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

COURSE SCHEME

&

SYLLABI

for

B.E.

ELECTRICAL
ENGINEERING

2019

Nature of Course	CODE
Core-Foundation Courses	**CF**
Core-Professional Courses	**CP**
Project Based Courses	**PR**
Professional Electives	**PE**
Generic Electives	**GE**

SEMESTER-I

S No	Course No	Course Title	Code	L	T	P	Cr.
1	UPH004	APPLIED PHYSICS	CF	3	1	2	4.5
2	UMA010	MATHEMATICS-I	CF	3	1	0	3.5
3	UTA017	COMPUTER PROGRAMMING	CF	3	0	2	4.0
4	UEC001	ELECTRONIC ENGINEERING	CF	3	1	2	4.5
5	UTA015	ENGINEERING DRAWING	CF	2	4	0	4.0
6	UHU003	PROFESSIONAL COMMUNICATION	CF	2	0	2	3.0
		TOTAL		**16**	**7**	**8**	**23.5**

SEMESTER-II

S No	Course No	Course Title	Code	L	T	P	Cr.
1	UCB008	APPLIED CHEMISTRY	CF	3	1	2	4.5
2	UEE001	ELECTRICAL ENGINEERING	CF	3	1	2	4.5
3	UEN002	ENERGY AND ENVIRONMENT	CF	3	0	0	3.0
4	UMA004	MATHEMATICS-II	CF	3	1	0	3.5
5	UES009	MECHANICS	CF	2	1	2*	2.5
6	UTA018	OBJECT ORIENTED PROGRAMMING	CF	3	0	2	4.0
7	UTA013	ENGINEERING DESIGN PROJECT-I	PR	1	0	2	4.0
		TOTAL		**18**	**4**	**8**	**26.0**

SEMESTER-III

S No	Course No	Course Title	Code	L	T	P	Cr.
1	UES012	ENGINEERING MATERIALS	CF	3	1	2	4.5
2	UMA033	NUMERICAL AND STATISTICAL METHODS	CF	3	0	2	4.0
3	UTA012	INNOVATION ANDENTREPRENEURSHIP	CF	1	0	2*	3.0
4	UEE505	ANALOG AND DIGITAL SYSTEMS	CP	3	1	2	4.5
5	UEE	ELECTRO-MECHANICAL ENERGY CONVERSION	CP	3	1	2	4.5
6	UTA014	ENGINEERING DESIGN PROJECT-II	PR	1	0	4	4.0
		TOTAL		**14**	**3**	**14**	**24.5**

*   ALTERNATE WEEK

SEMESTER-IV

S No	Course No	Course Title	Code	L	T	P	Cr.
1	UEE401	ALTERNATING CURRENT MACHINES	CP	3	1	2	4.5
2	UEE	TRANSMISSION AND DISTRIBUTION OF ELECTRIC POWER	CP	3	1	0	3.5
3	UMA033	OPTIMIZATION TECHNIQUES	CF	3	0	2	4.0
4	UEE	NETWORK THEORY	CP	3	1	2	4.5
5	UEI610	FUNDAMENTALS OF MICROPROCESSORS AND MICROCONTROLLERS	CP	3	0	2	4.0
6		ELECTIVE-I	PE	3	1	0	3.5
7	UHU005	HUMANITIES FOR ENGINEERS	CF	2	0	2	3.0
		TOTAL		**20**	**4**	**10**	**27.0**

SEMESTER-V

S No	Course No	Course Title	Code	L	T	P	Cr.
1	UEE	LINEAR CONTROL SYSTEMS	CP	3	1	2	4.5
2	UTA002	MANUFACTURING PROCESSES	CF	2	0	3	3.5
3	UEE	POWER SYSTEM ANALYSIS	CP	3	1	2	4.5
4	UEE502	HIGH VOLTAGE ENGINEERING	CP	3	0	2	3.0
5	UEE504	POWER ELECTRONICS	CP	3	1	2	4.5
6		ELECTIVE-II	PE	2	0	2	3.0
		TOTAL		**16**	**3**	**13**	**23.0**

