, Overfitting, Regularization (L1/L2), Cross-validation.

Decision Tree Learning for classification and regression: Representing concepts as decision trees, Recursive induction, splitting attributes, simple trees and computational complexity, Overfitting, noisy data, and pruning.

Support Vector Machines for classification: Maximum margin linear separators, solution approach to finding maximum margin separators, Radial basis function network, kernels and Mercer's theorem, Kernels for learning non-linear functions, support vector regression.

Bayesian Learning: Probability and Bayes rule, Naive Bayes learning algorithm, Parameter smoothing, Generative vs. discriminative training, Bayes nets and Markov nets for representing dependencies.

Clustering: Learning from unclassified data, Clustering and its types, k-means partitioned clustering, Fuzzy C-means, Expectation maximization (EM) for soft clustering, Gaussian Mixture Model.

Applications to Power System: Some of the Power System applications but not restricted to energy pricing estimation, energy meter analytics, renewable generation forecasting, load profile and consumer classification, Controller design for ALFC, Filter design, Economic load dispatch.

Laboratory Work: The laboratory work includes supervised learning algorithms, linear regression, logistic regression, decision trees, k-nearest neighbor, Bayesian learning and the naïve Bayes algorithm, support vector machines and kernels and neural networks with an introduction to Deep Learning and basic clustering algorithms.

Course Outcomes (COs)

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

1. Apply supervised and unsupervised learning algorithms to solve classification, regression, and clustering tasks
2. Exhibit the knowledge of dimensionality reduction and other pre-processing steps on raw datasets.
3. Apply regularization methods to reduce overfitting in machine learning models.
4. Select and apply appropriate evaluation metrics to assess model accuracy and robustness.
5. Demonstrate the ability to evaluate and compare learning models on real world problems.

Text Books

1. Mitchell T.M., Machine Learning, McGraw Hill (1997).
2. Alpaydin E., Introduction to Machine Learning, MIT Press (2010).

Reference Books

1**.** *Bishop C., Pattern Recognition and Machine Learning, Springer-Verlag (2006).*
2. Michie D., Spiegelhalter D. J., Taylor C. C., Machine Learning, Neural and Statistical Classification. Overseas Press (2009).

CO MAPPING WITH PO and PSO													
CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2
CO1	3	3	3	3	-	-	-	-	-	-	-	2	-
CO2	3	3	3	3	-	-	-	-	-	-	-	2	1
CO3	3	3	3	3	-	-	-	-	-	-	-	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	3
CO5	3	3	3	3	-	-	-	-	-	-	-	3	3

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓	✓			✓	
CO2		✓	✓	✓	✓			✓	
CO3		✓	✓	✓	✓			✓	
CO4		✓	✓	✓	✓			✓	
CO5		✓	✓	✓	✓			✓	

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEE510: **High Voltage Engineering**

L	T	P	SL	Cr
30	0	30	30	3.0

Course Objective: To introduce the concepts of breakdown of gaseous, solid, and liquid insulations including generation and measurement of high voltage DC, AC and HV Impulse. Also, learning about insulation coordination and high voltage test methods.

Syllabus:

Introduction: Basic concept of high voltage engineering, need for higher voltages in power systems, classification of levels of voltage, concept of electrical insulation or dielectric materials, importance of high voltage measurement and testing, safety measures for high voltage systems. Concept of uniform and non-uniform electric field, electric stress control in dielectrics, electric strength of dielectric, types of breakdowns.

Breakdown in Gaseous Insulations: Elementary ideas on ionization by electron collision, Townsend mechanism, Townsend's first and second ionization coefficients, Paschen's law, breakdown in non-uniform fields and corona discharges, vacuum breakdown mechanisms, application of gaseous insulations.

Breakdown in Liquid Insulations: Breakdown in liquids, fundamentals of insulating oils, pure and commercial liquids, properties of liquid insulation- transformer oil, testing of insulating oils/fluids, effect of moisture on dielectric properties of liquid insulation, biodegradable natural ester and synthetic ester based liquid insulations, applications.

Breakdown in Solid Insulations: Fundamentals of solid insulating materials intrinsic, electromechanical, and thermal breakdown, breakdown in simple and composite dielectrics, types of solid insulating materials, temperature classification, factor affecting dielectric strength, applications of solid insulations in rotating machines, transformers, transmission lines, switchgear, etc.

Generation of High Voltages and Currents: Generation of HVDC, half and full wave rectifier circuits, voltage doubler and cascaded circuits, electrostatic machines, generation of HVAC, cascade transformers, resonant transformer, generation of high-frequency AC high voltage, high voltage impulse, circuits for impulse wave, single stage impulse generator circuits, Marx circuit for multistage impulse generation, generation of high impulse current.

Measurement of High Voltages: Principles, classification, and applications of potential dividers, generating voltmeters, Measurement of HVDC, HVAC and HV impulse, peak voltage measurement using: Chubb-Fortescue method, capacitive voltage divider, and using sphere gaps, ammeter in series with high voltage resistors, capacitive voltage transformer (CVT), potential transformer. Working principle and construction of electrostatic voltmeters.

Overvoltage Phenomenon and Insulation Coordination: Causes of overvoltages in power systems: lightning, switching surges, traveling waves, lattice diagram, insulation coordination in high voltage power network, Basic Insulation Level (BIL), practices adopted for insulation coordination, the role of surge diverters in insulation coordination.

Non-Destructive & High Voltage Tests: Measurement of DC resistivity, capacitance, dielectric constant, and dissipation factor of solid and liquid insulations; measurement of dielectric properties by Schering bridge; partial discharge measurement technique in dielectrics; partial discharge detection in power cables. Determination of breakdown voltage

of solid and liquid insulations, high voltage testing of insulators, circuit breakers, cables, and transformers; testing of surge arresters.

Laboratory Work: .BDV measurement for liquid and solid insulation, Generation of HVDC, HVAC and Impulse, Voltage measurement by sphere gap and Chubb and Fortesque methods, Insulation resistance measurement, experimental setup for standard lightning wave, peak voltage measurement by sphere gap, capacitance and dissipation factor measurement, partial discharge measurements, flashover voltage measurement for string insulator.

