COURSE SCHEME AND SYLLABUS

FOR

B.E. (ELECTRICAL ENGINEERING)

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

2023

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 07,2025, respectively.

SEMESTER-I

S. No.	Course Code	Course Name	CODE	L	T	P	Cr
1.	UPH013	PHYSICS	BSC	3	1	2	4.5
2.	UES101	ENGINEERING DRAWING	ESC	2	4	0	4.0
3.	UHU003	PROFESSIONAL COMMUNICATION	HSS	2	0	2	3.0
4.	UMA010	MATHEMATICS-I	BSC	3	1	0	3.5
5.	UES102	MANUFACTURING PROCESSES	ESC	2	0	2	3.0
		TOTAL		**12**	**6**	**6**	**18.0**

SEMESTER-II

S. No.	Course Code	Course Name	CODE	L	T	P	Cr
1.	UCB009	CHEMISTRY	BSC	3	0	2	4.0
2.	UES103	PROGRAMMING FOR PROBLEM SOLVING	ESC	3	0	2	4.0
3.	UES013	ELECTRICAL & ELECTRONICS ENGINEERING	ESC	3	1	2	4.5
4.	UEN008	ENERGY AND ENVIRONMENT	HSS	2	0	0	2.0
5.	UMA004	MATHEMATICS-II	BSC	3	1	0	3.5
		TOTAL		**14**	**2**	**6**	**18.0**

SEMESTER-III

S. No.	Course Code	Course Name	CODE	L	T	P	Cr
1.	UMA028	MATHEMATICS FOR DATA SCIENCE	BSC	3	0	2	4.0
2.	UEE307	TRANSMISSION AND DISTRIBUTION OF ELECTRIC POWER	PCC	2	1	0	2.5
3.	UES301	ANALOG CIRCUITS	ESC	2	0	2	3.0
4.	UEE301	DIRECT CURRENT MACHINES AND TRANSFORMERS	PCC	3	1	2	4.5
5.	UES302	INTRODUCTION TO MEASUREMENT SYSTEMS	ESC	2	0	2	3.0
6.	UTA030	ENGINEERING DESIGN PROJECT (BUGGY)	PRJ	1	0	4	3.0
7.	UTD003	APTITUDE SKILLS BUILDING	HSS	2	0	0	2.0
		TOTAL		15	2	12	**22.0**

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SEMESTER-IV

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UEE401	ALTERNATING CURRENT MACHINES	PCC	3	1	2	4.5
2.	UTA018	OBJECT ORIENTED PROGRAMMING	ESC	3	0	2	4.0
3.	ULC303	COMPUTER ARCHITECTURE AND ORGANIZATION	PCC	3	0	0	3.0
4.	UEE409	NETWORK THEORY	PCC	3	1	2	4.5
5.	UEI501	CONTROL SYSTEMS	PCC	3	1	2	4.5
6.	UMA035	OPTIMIZATION TECHNIQUES	BSC	3	0	2	4.0
7.	UHU050	EVOLUTIONARY PSYCHOLOGY (1 SELF EFFORT HOUR)	HSS	1*	0	0	1.0
		TOTAL		18+1*	3	10	**25.0**

*****Alternate Week

SEMESTER-V

S. No.	Course Code	Course Name	CODE	L	T	P	Cr
1.	UEE509	POWER SYSTEM ANALYSIS	PCC	3	1	2	4.5
2.	UEE511	EMBEDDED SYSTEM DESIGN AND IOT	PCC	3	0	2	4.0
3.	UEE504	POWER ELECTRONICS	PCC	3	1	2	4.5
4.	UPH401	ELECTRICAL AND ELECTRONIC ENGINEERING MATERIALS	BSC	2	0	2	3.0
5.	UTA025	INNOVATION AND ENTREPRENEURSHIP	OTH	1	0	2*	3.0
6.	UEE410	DATA STRUCTURES AND ALGORITHMS	PCC	3	0	2	4.0
7.		ELECTIVE-I	PEC	2	0	2	3.0
		TOTAL		17	2	12+2*	**26.5**

*Lab in alternate week

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SEMESTER-VI

S. No.	Course Code	Course Name	CODE	L	T	P	Cr
1.	UEE616	INDUSTRIAL DRIVES AND AUTOMATION	PCC	3	0	2	4.0
2.	UEE513	ELECTRICAL SYSTEM DESIGN	PRJ	1	0	2	2.0
3.	UEE610	POWER SYSTEM PROTECTION	PCC	3	0	2	4.0
4.	ULC601	MACHINE LEARNING TECHNIQUES	PCC	3	0	2	4.0
5.	UEE510	HIGH VOLTAGE ENGINEERING	PCC	2	0	2	3.0
6.	UHU005	HUMANITIES FOR ENGINEERS	HSS	2	0	2	3.0
7.		ELECTIVE-II	PEC	2	0	2	3.0
8.	UEE795	CAPSTONE PROJECT (START)	PRJ	0	0	2*	-
		TOTAL		16	0	14	**23.0**

*****Not included in teaching load

SEMESTER-VII

S. No.	Course Code	Course Name	CODE	L	T	P	Cr
1.	ULC603	ELECTRIC VEHICLE AND REAL TIME SYSTEMS	PCC	3	0	2	4.0
2.	UMA601	MATHEMATICS FOR SIGNAL PROCESSING	BSC	2	1	2	3.5
3.	UEE795	CAPSTONE PROJECT	PRJ	0	0	2*	8.0
4.		GENERIC ELECTIVE	OEC	2	0	0	2.0
5.		ELECTIVE-III	PEC	2	0	2	3.0
		TOTAL		9	0	6	**20.5**

*****Not included in teaching load

SEMESTER-VIII

S. No.	Course Code	Course Name	CODE	L	T	P	Cr
1.	UEE894	PROJECT Semester	PRJ	-	-	-	**15.0**
		OR					
1.	UEE522	ENERGY AUDITING AND MANAGEMENT	PCC	3	1	3	3.5
2.	UEI625	ANALOG AND DIGITAL COMMUNICATION	PCC	3	1	0	3.5
3.	UEE895	DESIGN PROJECT	PRJ	-	-	-	8.0
		TOTAL		6	0	2	**15.0**
		OR					
1.	UEE896	START-UP SEMESTER	PRJ	-	-	-	**15.0**

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BASKETS OF SPECIALIZATION

DATA ANALYTICS	ELECTRIC VEHICLES	SMART AND MICRO GRID SYSTEMS	POSITION
MATHEMATICS FOR DATA SCIENCE **(COMPULSORY SUBJECT IN SEMESTER III)**	EMBEDDED SYSTEM DESIGN AND IOT **(COMPULSORY SUBJECT IN SEMESTER V)**	RESTRUCTURED POWER SYSTEMS	**ELECTIVE-I**
DATA MINING AND VISUALIZATION	PLC AND SCADA	SMART GRID SYSTEMS	**ELECTIVE-II**
STOCHASTIC MODELING OF ELECTRICAL SYSTEMS	DIGITAL CONTROLLERS FOR POWER APPLICATIONS	CLOUD COMPUTING BASED ELECTRICAL SYSTEMS	**ELECTIVE-III**

ELECTIVE-I

S. No.	Course Code	Course Name	CODE	L	T	P	Cr
1.	UEE514	INTRODUCTION TO DATABASE MANAGEMENT SYSTEMS	PEC	2	0	2	3.0
2.	UEE515	DATA COMMUNICATION AND COMPUTER NETWORKS	PEC	2	0	2	3.0
3.	UEE527	RESTRUCTURED POWER SYSTEMS	PEC	3	0	0	3.0
4.	UEE406	POWER SYSTEM PRACTICES	PEC	3	0	0	3.0
5.	UEE528	POWER QUALITY MONITORING AND CONDITIONING	PEC	3	0	0	3.0
6.	UEE516	ELECTROMAGNETIC FIELDS AND WAVES	PEC	2	2	0	3.0