Course Outcomes (COs)

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

1. Analyze the breakdown mechanism of solids, liquids and gases.
2. Propose methods to generate HVDC, HVAC, and high voltage impulses.
3. Measure direct, alternating and impulse high voltage signals.
4. Justify application of insulation coordination for high voltage power system.
5. Interpret the results of non-destructive tests and high voltage tests on electrical apparatus.

Text Books

1. Khalifa, M., High Voltage Engineering: Theory and Practice, Marcel Dekker Inc. (2000).
2. Naidu, M.S. and Kamaraju, V., High Voltage Engineering, 6th Ed, McGraw Hill (2020).
3.Arora Ravindra and Rajpurohit Bharat Singh, Fundamentals of High-Voltage Engineering, 1st Ed, Wiley, 2019
4. Wadhwa, C. L. High Voltage Engineering, 3rd Ed, New Age International (P) Limited Publishers, 2020.

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓				✓		✓	
CO2		✓			✓	✓		✓	
CO3		✓				✓			
CO4		✓				✓			

CO5		✓				✓			

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UHU005: **Humanities for Engineers**

L	T	P	SL	Cr
30	0	30	30	3.0

Course Objective: The objective of this course is to introduce values and ethical principles that will serve as a guide to behavior on a personal level and in professional life. The course is designed to help the students to theorize about how leaders and managers should behave to motivate and manage employees; to help conceptualize conflict management strategies that managers can use to resolve organizational conflict effectively. It also provides background of demand and elasticity of demand to help in devising pricing strategy; to make strategic decisions using game theory and to apply techniques of project evaluation.

Syllabus:

Unit 1: Human Values and Ethics

Values: Introduction to Values, Allport-Vernon-Lindzey Study of Values, Rokeach Value Survey, Instrumental and Terminal Values.

Moral and Ethical Values: Types of Morality, Kant's Principles of Morality, Factors for taking ethical decisions, Kohlberg's Theory of Moral Development

Professional Ethics: Profession: Attributes and Ethos, Whistle-blowing.

Unit 2: Organizational Behaviour

Introduction to the Field of Organizational Behaviour Individual Behaviour, Personality, and Values Perceiving Ourselves and Others in Organizations Workplace Emotions, Attitudes, and Stress Foundations of Employee Motivation and Leadership Performance Appraisal Conflict and Negotiation in the Workplace

Unit 3: Economics

Demand, supply & elasticity-Introduction to economics, Demand & its determinants, Elasticity & its types,

Production & Cost Analysis: Short-run and Long run production Functions, Short-run and Long run Cost Functions, Economies and Diseconomies of Scale

Competitive Analysis& Profit Maximization – Perfect competition, Monopoly, Monopolistic & Oligopoly Markets

Strategy & Game Theory – Pure Strategy & Mixed Strategy Games, Dominance, Nash Equilibrium, & Prisoner's Dilemma

Capital Budgeting– Capital Projects, Net Present Value (NPV) & IRR techniques.

Laboratory Work:

1. Practical application of these concepts by means of Discussions, Role-plays and Presentations,
2. Analysis of Case Studies on ethics in business and whistle-blowing, leadership, managerial decision-making.
3. Survey Analysis
4. Capital Budget in assignment

Course Outcomes (COs)

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

1. Comprehend ethical principles and values and apply them as a guide to behavior in personal and professional life.
2. Apply tools and techniques to manage and motivate employees.
3. Analyse and apply conflict management strategies that managers can use to resolve organizational conflict effectively.

4. Devise pricing strategy for decision-making.
5. Apply techniques for project evaluation.

Text Books

1. A. N. Tripathi, Human Values, New Age International (P) Ltd.(2009).
2. Robbins, S. P/ Judge, T. A/ Sanghi, S Organizational Behavior Pearson, New Delhi, (2009).
3. Petersen,H.C., Lewis , W.C. and Jain, S.K., Management Economics, Pearson (2006)

Reference Books

1. McKenna E. F. Business psychology and organisational behaviour. Psychology Press, New York (2006).
2. Furnham A. The Psychology of Behaviour at Work: The Individual in the organization. Psychology Press, UK (2003).
3. Salvatore, D and Srivastava, R., Managerial Economics, Oxford University Press (2010).
4. Pindyck, R and Rubinfiled, D., Microeconomics, Pearson (2017).

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓				✓		✓	
CO2		✓			✓	✓		✓	
CO3		✓				✓			
CO4		✓				✓			
CO5		✓				✓			

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEE638: PLC and SCADA (Elective-II)

L	T	P	SL	Cr
30	0	30	30	3.0

Course Objective: To make the students understand the fundamentals of automation and various automation systems used in industry such as PLC and SCADA.

Syllabus:

Programmable Logic Controller (PLC)

Overview, Components of PLC, Principles of Operation, PLC and Computers, PLC Size and Applications, Input and Output hardware of PLC, CPU, Memory, PLC Programming Devices.

PLC Programming

Fundamentals of Logic, Basics of PLC programming, PLC programming languages, Ladder Programming, Logic functions, latching, Ladder logic for relays, motor starters, switches, transducers and sensors.

Information and Communication Technology (ICT)

ICT as Automation enabler, ICT Technologies and Protocols, Communication Basics, OSI Architecture, TCP/IP Architecture, Network Topology, Communication Protocol, Industry Open Protocols: RS-232, RS- 422, RS-485.

SCADA

Structure of SCADA, distributed and supervisory control, SCADA and its organization and structure, centralized, hierarchical and decentralized control schemes, man machine interface, energy management system, RTU, Communication system requirements for Smart grid, SCADA communication topologies, SCADA communication protocols: Modbus, Distributed Network Protocol3 (DNP3), Ethernet, IEC 61850, Communication media for SCADA communication: Wired and Wireless communication. Optical Fiber, Power Line Carrier Communication (PLCC), interfacing of PLC with SCADA. SCADA implementation for solar and wind energy generation and utilization

Power System Automation

Evolution of automation systems, Supervisory control and data acquisition (SCADA) systems, Components of SCADA systems, SCADA in power systems (generation, transmission and distribution), Advantages of SCADA in Power System. SCADA automation for sustainable growth in power industry

Laboratory Work: Ladder logic for control panels, motor starters, relays and counters; traffic light control; experiment on industrial training kits.

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Course Outcomes (COs)

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

1. Design PLC based application by proper selection and sizing criteria
2. Develop ladder program using PLC.
3. Analyze communication in SCADA.
4. Develop SCADA application for sustainable power solutions,

Text Books

1. Thomas, M.S. and Donald, John, “Power System SCADA and Smart Grids”, CRC Press.
2. Petruzella F, “Programmable Logic Controller” Third Edition, Tata McGraw Hills.

Reference Books

1. Forouzan, B. A, "Data Communications and Networking" Fourth Edition, Tata McGraw Hills.
2. Bolton, W, "Programmable Logic Controllers" Fourth Edition, Elsevier Press.

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK

CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓				✓		✓	
CO2		✓			✓	✓		✓	
CO3		✓				✓			
CO4		✓				✓			
CO5		✓				✓			

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEE636: **Smart Grid Systems (Elective-II)**

L	T	P	SL	Cr
30	0	30	30	3.0

Course Objective: To explain general communication techniques used in smart grid power system communication infrastructure and information system for control centers. To familiarize with interconnection issues related with integration of distributed generation technologies for microgrid.

Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart-Grid, Definitions, Need of Smart-Grid, Concept of Robust & Self-Healing Grid Present development & International policies in Smart-Grid.

Communication Technologies for Smart Grid Power System: Fiber Optical Networks, WAN based on Fiber Optical Networks, IP based Real Time data Transmission, Substation communication network, Zigbee.

Information System for Control Centers (ICCS): ICCS Configuration, ICCS communication Network, ICCS Time Synchronization, E-Commerce of Electricity, GIS, GPS.

Smart-grid: Smart-grid infrastructure, Load dispatch centers, wide-area monitoring system (WAMS), PMU; Smart sensors/telemetry, advanced metering infrastructure (AMI); smart metering; smart grid system monitoring; communication infrastructure and technologies; self-healing.

Distributed Energy Resources (DERs): Distributed Generation (DG), Distributed Generation Technologies and its benefits, Combined heat and power (CHP) systems, Wind energy conversion systems (WECS), Solar photovoltaic (PV) systems, Small-scale hydroelectric power generation, Other renewable energy sources, storage devices.

Integration of Distributed Generation: Distributed Generation Utilization Barriers, Integration of Distributed Energy Resources: Distributed Generation integration to power grid.

Microgrid:; Hybrid power system; Microgrid Concept; Layout, Advantages and challenges in Microgrid system, Interconnection issues, AC and DC Microgrid, Comparison, Operation, Control and Protection Issues of Microgrid**;** Need of Communication Infrastructure in Microgrid, Smart grid and Microgrid: Correlations.

Course Outcomes (COs)

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

1. Interpret various aspects of the smart Grid, including technologies, components, architectures and applications.
2. Select the modern communication infrastructure and control centre components of smart grid.
3. Relate the impact of distributed energy resources and microgrid in a sustainable environment
4. Demonstrate distributed generation coordination including monitoring of smart grid using modern communication infrastructure.
5. Analyse operation, control and protection issues in micro grid in the perspective of smart grid.

Text Books

1. *INIEWSKI , Smart Grid Infrastructure And Networking, McGraw-Hill Education India Pvt. Ltd (2012), 1st Edition*
2. *James Momoh, Smart Grid: Fundamentals of Design and Analysis, IEEE Computer Society Press (2012)*
3. *Microgrids: Architectures and Control, Nikos Hatziargyriou (Editor), ISBN: 978-1-118-72068-4, 340 pages, December 2013, Wiley-IEEE Press*
4. *Microgrids and Active Distribution Networks, S. Chowdhury, S.P. Chowdhury and P. Crossley, The Institution of Engineering and Technology, London, U.K,2009.*

Reference Books

1. *Ekanayake J.,Jenkins N., Liyanage K., Wu, J., Yokoyama A., Smart Grid: Technology and applications, Wiley Publications.*
2. *Momoh J., Smart Grid: Fundamentals of design and analysis, John Wiley &Sons.*
3. *Flick T., Morehouse J., Securing the smart grid: Next generation power grid security, paper back.*

CO MAPPING WITH PO and PSO												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	-	3	2	-	-	-	-	-	-	3	-
CO2	1	1	3	3	2	-	-	-	-	-	-	3	-
CO3	1	1	-	-	2	-	-	-	-	-	-	3	3
CO4	1	1	-	-	2	-	-	-	-	-	-	3	3
CO5	1	1	-	-	2	-	-	-	-	-	-	3	3

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓				✓		✓	
CO2		✓			✓	✓		✓	
CO3		✓				✓			
CO4		✓				✓			
CO5		✓				✓			

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEE637: **High Voltage Transmission Systems (Elective-II)**

L	T	P	SL	Cr
45	0	0	45	3.0

Course objective: To introduce the concepts of DC transmission systems, HVDC control, protection methods, and AC & DC side filter design. To get familiarize with concept of reactive power control.

Syllabus:

DC power transmission technology: Introduction, Comparison of HVAC and HVDC transmission system, Applications of DC transmission, Description of DC transmission system, Configurations, Modern trends in DC transmission.

Analysis of HVDC converters: Pulse number, Choice of converter configuration, Simplified analysis of Graetz circuit, Converter bridge characteristics, Characteristics of a twelve-pulse converter, detailed analysis of converters with and without overlap.

Converter and HVDC system control: General, Principles of DC link control, Converter control characteristics, System control hierarchy, Firing angle control, Current and extinction angle control, Starting and stopping of DC link, Power control, Higher level controllers.

Converter faults and protection: Converter faults, Protection against over-currents, Over-voltages in a converter station, Surge arresters, Protection against over-voltages.

Smoothing reactor and DC line: Introduction, Smoothing reactors, DC line, Transient over voltages in DC line, Protection of DC line, DC breakers, Monopolar operation, Effects of proximity of AC and DC transmission lines.

Reactive power control: Reactive power requirements in steady state, Sources of reactive power, Static VAR systems, Reactive power control during transients, Harmonics and filters, Generation of harmonics, Design of AC filters, DC filters.

Component models for the analysis of AC/DC systems: General, Converter model, Converter control, Modelling of DC network, Modelling of AC networks.

Power flow analysis in AC/DC systems: General, Modelling of DC links, Solution of DC load flow, Discussion, Per unit system for DC quantities.