ELECTIVE-II

S. No.	Course Code	Course Name	CODE	L	T	P	Cr
1.	UEE615	DATA MINING AND VISUALIZATION	PEC	2	0	2	3.0
2.	UEE638	PLC AND SCADA	PEC	2	0	2	3.0
3.	UEE636	SMART GRID SYSTEMS	PEC	2	0	2	3.0
4.	UEE721	NONLINEAR AND DIGITAL	PEC	3	0	0	3.0

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		CONTROL SYSTEMS					
5.	UEE637	HIGH VOLTAGE TRANSMISSION SYSTEMS	PEC	3	0	0	3.0
6.	UEE614	INTRODUCTION TO OPERATING SYSTEMS	PEC	2	0	2	3.0

ELECTIVE-III

S. No.	Course Code	Course Name	CODE	L	T	P	Cr
1.	UEE741	STOCHASTIC MODELING OF ELECTRICAL SYSTEMS	OEC	3	0	0	3.0
2.	UEE742	DIGITAL CONTROLLERS FOR POWER APPLICATIONS	OEC	2	0	2	3.0
3.	UEE743	CLOUD COMPUTING BASED ELECTRICAL SYSTEMS	OEC	3	0	0	3.0
4.	UEE744	INDUSTRIAL ELECTRONICS	OEC	2	0	2	3.0
5.	UEE601	FLEXIBLE AC TRANSMISSION SYSTEM DEVICES	OEC	3	0	0	3.0

GENERIC ELECTIVE

S. No.	Course Code	Course Name	CODE	L	T	P	Cr
1.	UHU016	INTRODUCTORY COURSE IN FRENCH	OEC	2	0	0	2.0
2.	UHU017	INTRODUCTION TO COGNITIVE SCIENCE	OEC	2	0	0	2.0
3.	UHU018	INTRODUCTION TO CORPORATE FINANCE	OEC	2	0	0	2.0
4.	UCS002	INTRODUCTION TO CYBER SECURITY	OEC	2	0	0	2.0
5.	UPH064	NANOSCIENCE AND NANOMATERIALS	OEC	2	0	0	2.0
6.	UEN006	TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT	OEC	2	0	0	2.0
7.	UMA069	GRAPH THEORY AND APPLICATIONS	OEC	2	0	0	2.0
8.	UMA070	ADVANCED NUMERICAL METHODS	OEC	2	0	0	2.0
9.	UBT510	BIOLOGY FOR ENGINEERS	OEC	2	0	0	2.0
10.	UTD004	CAMPUS 2 CORPORATE	OEC	2	0	0	2.0

TOTAL CREDITS: 168

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Table 1: Nature of course and code

Nature of the course	**CODE****
Basic Science Courses	BSC
Engineering Science Courses	ESC
Humanities and Social Science Courses	HSS
Professional Core Courses	PCC
Professional Elective Courses	PEC
Open Elective Courses	OEC
Project	PRJ
Others {not available/specified in the categories mentioned here}	*OTH*

Table 2: Total Credit Score for specific Nature of course/s

Nature of the course	CODE	Total Credits	Semester and Course Name
Basic Science Courses	BSC	*30*	<Semester I, Mathematics-I> <Semester I, Applied Physics> <Semester II, Mathematics-II> <Semester II, Applied Chemistry> <Semester III, Mathematics for Data Science> <Semester IV, Electrical and Electronic Engineering Materials> <Semester IV, Optimization Techniques> <Semester VI, Mathematics for Signal Processing>
Engineering Science Courses	ESC	*25.5*	<Semester I, Engineering Drawing> <Semester I, Manufacturing Processes> <Semester II, Electrical and Electronics Engineering> <Semester II, Programming for Problem Solving> <Semester III, Object Oriented Programming> <Semester III, Introduction to Measurement Systems> <Semester III, Analog Circuits>
Humanities and Social Science Courses	HSS	*11*	<Semester I, Professional Communication> <Semester II, Energy and Environment> <Semester III, Employability Development Skills> <Semester IV, Evolutionary Psychology> <Semester VI, Humanities for Engineers>

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Nature of the course	CODE	Total Credits	Semester and Course Name
Professional Core Courses	PCC	*60.5*	<Semester III, Transmission and Distribution of Electric Power> <Semester III, Direct Current Machines and Transformers> <Semester IV, Alternating Current Machines> <Semester IV, Data Structures and Algorithms> <Semester IV, Computer Architecture and Organization> <Semester IV, Network Theory> <Semester V, Power System Analysis> <Semester V, Control Systems> <Semester V, Embedded System Design and IOT> <Semester VI, Industrial Drives and Automation> <Semester VI, Power System Protection> <Semester VI, Machine Learning Techniques> <Semester VI, High Voltage Engineering> <Semester VII, Electric Vehicle and Real Time Systems>
Professional Elective Courses	PEC	*9*	<Semester V, Elective-I> <Semester VI, Elective-II> <Semester VII, Elective-III>
Open Elective Courses	OEC	*2*	<Semester VII, Generic Elective>
Project	PRJ	*28*	<Semester III, Engineering Design Project (Buggy)> <Semester VI, Electrical System Design> <Semester VII, Capstone Project> <Semester VIII, Project>
Others	OTH	*2*	<Semester V, Innovation and Entrepreneurship>

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SEMESTER-I

UPH013: Physics

L	T	P	Cr
3	1	2	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.

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

Course Learning Objectives (CLO)
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.

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	Cr
	2	4	0	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 Learning Objectives (CLO)

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).

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.*

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UHU003: Professional Communication

L	T	P	Cr
2	0	2	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.

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Course Learning Objectives (CLO)

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).

Reference Books

1. Riordan, G.R. Technical Communication. Cengage Learning India Private Ltd. (2012)
2. Butterfield, Jeff., Soft Skills for everyone, Cengage Learning New Delhi, (2013).
3. Robbins, S.P., & Hunsaker, P.L., Training in Interpersonal Skills, Prentice Hall of India, New Delhi, (2008).
4. Orwell, G., Animal Farm, Fingerprint Publishing, New Delhi, (2017).
5. Golding, W, Lord of the Flies, Faber & Faber; Export edition (1999)
6. Martel,Y., Life of Pi, RHC, New Delhi, (2012).
7. Lahiri,J., The Namesake, Harpercollins (2007)
8. Arundhati Roy,A., The God of Small Things, Penguin India, (2002).
9. Swarup,V., Q&A, Black Swan,(2009).

Evaluation Scheme

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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

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UMA010: Mathematics-I

L	T	P	Cr
3	1	0	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 Learning Objectives (CLO)

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).

Reference Books

1. Wider David V, Advanced Calculus: Early Transcendentals, Cengage Learning (2007).
2. Apostol Tom M, Calculus, Vol I and II, John Wiley (2003).
3. Brown J.W and Churchill R.V, Complex variables and applications, McGraw Hill, (7th edition)

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UES102: Manufacturing Processes

L	T	P	Cr
2	0	2	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 Learning Objectives (CLO)

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.

Reference Books

1. Martin, S.I., Chapman, W.A.J., Workshop Technology, Vol.1 & II, Viva Books (2006) 4th ed.
2. Zimmer, E.W. and Groover, M.P., CAD/CAM - Computer Aided Designing and Manufacturing, Dorling Kingsley (2008).
3. Pandey, P.C. and Shan, H. S., Modern Machining Processes, Tata McGraw Hill (2008).
4. Mishra, P. K., Non-Conventional Machining, Narosa Publications (2006).
5. Campbell, J.S., Principles of Manufacturing, Materials and Processes, Tata McGraw Hill Company (1999).
6. Lindberg, Roy A., Processes and Materials of Manufacture, Prentice Hall of India (2008) 4th ed.

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-II

UCB009: Chemistry

L	T	P	Cr
3	0	2	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 Learning Objectives (CLO)

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.