Course Outcomes (COs)

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

1. Choose intelligently AC and DC transmission systems for the dedicated application(s).
2. Identify the suitable two-level/multilevel configuration for high power converters.
3. Select the suitable protection method for various converter faults.
4. Identify suitable reactive power compensation method.
5. Decide the configuration for harmonic mitigation on both AC and DC sides.

Text Books

1. *Arrillaga, J., HVDC Transmission, IEE Press (2007).*
2. *Edwart, K., Direct Current Transmission (Vol. 1), John Wiley and Sons (2008).*
3. *Padiyar, K.R., HVDC Power Transmission System, New Age International (P) Limited, Publishers (2008).*

CO MAPPING WITH PO and PSO													
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	-	-	-	-	-	-	-	-	2	-
CO2	3	3	3	-	-	-	-	-	-	-	-	2	-
CO3	3	3	3	-	-	-	-	-	-	-	-	2	-
CO4	3	3	3	-	-	-	-	-	-	-	-	2	-
CO5	3	3	3	-	-	-	-	-	-	-	-	2	-

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓	✓				
CO2		✓	✓	✓	✓				
CO3		✓	✓	✓	✓				
CO4		✓	✓	✓	✓				
CO5		✓	✓	✓	✓				

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEE614: **Introduction to Operating Systems (Elective-II)**

L	T	P	SL	Cr
30	0	30	30	3.0

Course Objective: To understand the role, responsibilities, and the algorithms involved for achieving various functionalities of an Operating System.

Syllabus:

Introduction and System Structures: Computer-System Organization, Computer-System Architecture, Operating-System Structure, Operating-System Operations Overview, Computing Environments, User and Operating-System Interface, System Calls, Types of System Calls, System Programs, , Operating-System Structure.

Process Management: Process Concept, Process Scheduling, Operations on Processes, Inter- process Communication, Multi-threaded programming: Multi-core Programming, Multithreading Models, Process Scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms,

Concurrency: The Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Mutex Locks, Semaphores, Classic Problems of Synchronization, Monitors.

Deadlock: System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock.

Memory Management: Basic Hardware, Address Binding, Logical and Physical Address, Dynamic linking and loading, Shared Libraries, Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table, Virtual Memory Management: Demand Paging, Page Replacement, Allocation of Frames, Thrashing.

File Systems: File Concept, Access Methods, Directory and Disk Structure, File-System Mounting, File Sharing, Protection, File-System Structure, File-System Implementation, Directory Implementation, Allocation Methods, Free-Space Management.

Disk Management: Mass Storage Structure, Disk Structure, Disk Attachment, Disk Scheduling, Disk Management, Swap-Space Management, RAID Structure.

Laboratory Work: To explore detailed architecture and shell commands in Linux / Unix environment, and to simulate CPU scheduling, Paging, Disk-scheduling and process synchronization algorithms.

Course Outcomes (COs)

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

1. Interpret the basics of an operating system including the kernel, system calls, system operations and computing environments.
2. Evaluate the effectiveness and trade-offs of different models of multithreading and CPU scheduling algorithms.
3. Infer the concurrent computer environment and handle the situations leading to deadlock.
4. Analyze various memory management strategies and virtual memory.
5. Evaluate the effectiveness of different disk management strategies and criticize the design and implementation of file system.

Text Books

1.Silberschatz A., Galvin B. P. and Gagne G., Operating System Concepts, John Wiley & Sons Inc (2013) 9th ed.

2.Stallings W., Operating Systems Internals and Design Principles, Prentice Hall (2018) 9th ed.

Reference Books

1.Ogata, K., Discrete-time Control Systems, Pearson Education *(2005).*

CO MAPPING WITH PO and PSO												
CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO 1	PSO 2
CO1	3	3	-	-	-	-	-	-	-	-	-	3	-
CO2	3		3	-	-	-	-	-	-	-	-	3	-
CO3	3	3	3	-	-	-	-	-	-	-	-	3	3
CO4	3	3	-	-	-	-	-	-	-	-	-	3	3
CO5	3	3	3	-	-	-	-	-	-	-	-	3	3

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓					
CO2		✓	✓	✓	✓				
CO3		✓	✓	✓	✓				
CO4		✓	✓	✓					
CO5		✓	✓	✓	✓				

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

SEMESTER-VII

UEE705: SUSTAINABLE ENERGY SYSTEMS

L	T	P	SL	Cr
30	0	30	30	3.0

Course objective: To introduce the students about Electric vehicles and renewable energy sources like Solar and Wind, their technical challenges, benefits, and perspectives. To make the students familiar with the working and integration with grid.

Introduction to renewable energy resources and policies of renewable energy, Environmental issues, renewable sources integration – overcoming intermittence, centralized vs. distributed generation.

Wind Energy: Speed and Power Relations, Power Extracted from the Wind, different types of Wind Turbines, Aerodynamic Power Control: Pitch and Tip Speed Ratio control, Wind Generators, Fixed and Variable-Speed Wind Energy Systems, Induction Generator Based WECS, Synchronous Permanent Magnet Generator (PMG) based wind generators, Control of DFIG & PMG.

Solar energy: Solar Cell Physics, Solar Cell Efficiency variation with band-gap and temperature, High efficiency cells, Principle of photovoltaic conversion of solar energy, types of solar cells and PV cell panel, Solar heating, cooling and thermal system; domestic photovoltaic applications, Stand-alone & Grid connected systems: PV Inverters, Optimal economic coordinated operation of conventional and renewable sources, Operational issues and challenges.

Energy mix in generation, planning scheduling and forecasting of renewable energy systems, variability issues in renewable energy systems, study of solar radiation and design, concept of virtual power plant.

Introduction to Electric vehicles: Types of EVs, architecture and working of electric vehicles, integration of EVs in smart grid, economic advantages and challenges in installation of EVs.

Electric Propulsion unit, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, switched reluctance motor, Bidirectional DC-DC converters, Inverters and motor drives Chargers, Electric Vehicle dynamics.

Battery management system, hybridization of different energy storage devices, Sizing the drive system, Design of Plug-in Electric Vehicle, Energy Management Strategies, Automotive networking and communication, EV and EV charging standards, V2G, G2Vconcepts.

Laboratory work: Experiments involving simulation and hardware which will involve working of Electric vehicle using DC-DC buck-boost converter, hardware involving Renewable energy sources like Solar and Wind energy systems, Demonstration of I-V and P-V characteristics of series and parallel combination of PV modules, Demonstration of the effect of shading on module output power, Demonstration of diode as bypass diode and blocking diode, Study of charging and discharging characteristics of battery, Analysis of Maximum Power Point (MPPT) manually by varying the resistive load across the PV panel.