Reference Books

1. Engineering Chemistry, B. Sivasankar, Tata McGraw-Hill Pub. Co. Ltd, New Delhi, 2008.
2. Engineering Chemistry, M.J. Shulz, Cengage Learnings, 2007.
3. J. Chem. Inf. Comput. Sci., D. Weininger, Vol. 28, 1988, 31-36.

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	Cr
3	0	2	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 Closing), 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 Learning Outcomes (CLOs) /Course Objectives (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

Reference Books

1. Let Us C, Kanetkar Y., 16th ed., 2017
2. Programming with C, Byron S Gottfried, McGraw Hill Education, Forth edition, 2018

<UES013> : <Electrical and Electronics Engineering>				
	L	T	P	Cr
	3	1	2	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 Learning Outcomes (CLO)

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).

UEN008: Energy and Environment

L	T	P	Cr
2	0	0	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 Learning Objectives (CLO)
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).

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 07,2025, respectively.

Reference Books

1. Peavy H.S., Rowe D.S., and Tchobanoglous, G. (2013) Environmental Engineering, McGraw Hill.
2. Rao, M.N. and Rao, H.V.N. (2014) Air Pollution, McGraw Hill.
3. Metcalf and Eddy. (2003) Wastewater Engineering: Treatment and Reuse, Fourth Edition, McGraw Hill.
4. Rai, G.D. (2014) Non-conventional Energy Resources, Khanna Publishers.

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

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 07,2025, respectively.

UMA004: Mathematics - II

L	T	P	Cr
3	1	0	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 Learning Objectives (CLO)
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).

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 07,2025, respectively.

Reference Books

1. Kreyszig Erwin, Advanced Engineering Mathematics, John Wiley (2006), 8th edition.
2. Jain, R.K. and Iyenger, S.R.K., Advanced Engineering Mathematics, Narosa Publishing House (2011), 4th edition.

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

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 07,2025, respectively.

SEMESTER-III

<**UMA028**> : <**Mathematics for Data Science**>				
	L	T	P	Cr
	3	0	2	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 probability 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 Learning Outcomes (CLO)

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.

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 07,2025, respectively.

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).

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 07,2025, respectively.

<**UEE307**> : <**Transmission and Distribution of Electric Power**>				
	L	T	P	Cr
	2	1	0	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 Learning Outcomes (CLO)

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).

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 07,2025, respectively.

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).

<**UES301**> : <**Analog Circuits**>				
	L	T	P	Cr
	2	0	2	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 Learning Outcomes (CLO)
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).

<**UEE301**> : <**Direct Current Machines and Transformers**>				
	L	T	P	Cr
	3	1	2	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 Learning Outcomes (CLO)

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).

<**UES302**> : < **Introduction to Measurement Systems**>				
	L	T	P	Cr
	2	0	2	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 Learning Outcomes (CLO)

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).

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 07,2025, respectively.

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).

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 07,2025, respectively.

<**UTA030**> : <**Engineering Design Project (Buggy)**>				
	L	T	P	Cr
	1	0	4	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.

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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 Learning Outcomes (CLO)

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).

APTITUDE SKILLS BUILDING				
	L	T	P	Cr
	2	0	0	2

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 Learning Outcome

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

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

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

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

CLO 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)*

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 07,2025, respectively.

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*

Evaluation Scheme

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

SEMESTER-IV

<**UEE401**> : <**Alternating Current Machines**>				
	L	T	P	Cr
	3	1	2	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 Learning Outcomes (CLO)

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.

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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).

<**UTA018**> : <**Object Oriented Programming**>				
	L	T	P	Cr
	3	0	2	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 Learning Outcomes (CLO)

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

<**ULC303**> : < **Computer Architecture and Organization**>				
	L	T	P	Cr
	3	0	0	3.0

Course Objective: Focus is on the architecture and organization of the basic computer modules viz. controls unit, central processing unit, input-output organization and memory unit.

Syllabus:

Basics of Computer Architecture: Number system and code conversion , Logic gates, Flip flops, Registers, Counters, Multiplexer, De-multiplexer, Decoder, Encoder etc.

Register Transfer and Micro operations: Register transfer Language, Register transfer, Bus & memory transfer, Arithmetic micro operations, Logic micro operations, Shift micro operations, Design of ALU.

Basic Computer Organization: Instruction codes, Computer instructions, Timing &control, Instruction Cycles, Memory, register, and input-output reference instructions, Interrupts, Complete computer description & design of basic computer.

Central Processing Unit: General register organization, Stack organization, Instruction format, Addressing modes, Data transfer & manipulation, Program control, RISC, CISC. Pipelining and hazards.

Computer Arithmetic: Addition &Subtraction, Multiplication Algorithms, Division algorithms. Memory Unit: Memory hierarchy, Processor vs. memory speed, High-speed memories, Main Memory, Cache memory and mapping schemes, Associative memory, Interleaving, Virtual memory, Memory management techniques.

Multiprocessors: Characteristics of multiprocessors, Interconnection structures, Interprocessor arbitration, Inter-processor communication & synchronization. Peripheral devices, I/O interface Data transfer schemes, Program control, Synchronous and asynchronous data transfer, Interrupt, DMA transfer, I/O processor.

Course Learning Outcomes (CLO)

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

1. Illustrate various elementary concepts of computer architecture including, syntax of register transfer language, micro operations, instruction cycle, and control unit.
2. Describe the design of basic computer with instruction formats & addressing modes
3. Explore various memory management techniques and algorithms for performing addition, subtraction and division etc.
4. Interpret the concepts of pipelining, multiprocessors, and inter processor communication.

Text Books

1. Mano, Morris M., Computer System Architectue, Prentice Hall (1992).
2. Hayes, J.P., Computer Architecture and Organization, McGraw Hill (1998).

Reference Books

1. Hennessy, J.L., Patterson, D.A, and Goldberg, D., Computer Architecture A Quantitative Approach, Pearson Education Asia (2006).
2. Leigh, W.E. and Ali, D.L., System Architecture: software and hardware concepts, South Wester Publishing Co. (2000).

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 07,2025, respectively.

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 07,2025, respectively.

<**UEE409**> : < **Network Theory**>				
	L	T	P	Cr
	3	1	2	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 Learning Outcomes (CLO)

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).

<**UMA035**> : < **Optimization Techniques**>				
	L	T	P	Cr
	3	0	2	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 Learning Outcomes (CLO)

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.PhillipsandJamesJ.Solberg:OperationsResearch-Principlesand Practice, John Wiley & Sons, Second edn.(2005).

<UEI501> : <Control Systems>				
	L	T	P	Cr
	3	1	2	4.5

Course Objective: To understand concepts of the mathematical modelling, feedback control and stability analysis in Time and Frequency domains. The concept of time response and frequency response of the system will be studied.

Syllabus:

Basic Concepts: Historical review, Definitions, Classification, Relative merits and demerits of open and closed loop systems, Linear and non-linear systems, Transfer function, , Block diagrams and signal flow graphs.

Components: D.C. and A.C. Servomotors, D.C. and A.C. Tach generators, Potentiometers and optical encoders, Synchro and stepper motors

Analysis: Steady-state errors and error constants, Concepts and applications of P, PD, PI and PID types of control. Stability: Definition, Routh-Hurwitz criterion, Root locus techniques, Nyquist criterion, Bode plots, Relative stability, Gain margin and phase margins.

Compensation: Lead, Lag and lag-lead compensators, Design of compensating networks for specified control system performance.

State Space Analysis: Concepts of state, State variables and state models, State space equations, Transfer function, Transfer model, State space representation of dynamic systems, State transition matrix, Decomposition of transfer function, Controllability and observability.

Laboratory Work: Linear system simulator, Compensation design, D.C. position control and speed control, Synchro characteristics, Servo demonstration, Stepper motor, Potentiometer error detector, Rate control system, Series control system, Temperature control system.

Course Learning Outcomes (CLO)

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

1. Develop the transfer function of the physical systems
2. Analyze the response of the closed and open loop systems
3. Analyze the stability of the closed and open loop systems
4. Design the various kinds of compensator
5. Develop and analyze state space models

Text Books

1.Gopal, M., Digital Control System, Wiley Eastern (1986).

2. Nagrath, I.J. and Gopal, M., Control System Engineering, New Age International (P) Limited, Publishers (2003).

3. Ogata, K., Modern Control Engineering, Prentice–Hall of India Private Limited (2001).

Reference Books

1.Kuo, B.C., Automatic Control System, Prentice–Hall of India Private Limited (2002).

2. Sinha, N.K., Control System, New Age International (P) Limited, Publishers (2002).

SEMESTER-V

<UEE509> : <Power Systems Analysis>				
	L	T	P	Cr
	3	1	2	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 Learning Outcomes (CLO)

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

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	Cr
	3	0	2	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 Learning Outcomes (CLO)

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)

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	Cr
	3	1	2	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 Learning Outcomes (CLO)

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.*

Reference Books

1. *Mohan, N., Underland, T. and Robbins, W. P., Power Electronics: Converter Applications and Design, John Wiley (2007)3rd ed.*
2. *Bose, B.K., Handbook of Power Electronics,* Auris *Publisher, 2016.*

Evaluation Scheme

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

Approved in 109th meeting of the Senate held on March 16,2023. Revised in 112th and 114th meeting of the Senate held on March 11,2023 and March 7,2025, respectively.

<**UPH401**> : <**Electrical and Electronic Engineering Materials** >				
	L	T	P	Cr
	2	0	2	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 Learning Outcomes (CLO)

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).

Reference Books

1. Smith, W.F., Principles of Materials Science and Engineering: An Introduction, Tata Mc-Graw Hill (2008).
2. Callister, W.D., Materials Science and Engineering, John Wiley & Sons, Singapore (2005).

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	Cr
	1	0	2*	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 Learning Outcomes (CLO)

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*

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	Cr
	3	0	2	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 Learning Outcomes (CLO)

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)

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	Cr
	3	0	2	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 Learning Outcomes (CLO)

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 Drives *New Age International (P) Limited, Publishers (1989), Reprint 2004.*.

Reference Books

1. *Bose, B.K., Modern Power Electronics and AC Drives, Prentice-Hall of India Private Limited (2006)*

Evaluation Scheme

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

Approved in 109th meeting of the Senate held on March 16,2023. Revised in 112th and 114th meeting of the Senate held on March 11,2023 and March 7,2025, respectively.

<**UEE513**> : <**Electrical System Design** >				
	L	T	P	Cr
	1	0	2	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 Learning Outcomes (CLO)

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).

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	Cr
	3	0	2	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 Learning Outcomes (CLO)

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)

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	Cr
	3	0	2	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 Learning Outcomes (CLO)

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).

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	Cr
	2	0	2	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 Learning Outcomes (CLO)

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.

Reference Books

1.Kuffel, E., Zaengl, W.S., Kuffel, J. High Voltage Engineering Fundamentals, Butterworth-Heinemann, 2000
2. Huge M. Ryan, Editor; High-Voltage Engineering and Testing, 3rd Edition, Institution of Engineering and Technology, 2013.

Evaluation ScheFme

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	Cr
	2	0	2	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 Behavior

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 gassignment

Course Learning Outcomes (CLO)

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

1. Ccomprehend 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).

Evaluation Scheme

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

SEMESTER-VII

<**ULC603**> : <**Electric Vehicles and Real Time System** >				
	L	T	P	Cr
	3	0	2	4.0

Course Objective: To introduce the electric vehicle (EV) technology, its benefits and challenges and make the students familiar with EV sub-systems and application of real-time simulation tools as an aid to realize EV sub systems.

Syllabus:

Introduction to Electric Vehicle – History, Components of Electric Vehicle, Comparison with Internal combustion Engine: Technology, e-mobility as sustainable solution, EV classification, Motor Torque Calculations - rolling resistance, e grade resistance, acceleration force, total Tractive Effort, Torque required on the Drive Wheel.

Electric Drive and controller-Types of Motors, Selection and sizing of Motor, RPM and Torque calculation of motor, Motor Controllers, Component sizing, Physical locations, Mechanical connection of motor, Electrical connection of motor.

Energy Storage Solutions (ESS) - Cell Types (Lead Acid/Li/NiMH), Battery charging and discharging calculation, Cell selection and sizing, Battery lay-outing design, Battery pack configuration, Battery pack construction, Battery selection criteria.

Battery Management System (BMS)/Energy Management System (EMS) - Need of BMS, active and passive cell balancing, state of charge and state of health estimation, Battery thermal management system.

Introduction to Real Time Systems - 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.

Control architecture in Real Time simulation: Developing a mathematical model for Power system and control, Mathematical model of the real environment, Design of hardware device meant to be used in HIL, Design of desired control schemes for AC and DC electrical machine drives and other applications.

Laboratory Work: Working and Control of BLDC Motor for Two Wheeler Electrical Vehicle, PMSM Motor for 2-Wheeler Electrical Vehicle, Design and analyse a Passive Battery Management System for small Li-ion Battery Study of Battery Packaging using Cylindrical/Prismatic Cells. Testing of Charger of Electric vehicles for EV Battery, Design and analysis of speed control controller for EV. Analysis the Symmetrical Components of Power System Network Using OPAL-RT. Design and analyse a three Level PWM Generation in OPAL-RT.

Course Learning Outcomes (CLO)

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

1. Relate to the importance of electric vehicle technology in achieving sustainable development.
2. Justify the working of Motor(s) and Controller(s) used in EV
3. To design battery-pack for an electric vehicle drivetrain.
4. Illustrate the knowledge of hardware-in-loop systems for real time applications.
5. Develop mathematical model of electric system and its control in real environments.

Text Books

1. James Larminie, Electric Vehicle Technology, Wiley, A John Wiley & Sons, Ltd., Publication

(2012)
2.. Tom Denton, Electric and Hybrid Vehicles, 2nd Edition, (2016)
3. HIL System catalogues; Opal-RT, RTDS and Typhoon (2017)

Reference Books

1. Ehsani, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Third Edition, CRC Press, (2018).
2. N. Hatziargyriou, Microgrids: Architectures and Control, Wiley-IEEE Press, January (2014).

Evaluation Scheme

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

<**UMA601**> : <**Mathematics of Signal Processing** >				
	L	T	P	Cr
	2	1	2	3.5

Course Objective: To explain the concepts of Fourier analysis, digital signal processing, stability analysis of digital system, and to design digital filters.

Syllabus:

Introduction: Signals and Systems, Classification of signals, Continuous and discrete time signals and its classifications, Nyquist rate, Sampling theorem, Aliasing, Convolution, Correlation.

Fourier Series and Fourier Transform: Introduction to Fourier Series and Fourier Transform, Dirichlet Conditions, Determination of Fourier Coefficients, Properties of Fourier Transform, Energy density, Power Spectral Density.

Z-Transform: Region of Convergence (ROC), Properties of z-transform, Initial and Final Value theorems, Partial sum, Parseval's Theorem, z-transform of standard sequences, Inverse z-transform, Pole-Zero plot, System function of LTI system, Causality and Stability in terms of z-transform.

DFT and FFT: Discrete Fourier Series, Discrete Fourier Transform and its Properties, Efficient Computation of DFT using FFT algorithms, Linear Filtering Approach to Computation of DFT.

Digital Filter Structure: Describing Equation, Structures for FIR Systems, Structures for IIR Systems, Representation of Structures using Signal Flow Graph.