Course Outcomes (COs):

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

1. Analyse the working of Wind and Solar energy systems.
2. Demonstrate the concepts of Grid integration of Renewable energy sources and associated challenges.
3. Demonstrate the energy storage capability of electric vehicles.
4. Analyse the Grid integration of Electric vehicles and its challenges.
5. Establish the communication and networking in Electric vehicles.

Text Books:

1. *M. H. Rashid, Power Electronics, Prentice-Hall of India.*
2. *Emadi,A.(Ed.),Miller,J.,Ehsani,M.,VehicularElectricPowerSystems,BocaRaton,CRC Press, 2003.*
3. *Larminie, James, and John Lowry, Electric Vehicle Technology Explained, John Wiley and Sons, 2012.*
4. *Simon, Christopher A., Alternate Source of Energy, Rowman and Little Field Publishers Inc. (2007).*
5. *Patel, M. R., Wind and Solar Power Systems, Boca Raton, FL: CRC Press, (1999).*

Reference Books:

1. *P.S Bhimbra, Power Electronics, Khanna Publishers.*
2. *Tariq Muneer and Irene Illescas García, The automobile, In Electric Vehicles: Prospects and Challenges, Elsevier, 2017.*
3. *Sheldon S. Williamson, Energy Management Strategies for Electric and Plugin Hybrid Electric Vehicles, Springer, 2013.*
4. *Masters G. M., Renewable and Efficient Electric Power Systems, John Wiley &Sons, (2004).*
5. *Garg H P., Prakash J., Solar Energy: Fundamentals & Applications, Tata McGraw Hill, New Delhi, 1997.*

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	✓	✓	✓	✓			✓	✓	
CO2		✓	✓	✓			✓		
CO3		✓	✓	✓			✓		
CO4		✓	✓	✓			✓	✓	
CO5		✓	✓	✓			✓		

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEE706: IoT AND REAL TIME SYSTEMS

L	T	P	SL	Cr
45	0	30	15	3.0

Course Objectives: The objective of the course is to provide basic understanding of Internet of Things, its architecture, communication protocols, platforms and its deployment, applications; to introduce the students about important contemporary issues due to the integration of DG: technical challenges, benefits, and perspectives in real time environment; to make them familiar with hardware components including measurement and control in hardware in loop system.

Internet of Things

Introduction to Internet of Things (IoT), vision and challenges for realizing the Internet of Things, IoT architecture, design, Introduction to IoT based measurements, Smart sensors, Digital transducers, Solid state relay, Arduino and Rasberry Pi as IoT Gateways, IoT enabled Applications: Home and Building Automation, Smart Grid, Smart City, Smart Farming, Smart Healthcare.

IoT in Power System

IoT structure, Communication Protocol, Physical/Link Layer, IEEE 802.3 (Ethernet), Network Layer, IPv6 and IPv4, Transport Layer, TCP and UDP, Application Layer, Interoperability in IoT, Interoperable communication standards: IEC 61850, concepts of clouds in IoT

Role of IoT in Power System, Monitoring and control for Wide Area Application, Phasor Measurement Unit (PMU), Phasor Data Concentrator (PDC), IEEE C37.118 standard for PMU, IEC 61850-90-5 based PMU communication.

Data Acquisition System: Role of dedicated computers, analog and digital control, computer systems for real time applications, Hardware-in-loop simulation systems, distributed control architecture, reliability enhancement by redundancy, Real time operating systems: Features, primary components, Structured design of real time systems. Developing a mathematical model for Power system and control, Mathematical model of the real time environment, Design of hardware device meant to be used in HIL. Testing and parameter adjustment for real time implementation of real-time simulator, Design of desired control schemes for AC and DC electrical machine drives and other applications: Micro-grid and renewable and its testing in HIL. Real time control strategy based on FPGA, dSpace, Understanding four-quadrant amplifier for HIL system.

Real Time Control Applications: Instrumentation and conditioning of drive signals, data acquisition of drive system, energy management system for AGC, VAR Control, state estimation, security monitoring, economic dispatch, on line load management, Power system digital relaying, Power plant instrumentation.

Laboratory Work:

Deployment of an embedded system on IoT cloud using USB serial and /orWi-Fi modules. Off-line simulations for the various experiments related to hardware in-loop simulation system to predict ahead of conducting the lab experiment, the operating characteristics and compare the

results, Microgrid operation and control using HIL, Implement hardware such as PV and Wind system on the simulated grid to test hardware device in the real time environment, Analysis of the Symmetrical components of Power System Network, Study of the principles of transient stability analysis, Demonstrate the load frequency control using PI and Fuzzy logic, Design and analysis of a 3 Level PWM generation in MATLAB/Simulink, Analysis of unsymmetrical Fault (LL, LG, LLG), Analysis of voltage disturbance in single phase model due to non-linear load, Power quality improvement using STATCOM, Analysis of voltage sag during high power induction motor starting and Harmonic analysis for nonlinear load.

Course Outcomes (COs):

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

1. Exhibit the concept and benefits of IoT
2. Implement IoT system using protocols and IoT cloud
3. Demonstrate about Hardware-in-loop simulation systems.
4. Develop the mathematical modelling of power system and control in real time environment.
5. Demonstrate the concepts of real time control strategy based on FPGA, dSpace.
6. Demonstrate the various Real time control applications.