Design of Digital Filters: Introduction, Difference between analog and digital filters, Types of filters, LTI systems as filters, Design of IIR filters from analog filters, FIR filters design, Least square filter design, Designing digital filter from pole-zero placement, Butterworth filter design using Bilinear transformation, FIR filter design using windows, Design of filters using pole-zero combination, Analysis of coefficient quantization effects in FIR filters, Analysis of round-off errors, Dynamic range scaling, Low sensitivity digital filters, Limit cycles in IIR filters.

Laboratory Work: Convolution and correlation, Solution of difference equations using z-Transform and Fourier tools, FFT and spectrum analysis, design of high pass, low pass, band pass and band stop FIR filter using window method, design of IIR filter using Matched Z Transform (MZT), Bilinear Z Transform (BZT), Pole Zero Placement and Impulse invariant methods.

Course Learning Outcomes (CLO)

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

1. Apply the fundamental concepts of signals and systems
2. Apply transform techniques like Fourier and Z-transform to analyze signals and systems.
3. Implement efficient structures for Digital IIR and FIR filters in signal processing applications.
4. Design and analyze digital filters to meet specific signal processing requirements.

Text Books

1. Proakis, J.G. and Manolakis, D.G., Digital Signal Processing, Prentice Hall of India (1996). 4th edition 2007.

2. Rabiner, C.R. and Gold, B., Theory and Applications of Digital Signal Processing, Prentice Hall of India (2000)

Reference Books

1. Antoniou, A., Digital Filters: Analysis Design and Application, McGraw-Hill Education 2018.
2. Oppenhein, A.V. and Schafer, R.W., Digital Signal Processing, Pearson Education India
3. Helmut, U. and Willibald, W., Protection Techniques in Electrical Engg. Systems, Marcel Dekker Inc. (2001)

Evaluation Scheme

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

<**UEE795**> : <**Capstone Project** >				
UEE795: Semester VI(starts)	L	T	P	Cr
UEE795: SemesterVII (Completion)	0	0	2*	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 Learning Outcomes (CLO)

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.

SEMESTER-VIII

<**UEE 894**> : <**Project Semester**>				
	L	T	P	Cr
	0	0	0	15.0

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 Learning Outcomes (CLO)

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.

<**UEI625**> : <**Analog and Digital Communication** >				
	L	T	P	Cr
	3	1	0	3.5

Course Objective: The main objectives of this course are to acquire knowledge about analog and digital communication systems.

Syllabus:

Introduction: Introduction to communication systems: Modulation, type and need for modulation. Introduction to Analog communication, Introduction to Digital communication

Amplitude and SSB modulation: Theory of amplitude modulation, AM transmission. Basic principle of AM generation, Square law modulation, AM reception, Super heterodyne Receiver, Introduction and advantages of SSB Transmission, Generation of SSB, The Phase Shift Method, Vestigial Side-band Modulation, application of amplitude modulation.

Angle modulation: Theory of frequency modulation and demodulation Narrow band FM, Wide band FM, Phase modulation, Phase modulation obtained from frequency modulation, comparison ofvarious analog communication system (AM-FM-PM).

Analog Pulse Modulation: Introduction, Pulse amplitude modulation (PAM), Pulse Time Modulation (PTM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM)

Digital Pulse Modulation Systems: Pulse code modulation (PCM), Noise in PCM systems, Differential pulse code modulation (DPCM), Adaptive pulse code modulation (ADPCM), Delta modulation (DM), Comparison of PCM, DPCM and DM, Adaptive delta modulation.

Digital Modulation Techniques: Amplitude shift keying, frequency shift keying, phase shift keying. Quadrature amplitude modulation, Bandwidth efficiency, comparison of various communication techniques (ASK, FSK, PSK,QAM)

Course Learning Outcomes (CLO)

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

1. Illustrate the knowledge of Amplitude and SSB modulation
2. Interpret the knowledge of angle modulation
3 Formulate the mathematical representation of various analog and digital pulse modulation schemes
4. Evaluate ASK, FSK, PSK AND QAM in communication system

Text Books

1. Lathi.B.P., Modern Digital and Analog Communications Systems 3rd ed.

Reference Books

1.Taub, H., Principles of Communication Systems, McGraw-Hill (2008) 3rd ed.
2.Haykin, S., Communication Systems, John Willey (2009) 4th ed.
3.Proakis, J. G. and Salehi, M., Fundamentals of Communication Systems,Dorling Kindersley (2008) 2nd ed.
4.Kennedy, G., Electronic Communication Systems, McGraw-Hill (2008) 4th ed.

Evaluation Scheme

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

Approved in 109th meeting of the Senate held on March 16,2023. Revised in 112th and 114th meeting of the Senate held on March 11,2023 and March 7,2025, respectively.

<UEE522> : <Energy Auditing and Management >				
	L	T	P	Cr
	3	1	0	3.5

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

Syllabus:

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 Learning Outcomes (CLO)

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

1.Analyse energy scenario nationwide and worldwide

2. Examine energy management in more effective way.

3.Analyse various energy related aspect of electrical system.

4. Implement financial management for energy auditing

5. Investigate 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 Books

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

Evaluation Scheme

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

Approved in 109th meeting of the Senate held on March 16,2023. Revised in 112th and 114th meeting of the Senate held on March 11,2023 and March 7,2025, respectively.

Elective I

<**UEE514**> : <**Introduction to Database Management System** >				
	L	T	P	Cr
	2	0	2	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 Learning Outcomes (CLO)

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.

Reference Books

1.Bayross I., SQL, PL/SQL the Programming Language of Oracle, BPB Publications (2009) 4th ed.

2.Hoffer J., Venkataraman, R. and Topi, H., Modern Database Management, Pearson (2016) 12th ed

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** >				
	L	T	P	Cr
	2	0	2	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 Learning Outcomes (CLO)

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.

Evaluation Scheme

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

<**UEE527**> : <**Restructured Power Systems** >				
	L	T	P	Cr
	3	0	0	3.0

Course Objective:

1.To understand different types and mechanisms of electricity markets.
2.To understand reform practices in developing countries with special focus on Indian power system.
3.Understanding impact of restructuring on power system operation
4.To learn about un-integrated and bundled power systems
5.To explore appropriate strategies to ensure secure and reliable functioning of restructured power systems

Syllabus:

Introduction to restructuring of power industry: Introduction, Reasons for restructuring / deregulation of power industry, Understanding the restructuring process and unbundled structure – entities involved, the levels of competition, the market place mechanisms, sector-wise major changes required, Issues involved in deregulation for sustainable development.

Fundamentals of Economics: Consumer behaviour–(a) Total utility and marginal utility (b) Law of diminishing marginal utility (c) Consumer surplus (d) Consumer equilibrium (e) Market demand curve (f) Demand elasticity; **Supplier behaviour** – (a) Law of diminishing marginal product (b) Supply functions (c) Supplier equilibrium(d) Supplier surplus (e) Supplier elasticity; Market equilibrium: (a) Global welfare (b). Deadweight loss; Short-run and Long-run costs; Various costs of production: Total cost (TC), Average fixed cost (AFC), Average variable cost (AVC), Average cost (AC), Marginal cost (MC);

The Philosophy of Market Models: Market models based on contractual arrangements– Monopoly model, Single buyer model, Wholesale competition model, Retail competition model; Comparison of various market models; Electricity vis-à-vis other commodities – Distinguishing features of electricity as a commodity, Four pillars of market design Services; Market architecture - Timeline for various energy markets, Bilateral / forward contracts, the spot market – (i) Discriminatory or non- discriminatory pricing, (ii) Simple bids or complex bids, (iii) Day-ahead and real-time market;

Transmission Congestion Management: Definition of congestion; Reasons for transfer capability limitation; Importance of congestion management in deregulated environment; Effects of congestion, Desired features of congestion management schemes; Classification of congestion management methods - Basis for classification, Market methods and associated terms: ATC, TTC, TRM, CBM.

Locational Marginal Prices (LMP) and Financial Transmission Rights (FTR): Market clearing price - impact of demand elasticity and price CAP, Fundamentals of locational marginal pricing, Introduction to Financial Transmission Rights,

Ancillary Service Management: Introduction, Types of ancillary services, Classification, Load- generation balancing related services: Frequency regulation, Load following, Spinning reserve services; Voltage control and reactive power support services, Different sources of reactive power, Comparison between different sources of reactive power, Issues in reactive power management, Black start capability service.

Market power and generators bidding: Attributes of a perfectly competitive market,

Imperfect competition: Monopoly, Oligopoly, Cournot model, Bertrand model; Electricity markets under imperfect competition; Market power: Sources of market power, Effect of market power, Identifying market power: HHI Index, Entropy coefficient, Lerner index; Market power mitigation, Role of demand side bidding, Introduction to optimal bidding by a generator company.

Reforms in Indian power sector: Framework of Indian power sector, Historical Developments, The availability based tariff (ABT) and its mechanism, The Electricity Act 2003, Open Access issues - Operational Practices, Power exchanges in India and their operation, Reforms in near future for sustainable development.

Course Learning Outcomes (CLO)

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

1. Develop the concept of power system restructuring and integrated generation for sustainable energy.
2. Conceptualize the impact of bidding and pricing in competitive electricity markets for smart cities settings..
3. Demonstrate the different electricity market mechanisms for promotion of clean energy sources.
4. Analyze market power and reform for energy requirements.
5. Evaluate the marginal prices, transmission rights and ancillary services in deregulated environment

Text Books

1.Fundamentals of Power System economics Daniel Kirschen and Goran Strbac, John Wiley & Sons Ltd, 2004.

2.Operation of market oriented power systems Y.H. Song and Xi-Fan Wang, Springer,2003.

Reference Books

1.Making competition work in electricity Sally Hunt, John Wiley & Sons, Inc.,2002.

2.Operation of restructured power systems Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Bollen, Kluwer Academic Pub.,2001.

3.Power System Restructuring and Deregulation: TradingPerformanceand Information Technology, Lai, L.L., John Wiley and Sons,2001.

Evaluation Scheme

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

<**UEE406**> : <**Power System Practices** >				
	L	T	P	Cr
	3	0	0	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 Learning Outcomes (CLO)

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).

Evaluation Scheme

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

Approved in 109th meeting of the Senate held on March 16,2023. Revised in 112th and 114th meeting of the Senate held on March 11,2023 and March 7,2025, respectively.

<**UEE528**> : <**Power Quality Monitoring and Conditioning**>				
	L	T	P	Cr
	3	0	0	3.0

Course objective: To understand the aspects of power quality in distribution system and various indices to estimate the power quality. To get familiarize with power conditioning standards.

Syllabus:

Overview and Definition of Power Quality (PQ): Sources of pollution and regulations, Power quality problems, Rapid voltage fluctuations voltage unbalance, Voltage dips and voltage swells, Short duration outages, Long duration disturbances, Need of PQ , PQ problems.

Definitions Voltage Sag/Swell Analysis and Mitigation: Sag caused by motor starting, Sag caused by utility fault clearing, Sag mitigation, Sag magnitude and duration calculations, RMS voltage, Calculation in 1-phase systems, Equipment performance in presence of sag: Computers, AC and DC drives, Causes and Effects of Voltage Swell, Swell mitigation.

Harmonics: Effects-within the power system, Interference with communication harmonic measurements, Harmonic elimination.

Harmonic distortion: Power Overview system harmonics, Harmonic analysis, Harmonic sources-the static converters, Transformer magnetization and nonlinearities, Rotating machines, Arc furnaces, Fluorescent lighting, Induction furnance, Total harmonic distortion, RMS and average value calculations, Effects of harmonic distortion, THD Vs DIN.

Principles for controlling harmonics: Locating sources of harmonics, Passive and active filters, Harmonic filter design.

Monitoring power quality: Monitoring essentials, Power quality measuring equipment, Current industry trends.

Power Conditioning: Electric power conditioning, Active and passive filters IEEE, IEC, ANSI standards for various PQ parameters, Power acceptability curves, CBEMA and ITIC standards.

Course Learning Outcomes (CLO)

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

1. Reliably identify the sources of various power quality problems.
2. Analyse the causes of harmonic and its distortion effect.
3. Estimate the impact of various power quality problems on appliances.
4. Elucidate the harmful effects of poor power quality and harmonics.
5. Decide the compensators and filters to keep the power quality indices within the standards.

Text Books

1.Kennedy, B., Power Quality Primer, McGrawHill(2000).
2.Beaty, H. and Santoso,S., Electrical Power System Quality, McGrawHill(2002).

Reference Books

1.Bollen, M.H.J., Power Quality Problems: Voltage Sag and Interruptions, IEEE Press(2007).

Evaluation Scheme

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

Approved in 109th meeting of the Senate held on March 16,2023. Revised in 112th and 114th meeting of the Senate held on March 11,2023 and March 7,2025, respectively.

<**UEE516**> : <**Electromagnetic Fields and Waves** >				
	L	T	P	Cr
	2	2	0	3.0

Course Objective: This course introduces the fundamental concepts of electromagnetic fields and waves, exploring their physical principles, mathematical formulations, and practical applications. The course lays the foundation for advanced studies in electrical engineering, communication systems, and sustainable technologies.

Syllabus:

Basics of Electromagnetic Fields

Vector Analysis: Basics of vector algebra, coordinate systems (Cartesian, cylindrical, spherical), vector calculus (gradient, divergence, curl, and Laplacian). Electrostatics: Coulomb's law, electric field intensity, electric flux density, Gauss's law, and its applications. Potential and Energy: Electric potential, Poisson's and Laplace's equations, energy stored in an electrostatic field. Conductors and Dielectrics: Boundary conditions, capacitance, and polarization.

Magnetostatics

Magnetic Fields: Biot-Savart law, Ampere's law, magnetic flux density, and vector potential.
Magnetic Materials: Magnetization, magnetic boundary conditions, inductance, and energy stored in magnetic fields. Applications: Magnetic circuits and principles of electromagnetic actuators.

Electromagnetic Waves

Maxwell's Equations: Differential and integral forms, physical interpretation, and boundary conditions. Wave Propagation in Free Space: Plane waves, polarization, wave equation, and Poynting vector. Wave Propagation in Media: Dielectric, conductor, and lossy media; reflection and transmission at boundaries. Applications: Concepts of antennas, waveguides, and radiation fundamentals.

Time Varying Fields and Maxwell's Equations : Continuity of charge, Concept of displacement current, Maxwell's equation in integral and differential form: For static fields, For time varying fields, For free space, For good conductors, For harmonically varying fields, Poynting theorem, Energy stored and radiated power, Complex poynting vector, Properties of conductor and dielectrics, Wave equations for free space, Wave equations for conductors.

Uniform Plane Waves: Introduction, Uniform plane wave propagation: Wave equations, Transverse nature of uniform plane waves, Perpendicular relation between E and H , EM waves in charge free, Current free dielectric, Reflection by ideal conductor: Normal incidence ,reflection and transmission with normal incidence at another dielectric, Plane wave in lossy dielectric, Wave impedance and propagation constant, Depth of penetration, Surface impedance and surface resistance, Transmission lines-analogy with TEM waves, Application of EM propagation through Transmission Lines, Smith chart applications, Wave characteristics on an infinite and finite transmission lines, Rectangular Waveguides, TE and TM waves in rectangular waveguide, mode cut off frequencies and dominant mode, wave impedances.

Course Learning Outcomes (CLO)

After completion of the course, the students will be able to:
1. Analyse electric and magnetic fields in different coordinates for various charge and current configurations
2.Exhibit the concept of time varying fields and Maxwell's equations
3. Interpret different aspects of plane wave in dielectric and conducting media
4.-Relate the analogy of wave with transmission line and waveguides

Text Books

1.Hayt, W.H., Engineering Electromagnetics, Tata McGraw−Hill(2008).