Text Books:

1. *IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro by Cisco Press, 2017.*
2. *Internet of Things: A Hands-on Approach, by Arshdeep Bahga and Vijay Madisetti Universities Press, 2014.*
3. *N. Hatziargyriou, Microgrids: Architectures and Control, Wiley-IEEE Press, January (2014).*
4. *Wood A. J. and Wollenberg B., Power generation operation and control, John Wiley.*
5. *Kusic C. L., Computer Aided Power System Analysis, TMH, New Delhi.*

Reference Books:

1. *Internet of Things, Abhishek S Nagarajan, RMD Sundaram Shriram K Vasudevan, Wiley India 2019.*
2. *Internet of Things, Raj Kamal, McGraw Hill Education 2017.*
3. *HIL System catalogues, Opal-RT, RTDS and Typhoon.*
4. *Torsten Cegrell, Power System Control Technology, PHI, India.*
5. *Cerni R.H and Foster L.E., Instrumentation for Engineering Management, John Wiley and Sons.*

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓			✓			
CO2		✓	✓	✓		✓			
CO3		✓	✓	✓		✓			
CO4		✓	✓	✓	✓	✓			
CO5		✓	✓	✓		✓			
CO6		✓	✓	✓		✓			

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	45
3	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEE795: **Capstone Project**

L	T	P	SL	Cr
0	0	30**	210	8.0

Course Objective: To facilitate the students learn and apply an engineering design process in electrical engineering, including project resource management. As a part of a team, the students will make a project, that emphasizes, hands-on experience, and integrates analytical and design skills. The idea is to provide an opportunity to the students to apply what they have learned throughout the course of graduate program by undertaking a specific problem.

Syllabus:

Capstone Project is increasingly interdisciplinary, and requires students to function on multi-disciplinary teams. It is the process of devising a system, component or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs. It typically includes both analysis and synthesis performed in an iterative cycle. Thus, students should experience some iterative design in the curriculum. As part of their design experience, students have an opportunity to define a problem, determine the problem scope and to list design objectives. The project must also demonstrate that students have adequate exposure to design, as defined, in engineering contexts. Engineering standards and realistic constraints are critical in engineering design. The program must clearly demonstrate where standards and constraints are taught and how they are integrated into the design component of the project. Each group will have 4-5 students. Each group should select their team leader and maintain daily diary. Each Group will work under mentorship of a Faculty supervisor. Each group must meet the assigned supervisor (2hrs slot/week) till the end of the semester (record of attendance will be maintained), as per the time slot which will be provided to them by the respective supervisor. This is mandatory requirement for the fulfilment of the attendance as well as the successful completion of the project. The faculty supervisor of the project will continuously assess the progress of the works of the assigned groups. Some part of the analysis and design of the system will be done in the first section of project in semester VI. The second section would comprise of completion of the project in semester VII in which each team will have to submit a detailed report of the project along with a poster.

Course Outcomes (COs)

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

1. Identify design goals and analyse possible approaches to meet given specifications with realistic Engineering constraints.
2. Design an electrical engineering project implementing an integrated design approach applying knowledge accrued in various professional courses.
3. Perform simulations and incorporate appropriate adaptations using iterative synthesis.
4. Use modern engineering hardware and software tools.
5. Work amicably as a member of an engineering design team.
6. Improve technical documentation and presentation skills.

CO MAPPING WITH PO and PSO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2

CO1	2	3	3	2	-	3	1	3	2	2	3	3	3
CO2	3	3	3	3	3	2	2	3	2	2	2	3	3
CO3	3	2	2	3	3	2	2	3	2	2	2	2	2
CO4	3	2	2	2	3	2	2	3	2	2	3	3	3
CO5	1	-	2	-	-	1	2	3	2	1	2	2	2
CO6	1	-	2	-	-	2	3	3	3	1	2	2	2

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	✓	✓	✓	✓	✓		✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓		✓	✓	✓
CO6	✓	✓	✓	✓	✓		✓	✓	✓

UEE742: **Digital Controllers for Power Applications (Elective –III)**

L	T	P	SL	Cr
30	0	30	30	3.0

Course Objective: To provide a deep insight into the various digital controller schemes used in power converters.

Syllabus:

Introduction: Digital signals and coding, Shannon's sampling theorem, sample and hold devices, analog-to-digital conversion, digital-to-analog conversion, energy quantization, reconstruction of sampled signals, data conversion: zero order hold, first order hold, second order hold.

Mathematical modelling of digital power electronics: Introduction, zero order hold for AC/DC controlled rectifiers, first order transfer function for DC/AC PWM inverters, second order transfer function for DC/DC converters.

Digitally controlled converters: Detailed mathematical modelling of different types of DC/AC rectifiers, AC/DC PWM inverters, DC/DC choppers, AC/AC voltage controllers, cycloconverters and matrix converters.

Open and Closed loop control of digital power electronics: Stability analysis, step and impulse responses, PI control for AC/DC, DC/AC and AC/AC converters, PID control for DC/DC converters.

Applications of digital controllers in FACTS devices: Phase angle compensator, UPFC.

Laboratory Work: The laboratory work will emphasize on development of PI and PID controllers for various power converter topologies using MATLAB Simulink.

Course Outcomes (COs)

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

1.Conceptualize sample and hold circuit

2.Develop mathematical model of different power converters

3.Devise a controller for different power converters.

Text Books

1. Luo,F.L.,Ye,H.,&Rashid,M.H.*Digitalpowerelectronicsandapplications*.Elsevier *(2010).*

2. Buso, S., & Mattavelli, P. Digital control in power electronics. *Synthesis Lectures on Power Electronics*, *5*(1), 1-229, *(2015).*

Reference Books

1. Ogata, K., Discrete-time Control Systems, Pearson Education *(2005).*

CO MAPPING WITH PO and PSO													
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	3	2
CO2	3	3	-	-	-	-	-	-	-	-	-	3	2
CO3	3	3	3	-	-	-	-	-	-	-	-	3	2

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓					
CO2		✓	✓	✓					
CO3		✓	✓	✓	✓				

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEE743: **Cloud Computing Based Electrical Systems (Elective –III)**

L	T	P	SL	Cr
45	0	0	45	3.0

Course Objective: To realize and use the Cloud computing paradigms, familiarize with architectural models and resource allocation strategies, virtualization and electrical systems applications.

Syllabus:

Introduction to Cloud Technologies: Introduction to Cloud computing and its components, Cloud deployment models, Cloud enabling technologies, Internet of Things for miniaturization, wireless and intelligent transportation technologies, scalable Cloud architecture model and resource management

Virtualization and Cloud Platforms:
Exploring virtualization for Server, Storage and Network, Load balancing, Hypervisors, Machine imaging, Cloud marketplace overview, Comparison of Cloud providers.

Data Processing and security: Concept of Map Reduce for Simplified data processing on Large clusters, Data security and related issues, Identify and access management**,** Economics, Challenges like Cloud provider Lock-in, Security etc.

Resource Management in Clouds: Virtual machines, performance isolation and resource sharing between virtual machines, performance provisioning, introduction of RT-Xen for VM scheduling, VATC as network I/O and OpenStack for Cloud resource management.