2.Kraus, J.D., Electromagnetics, McGraw−Hill(2006).

3.Sadiku, M.N.O, Elements of Electromagnetics, Oxford University Press(2009).

Reference Books

1.Jordan, E.C. and Balmain K.G., Electromagnetic Waves and Radiating Systems, Prentice Hall of India (2008).

2.Paramanik, A, Electromagnetism: Theory and Applications, Prentice−Hall of India(2006).

Evaluation Scheme

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

Elective II

<**UEE615 Data Mining and Visualization** >				
	L	T	P	Cr
	2	0	2	3.0

Course Objective: What is data mining, data mining objectives, data mining process, input-output data knowledge representation and applications, standard data repositories.

Syllabus:

Overview: What is data mining, data mining objectives, data mining process, input-output data knowledge representation and applications, standard data repositories.

Data Pre-processing: Data cleaning, Data transformation, Data reduction, Discretization and generating concept hierarchies, Multidimensional data model

Data Analysis and Classification: Attribute generalization and class comparison, Statistical measures, mining through association rules, pattern mining methods, mining diverse frequent patterns, pattern evaluation, sequential pattern mining, graph pattern mining, constraint-based mining and pattern discovery, text mining examples.

Data Clustering: Issues in clustering, Partitioning methods: k-means, expectation maximization (EM), Hierarchical distance-based agglomerative and divisible clustering,

Data Visualization: Data visualization library and tools, 1D, 2D and 3D charts, Regression plot, Histogram plot, Box and Violin plots, Kernel density estimate plot, Heat maps and clustered matrix, Tree maps;

Visualizing large data: Decision Tree Analysis.

Course Learning Outcomes (CLO)

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

1. Apply basic concepts and techniques of Data Mining.
2. Develop skills of using data mining libraries for solving practical problems.
3. Interpret knowledge by doing hands on session
4. Test for different data traits

Text Books

1. Ian H. Witten and Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques (Second Edition), Morgan Kaufmann, 2005, ISBN: 0-12-088407-0.
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, "Probability & Statistics for Engineers & Scientists", (9th Edn.), Prentice Hall Inc.
3. Trevor Hastie Robert Tibshirani Jerome Friedman, "The Elements of Statistical Learning, Data Mining, Inference, and Prediction", (2nd Edn.), Springer, 2014.

Reference Books

1.1G James, D. Witten, T Hastie, and R. Tibshirani, "An Introduction to Statistical Learning: with Applications in R", Springer, 2013

2.John M. Chambers, "Software for Data Analysis: Programming with R" (Statistics and Computing), Springer

3.Rahlf, Thomas, "Data Visualisation with R", Springer, 2019.

Evaluation Scheme

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

Approved in 109th meeting of the Senate held on March 16,2023. Revised in 112th and 114th meeting of the Senate held on March 11,2023 and March 7,2025, respectively.

<**UEE638**> : <**PLC and SCADA** >				
	L	T	P	Cr
	2	0	2	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 Learning Outcomes (CLO)

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.

Approved in 109th meeting of the Senate held on March 16,2023. Revised in 112th and 114th meeting of the Senate held on March 11,2023 and March 7,2025, respectively.

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.

Evaluation Scheme

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

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<**UEE636**> : <**Smart Grid Systems** >				
	L	T	P	Cr
	2	0	2	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 Learning Outcomes (CLO)

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.*

Approved in 109th meeting of the Senate held on March 16,2023. Revised in 112th and 114th meeting of the Senate held on March 11,2023 and March 7,2025, respectively.

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.*

Evaluation Scheme

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

Approved in 109th meeting of the Senate held on March 16,2023. Revised in 112th and 114th meeting of the Senate held on March 11,2023 and March 7,2025, respectively.

<**UEE721**> : <**Nonlinear and Digital Control Systems** >				
	L	T	P	Cr
	3	0	0	3.0

Course Objective: To learn the methods for analyzing the behavior of nonlinear control systems and the design of control systems.

Syllabus:

Nonlinear control systems: Introduction to Nonlinear System and their properties, behavior of nonlinear system, classification of nonlinearities, common physical nonlinearities: saturation, friction, backlash, dead -zone, relay, on-off nonlinearity, nonlinear spring, concept of limit cycle, jump resonance, phase-plane method, singular points, stability of nonlinear system, construction of phase trajectories, describing functions approach, stability analysis by describing function method, Lyapunov's stability analysis, Lyapunov's stability criterion, direct method of Lyapunov and the linear systems, method of construction of Lyapunov functions for nonlinear systems.

Z-plane analysis of discrete-time control systems: Introduction, Impulse sampling and data hold, Reconstructing original signal from sampled signals, concept of pulse transfer function, Realization of digital controllers.

Design of discrete-time control systems: Introduction, Stability analysis of closed-loop systems in the z-plane, Transient and steady state response analysis, Design based on the root-locus method, Design based on the frequency-response method.

State-space analysis: Introduction, State-space representations of discrete-time systems, Solving discrete-time state-space equations, Pulse transfer function matrix, Discretization of continuous time state space equations, Lyapunov stability analysis, Controllability and Observability, Design via pole placement, State observer design.

Course Learning Outcomes (CLO)

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

1. Demonstrate non-linear system behaviour by phase plane and describing function methods.
2. Perform the stability analysis nonlinear systems by Lyapunov method
3. Formulate discrete-time mathematical models in both time domain (difference equations, state equations) and z-domain (transfer function using z-transform).
4. Predict and analyse transient and steady-state responses and stability linear, time-invariant, discrete-time control systems.

Text Books

1. Bandyopadhyay, M.N., Control Engineering: Theory and Practice, Prentice-Hall of India Private Limited (2003).
2. Khalil,H.K.,&Grizzle,J.W.*Nonlinearsystems*(Vol.3).UpperSaddleRiver,NJ:Prentice hall(2002).
3. Ku, B. C. *Digital control systems*. HRW (1980).

Reference Books

1. Slotine & Li, Applied Non-Linear Control, Englewood Cliffs, NJ: Prentice-Hall,(1991).
2. Ogata, K., Discrete-time Control Systems, Pearson Education(2005).

Evaluation Scheme

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

Approved in 109th meeting of the Senate held on March 16,2023. Revised in 112th and 114th meeting of the Senate held on March 11,2023 and March 7,2025, respectively.

<UEE637> : <High Voltage Transmission Systems>				
	L	T	P	Cr
	3	0	0	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 Learning Outcomes (CLO)

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).*

Reference Books

1. *Arrillaga, J. and Smith, B.C., AC to DC Power System Analysis, IEE Press (2008)*

Evaluation Scheme

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

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<**UEE614**> : <**Introduction to Operating Systems** >				
	L	T	P	Cr
	2	0	2	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 Learning Outcomes (CLO)

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).*

Evaluation Scheme

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

Elective III

<**UEE741**> : <**Stochastic Modeling of Electrical Systems** >				
	L	T	P	Cr
	3	0	0	3.0

Course Objective: The purpose is to understand the stochastic process and reliability concepts and their applications to power system problems such as power flow, expansion planning and protection etc.

Syllabus:

Introduction: Probability concepts, Permutations and Combinations, Rules for combining probabilities, probability distributions, Application of Binomial, Poisson, Normal, Exponential, Weibull,Gamma, Rayleigh, Log normal, Uniform distributions, Capacity outage probability tables.

Markov Chain and Monte Carlo Simulation: Discrete Markov chain, General modelling concept, transitional probability matrix, Absorbing states, Continuous Markov process, State-space diagrams, Concept of simulation, Random variates, Markov processes, Markov chain Monte Carlo simulations.

Stochastic Processes: Random process basics, probability distribution and cumulative distribution functions, Mean and correlation functions, Stationary processes, Gaussian random processes and applications.