Cloud Computing for Electrical Systems: Realization of Cloud based SCADA system, smart grid management, energy and load forecasting and scheduling, and power system protection etc.

Course Outcomes (COs)

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

1.Explain the Cloud architectures and use the IoT technologies for Cloud formulation.

2.Explain the virtualization and resource management concepts in Cloud s.

3.Confront storage, processing and security issues for Cloud computing.

4.Apply the Cloud computing concept for electrical system application.

Text Books

1. Rajkumar Buyya, James Broberg and Goscinski, Cloud Computing Principles and Paradigms, John Wiley and Sons, Second Edition,2012.
2. Gerard Blokdijk, Ivanka Menken, The Complete Cornerstone Guide to Cloud Computing Best Practices, Emereo Pvt Ltd, Second Edition,2009.

Reference Books

1.Anthony Velte, Toby Velte and Robert Elsenpeter, Cloud *Computing: A practical Approach, Tata McGrawHill, , Second Edition,2010.*

CO MAPPING WITH PO and PSO													
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2
CO1	3	3	-	-	2	-	-	-	-	-	-	2	3
CO2	3	3	-	-	2	-	-	-	-	-	-	3	2
CO3	3	3	-	-	-	-	-	-	-	-		2	2
CO4	3	3	3	3	2	-	-	-	-	-	3	2	3

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓		✓			
CO2		✓	✓	✓		✓			
CO3		✓	✓	✓					
CO4		✓	✓	✓	✓	✓		✓	

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST & EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UCS414: COMPUTER NETWORKS (Elective –III)

L	T	P	SL	Cr
30	0	30	30	3.0

Course Objectives: The subject will introduce the basics of computer networks to students through a study of layered models of computer networks and applications.

Introduction: Organization of the Internet, ISP, Network criteria, Categories of networks, Network performance and Transmission Impairments. Network Devices, OSI Model, TCP/IP Protocol Suite, Layering principles, Line Encoding, Switching technique and Multiplexing.

Local Area Networks: LAN topologies: Bus topology, Ring topology, Token passing rings, FDDI, Star topologies, Asynchronous transfer mode, Ethernet, IEEE standards 802.3, 802.5. Wireless LANs: IEEE 802.11 and Bluetooth, introduction to Virtual circuit switching including frame relay, X.25, and ATM.

Reliable Data Delivery: Error control (retransmission techniques, timers), Flow control (Acknowledgements, sliding window), Multiple Access, Performance issues (pipelining).

Routing and Forwarding: Routing versus forwarding, Static and dynamic routing, Unicast and Multicast Routing. Distance-Vector, Link-State, Shortest path computation, Dijkstra's algorithm, Network Layer Protocols (IP, ICMP), IP addressing, IPV6, Address binding with ARP, Scalability issues (hierarchical addressing).

Process-to-Process Delivery: UDP, TCP and SCTP, Multiplexing with TCP and UDP, Principles of congestion control, Approaches to Congestion control, Quality of service, Flow characteristics, Techniques to improve QoS.

Network Applications: Naming and address schemes (DNS, IP addresses, Uniform Resource Identifiers, etc.), Distributed applications (client/server, peer-to-peer, cloud, etc.), HTTP as an application layer protocol, Electronic mail, File transfer, Remote login.

Laboratory work: To design conceptual networks using E-Draw, Visual Studio etc. and to implement topologies BUS, RING, STAR, Mesh and configuring Router using Packet tracer or GNS3 platform.

Course Outcomes (COs):

After the completion of the course, the student will be able to:

1. Conceptualize and explain the functionality of the different layers within a network architecture
2. Analyze the requirements for a given organizational structure and select the most appropriate networking architecture and technologies, subnetting and routing mechanism.
3. Demonstrate the operation of various routing protocols and their performance analysis.
4. Illustrate design and implementation of datalink, transport and network layer protocols within a simulated/real networking environment.

Text Books:

1. *Forouzan A. B., Data communication and Networking, McGraw Hill (2012) 5th ed.*
2. *Tanenbaum S. A. and Wetherall J. D., Computer Networks, Prentice Hall (2013) 5th ed.*

Reference Books:

1. *Kurose J. and Ross K., Computer Networking: A Top Down Approach, Perason (2017) 7th ed.*
2. *Stallings W., Computer Networking with Internet Protocols and Technology, Pearson (2004).*

CO MAPPING WITH PO and PSO													
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	-	-	2	-	-	-	-	-	-	3	-
CO2	1	1	3	3	2	-	-	-	-	-	2	3	2
CO3	1	1	3	3	2	-	-	-	-	-	2	3	-
CO4	1	1	3	3	2	-	-	-	-	-	2	-	2

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓				✓			
CO2		✓			✓	✓		✓	
CO3		✓			✓	✓		✓	
CO4		✓			✓	✓		✓	

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab evaluations)	30

Semester VIII

UEE894: **Project Semester**

L	T	P	SL	Cr
0	0	0	450	15

Course Objective: The project semester is aimed at developing the undergraduate education program in Electrical Engineering to include a practical training in a professional engineering set up (a company, top educational institution, research institute, etc.) hereafter referred to as host "organization" as deemed appropriate. The participating organizations are selected that are either already visiting Thapar Institute of Engineering & Technology (TIET), Patiala for placement or are forming new relationships of mutual benefit. The project semester gives the students, the opportunity to translate engineering theory into practice in a professional engineering environment. The technical activity in the project semester should be related to both the student's engineering studies and to the host organization s activities and it should constitute as significant body of engineering work at the appropriate level. It should involve tasks and methods that are more appropriately completed in a professional engineering environment and should, where possible, make use of human and technology resources provided by the organization. It consolidates the student's prior learning and provides a context for later research studies. The student remains a fulltime registered student at TIET, Patiala during the project semester and this activity is therefore wholly distinct from any industrial interactions which may occur over vacation periods.

Assessment Details: Each student is assigned a faculty supervisor who is responsible for managing and assessment of the project semester. The faculty supervisor monitors the student's progress in a semester and interacts with the industry mentor during his/her visit to the host organization twice. This includes a Reflective Diary which is updated throughout the project semester, an Interim Project Report, a Final Report with Learning Agreement/Outcomes and a Final Presentation & Viva which involves the faculty Supervisor and some other members from the department. The mentor from the host organization is asked to provide his assessment on the designated form. The faculty supervisor is responsible for managing and performing the assessment of the project semester experience.