Network modelling and System Reliability: Series system, Parallel systems, Series-parallel systems, Partial and standby redundant systems, Reliability of non-repairable components, Survivor function, Mean time to failure, Mean residual life, Guarantee period, Hazard functions and Bath-tub curve.

Reliability in Power Systems: IEEE 1366 standard, IEEE reliability indices(SAIDI, SAIFI, CAIFI, MAIDI,MAIFI), Momentary and sustained interrupts, Reliability criterion in generation expansion planning, Deterministic reliability indices(reserve, margin and largest unit), Probability reliability indices(LOLP,LOLE)

Course Learning Outcomes (CLO)

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

1.Apply probability distributions for power outages.

2. Apply Markov chain Monte Carlo simulations for electrical systems.

3.Evaluate the reliability of non-repairable electrical systems and interrupts.

4.Analyze the expected power in random processes.

5. Asses the power generation as per LOLP/LOLE

Text Books

1.Anders, George J (1990). Probability concepts in electric power systems. Wiley, NewYork

2.R.L. Sullivan “Power System Planning”, Tata McGraw Hill Publishing Company Ltd.

3.Roy Billinton & Ronald N. Allan “Reliability Evaluation of Power System”,Springer.

Reference Books

1.Rohatgi, V. K., & Saleh, A. M. E. *An introduction to probability and statistics*. John Wiley & Sons,(2015).

2.Ross, S. M. *Introduction to probability and statistics for engineers and scientists*. Academic Press,(2014).

Evaluation Scheme

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

<**UEE742**> : <**Digital Controllers for Power Applications** >				
	L	T	P	Cr
	2	0	2	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 Learning Outcomes (CLO)

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.Decide a typical 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. Bovet P. D., Cesati M., Understanding the Linux Kernel, O'Reilly Media (2006), 3rd ed.
2. Kifer M., Smolka A. S., Introduction to Operating System Design and Implementation: The OSP 2 Approach, Springer (2007).

Evaluation Scheme

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

Approved in 109th meeting of the Senate held on March 16,2023. Revised in 112th and 114th meeting of the Senate held on March 11,2023 and March 7,2025, respectively.

<**UEE743**> : <**Cloud Computing Based Electrical Systems** >				
	L	T	P	Cr
	3	0	0	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 Learning Outcomes (CLO)

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 clouds.

3.Contrast 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. GerardBlokdijk,IvankaMenken,TheCompleteCornerstoneGuidetoCloudComputingBestPractices, EmereoPvt Ltd, Second Edition,2009.

Reference Books

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

Evaluation Scheme

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

Approved in 109th meeting of the Senate held on March 16,2023. Revised in 112th and 114th meeting of the Senate held on March 11,2023 and March 7,2025, respectively.

<**UEE744**> : <**Industrial Electronics** >				
	L	T	P	Cr
	2	0	2	3.0

Course Objective: Familiarize the students with the concept of electric traction system, illumination, electric heating principles, power factor control, and DC motor control.

Syllabus:

Conventional DC and AC Traction: Electric traction services, Nature of traction load, Coefficient of adhesion, Load sharing between traction motors, Main line and suburban train configurations, Calculation of traction drive rating and energy consumption. Important features of traction drives, Conventional DC and AC traction drives, Diesel electric traction.

Static converters for Traction: Semi-conductor converter controlled drive for ac traction, Semiconductor chopper controlled dc traction.

Illumination: Nature of light, Basic laws of illumination, Light sources and their characteristics, Light production by excitation and ionization, Incandescence and fluorescence, Different types of lamps, Their construction, Operation and characteristics, Applications, Latest light sources, Design of illumination systems.

Electric Heating: Introduction to electric heating, Advantages of electric heating, Resistance heating, Temperature control of furnaces, Induction and dielectric heating.

Power Supplies: Performance parameters of power supplies, Comparison of rectifier circuits, Filters, Regulated power supplies, Switching regulators, Switch mode converter.

Power factor Control: Static reactive power compensation, Shunt reactive power compensator, Application of static SCR controlled shunt compensators for load compensation, Power factor improvement and harmonic control of converter fed systems, Methods employing natural and forced commutation schemes, Methods of implementation of forced commutation.

Motor Control: Voltage control at constant frequency, PWM control, Synchronous tap changer, Phase control of DC motor, Servomechanism, PLL control of a DC motor.

Laboratory Work: Semi-conductor converter controlled drive for AC and DC traction, regulated power supplies, switching regulators, switch mode converter, power factor and motor control.

Course Learning Outcomes (CLO)

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

1. Outline the basics of Steam, Diesel and Electric traction
2. Analyse the semiconductor controlled ac and DC drive system
3. Design and develop an illumination system for domestic, industry and commercial sites.
4. Interpret the principle of electric heating for industrial applications.
   Build the skill to design and develop a regulated power supply.
5. Simulate and analyse the series and shunt compensators for power factor improvement in drive system.

Approved in 109th meeting of the Senate held on March 16,2023. Revised in 112th and 114th meeting of the Senate held on March 11,2023 and March 7,2025, respectively.

Text Books

1. *Dubey, G.K., Power Semiconductor Controlled Drives, Prentice Hall inc.(1989).*
2. *Paul, B., Industrial Electronic and Control, Prentice Hall of India Private Limited(2004).*

Reference Books

1.J.M.D. Murphy, F.G. Turnbull, Power Electronic Control of Ac Motors, Pergamon(1990).

2.Sen, P.C., Thyristor DC Drives, John Wiley and Sons(1981).

Evaluation Scheme

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

Approved in 109th meeting of the Senate held on March 16,2023. Revised in 112th and 114th meeting of the Senate held on March 11,2023 and March 7,2025, respectively.

<**UEE709**> : <**Flexible AC Transmission System Devices**>				
	L	T	P	Cr
	3	0	0	3.0

Course Objective: To review the concept of power system control, operational aspects of various FACTS compensators and their usage for power flow and stability improvement**.**

Syllabus:

Power Transmission control: Fundamentals of ac power transmission, Transmission problems and needs, Overview of stability, The emergence of FACTS, FACTS controller and consideration.

Static power convertor: Review of Power Electronics fundamentals: Static power convertor structures, AC controller-based structure, DC link convertor topologies, Convertor output and harmonic control.

Shunt Compensation: Shunt SVC principles, Configuration and control, STATCOM, Configuration applications

Series Compensation: Fundamental of series compensation, Principle of operation, Application of TCSC for different problems of power system, TCSC lay out, SSSC principle of operation.

Phase Shifter: Principle of operation, Steady state model of static phase shifter, Operating characteristics of SPS, Power current configuration of SPS application

Unified Power Flow Controllers: Basic operating principles and characteristics, Control UPFC installation applications, UPFC model for power flow studies.

Course Learning Outcomes (CLO)

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

1. Evaluate the performance of converters based on filtering of harmonics on AC and DC side.
2. Analyse power system behaviour with different shunt compensators.
3. Appraise series compensated power system behaviour with different series compensators.
4. Analyse system behaviour with hybrid shunt-series compensators.

Text Books

1.Hingorani, N.G. and Gyragyi,L., Understanding FACTS :Concepts and Technology of Flexible AC Transmission System, Standard Publishers and Distributors(2005).
2.Sang, Y.H. and John, A.T., Flexible AC Transmission Systems, IEEE Press(2006).
3.Ghosh,A. and Ledwich,G., Power Quality Enhancement Using Custom Power Devices, Kluwer Academic Publishers(2005).

Reference Books

1.Mathur, R.M. and Verma, R.K., Thyristor Based FACTS Controllers for Electrical Transmission Systems, IEEE Press(2002).

Approved in 109th meeting of the Senate held on March 16,2023. Revised in 112th and 114th meeting of the Senate held on March 11,2023 and March 7,2025, respectively.

Evaluation Scheme

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

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