Course Outcomes (COs)

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

1. Acquire knowledge and experience of software and hardware practices in the area of project.
2. Carry out design calculations and implementations in the area of project.
3. Associate with the implementation of the project requiring individual and teamwork skills.
4. Communicate their work effectively through writing and presentation.
5. Demonstrate the knowledge of professional responsibilities and respect for ethics.

CO MAPPING WITH PO and PSO

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

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓		✓	✓
CO3								✓	✓
CO4								✓	✓
CO5					✓		✓	✓	✓

UEE632: POWER GENERATION AND ECONOMICS

L	T	P	SL	Cr
45	15	0	45	3.5

Course objective: To impart learning about the principle and concept of conventional, non-conventional power plants and power plant economies.

Introduction: Energy sources and their availability, Principle types of power plants, their special features and applications, Present status and future trends.
Hydro Electric Power Plants: Essentials, Classifications, Hydroelectric survey, Rainfall run-off, Hydrograph, Flow duration curve, Mass curve, Storage capacity, Site selection, Plant layout, various components, Types of turbines, Governor and speed regulation, Pumped storage, Small scale hydro-electric plants (mini and micro).
Thermal Power Plant: General developing trends, Essentials, Plant layout, Coal & its storage, Preparation, Handling, Feeding and burning, Cooling towers, Ash handling, Water treatment plant, High pressure boilers and steam turbines, Components of thermal power plant.
Gas Turbine Power Plants: Field of use, Components, Plant layout, Comparison with steam power plants, combined steam and gas power plants.
Nuclear Power Plant: Nuclear fuels, Nuclear energy, Main components of nuclear power plant, Nuclear reactors types and applications, Radiation shielding, Radioactive and waste disposal safety aspect.
Non-Conventional Power Generation: Geothermal power plants, Electricity from biomass, Direct energy conversion systems (Solar and Wind) Thermo-electric conversion system, Fuel cells, Magneto Hydro dynamic system.
Cogeneration: Definition and scope, Cogeneration technologies, Allocation of costs, Sale of electricity and impact on cogeneration.
Power Plant Economics: Cost of electrical energy, Selection of type of generation and generation equipment, Performance and operating characteristics of power plants, Economic scheduling principle, Load curves, Effect of load on power plant design, Load forecasting, electric tariffs, Peak load pricing.

Course Outcomes (COs):

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

1. Apply knowledge of India's power scenario, power system structure and related agencies.
2. Harness power from conventional and renewable sources.
3. Select the methods and size of plant generating power for overall economy.
4. Decide the tariff structure for different type of users.

Text Books:

1. *Arora, S.C and Domkundawar, S., A course in Power Plant Engineering, Dhanpat Rai(2002).*
2. *Deshpande, M.V., Power Plant Engineering, Tata McGraw Hill(2004).*
3. *Gupta, B.R., Generation of Electrical Energy, S. Chand(1998).*

Reference Books:

1. *Deshpande, M.V., Electrical Power System Design, McGraw Hill (2004).*
2. *Wood, A.J. and Wollenberg, B.F., Power Generation and Control, John Wiley*

(2004).

CO MAPPING WITH PO and PSO													
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	-	-	-	-	3	-	-	-	-	2	1	-
CO2	2	2	-	-	-	3	-	-	-	-	2	1	-
CO3	-	-	-	-	-	3	-	-	-	3	2	1	-
CO4	-	-	-	-	-	3	-	-	-	3	2	1	-

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1					✓		✓		
CO2			✓	✓			✓		
CO3					✓		✓		
CO4							✓	✓	

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizzes)	25

UEE522: ENERGY AUDITING AND MANAGEMENT

L	T	P	SL	Cr
45	15	0	45	3.5

Course Objective: To make the student understand about the energy scenario and its importance.

Energy Scenario: Energy scenario of growing economy, Energy pricing, Energy sector reforms, Energy and environment, Energy security, Energy conservation and its importance, Energy conservation Act-2001 and its features.

Energy Management and Audit: Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Benchmarking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments

Material and Energy Balance: Methods for preparing process flow, Material and energy balance diagrams.

Financial Management: Investment-need, Appraisal and criteria, financial analysis techniques-Risk and sensitivity analysis, Financing options, Energy performance contracts and role of ESCOs.

Electrical System: Electricity tariff, Load management and maximum demand control, T&D losses. Losses and efficiency in induction motors, Factors affecting motor performance and remedial solutions, energy efficient motors. Light source, Choice of lighting, Luminance requirements, and Energy conservation avenues

Compressed Air System: Types of air compressors, Compressor efficiency, efficient compressor operation, Compressed air system components, Capacity assessment.

HVAC and Refrigeration System: Vapor compression refrigeration cycle, Coefficient of performance, Capacity, performance and savings opportunities, Vapour absorption refrigeration system: Working principle of fans, blowers and pumps-types, Performance evaluation, Flow control strategies and energy conservation opportunities.

Course Outcomes (COs):

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

1. Analyse energy scenario nationwide and worldwide
2. Decide about energy management in more effective way.
3. Analyse various energy related aspect of electrical system.
4. Carry out financial management.
5. Conduct studies related to operational aspects of compressed air system and refrigeration system.

Text Books:

1. *Abbi, Y.P. and Jain, S., Handbook on Energy Audit and Environment Management, Teri Bookstore (2006).*
2. *Diwan, P., Energy Conservation, Pentagon Press(2008).*

Reference Book:

1. *Younger, W., Handbook of Energy Audits, CRC Press(2008)*

CO MAPPING WITH PO and PSO													
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	3	3	-	-	-	-	-	-	2	2	2
CO2	1	1	3	3	-	-	-	-	-	-	2	1	2
CO3	1	1	3	3	-	-	-	-	-	-	-	3	2
CO4				3	-	-	-	-	-	3	-	3	2
CO5	1	1	3	3	-	-	-	-	-	-	-	3	-

CO MAPPING WITH WK									
CO/WK	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1				✓	✓			✓	
CO2				✓	✓			✓	
CO3				✓	✓			✓	
CO4					✓			✓	
CO5			✓	✓	✓				

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessional (Assignments/Projects/Tutorials/Quizzes)	25