SEMESTER-VI

S No	Course No	Course Title	Code	L	T	P	Cr.
1	UCS409	DATA STRUCTURES AND ALGORITHMS	CP	3	0	2	3.0
2	UEE	INDUSTRIAL DRIVES	CP	3	1	2	4.5
3	UEE	POWER SYSTEM PROTECTION	CP	3	0	2	4.0
4	UEE	PRINCIPLES OF DIGITAL SIGNAL PROCESSING	CP	3	0	2	4.0
5	UEE	MACHINE LEARNING TECHNIQUES	CP	3	0	2	4.0
6		ELECTIVE-III	PE	2	0	2	3.0
7	UEE793	CAPSTONE PROJECT (START)	PR	1*	0	2	0.0
		TOTAL		**18**	**1**	**14**	**22.5**

*ALTERNATE WEEK

SEMESTER-VII

S No	Course No	Course Title	Code	L	T	P	Cr.
1	UEE	ELECTRIC VEHICLE AND SUSTAINABLE ENERGY SYSTEMS	CP	2	0	2	3.0
2	UEE	REAL TIME POWER SYSTEMS	CP	2	0	2	3.0
3	UEE604	FLEXIBLE AC TRANSMISSION SYSTEMS	CP	3	0	0	3.0
4		ELECTIVE-IV	PE	2	0	2	3.0
5		GENERIC ELECTIVE	GE	3	0	0	3.0
6	UEE793	CAPSTONE PROJECT (COMPLETION)	PR	1*	0	2	8.0
		TOTAL		13	0	8	23.0

*ALTERNATE WEEK

SEMESTER-VIII

S No	Course No	Course Title	Code	L	T	P	Cr.
1	UEE891	PROJECT	PR	-	-	-	**15.0**
		OR					
1	UEE632	POWER GENERATION AND ECONOMICS	CP	3	1	0	3.5
2	UEE522	ENERGY AUDITING AND MANAGEMENT	CP	3	1	0	3.5
3	UEE892	DESIGN PROJECT	PR	-	-	-	8.0
		TOTAL		6	2	0	15.0
		OR					
1	UEE893	START- UP SEMESTER	PR	-	-	-	**15.0**

BASKETS OF SPECIALIZATION

DATA ANALYTICS	REAL TIME SYSTEMS	SMART ELECTRICAL NETWORKS	POSITION
DATA ANALYTICAL METHODS	EMBEDDED SYSTEM DESIGN	RESTRUCTURED POWER SYSTEMS	**ELECTIVE-II**
DATA MINING AND VISUALISATION	ENERGY MANAGEMENT SYSTEMS AND SCADA	SMART GRID SYSTEMS	**ELECTIVE-III**
STOCHASTIC MODELING OF ELECTRICAL	DIGITAL CONTROLLERS FOR POWER	CLOUD COMPUTING BASED ELECTRICAL SYSTEMS	**ELECTIVE-IV**

SYSTEMS	APPLICATIONS		

ELECTIVE-I

S No	Course No	Course Title	Code	L	T	P	Cr.
1	UEE305	ELECTROMAGNETIC FIELDS AND WAVES	PE	3	1	0	3.5
2	UEE	MEASUREMENT AND TRANSDUCERS	PE	2	1	2	3.5
3	UEI	ANALOG AND DIGITAL COMMUNICATION	PE	3	1	0	3.5

ELECTIVE-II

S No	Course No	Course Title	Code	L	T	P	Cr.
1	UEE	DATA ANALYTICAL METHODS	PE	3	0	0	3.0
2	UEE	EMBEDDED SYSTEM DESIGN	PE	2	0	2	3.0
3	UEE	RESTRUCTURED POWER SYSTEMS	PE	3	0	0	3.0
4	UEE406	POWER SYSTEM PRACTICES	PE	3	0	0	3.0
5	UEE524	POWER QUALITY MONITORING AND CONDITIONING	PE	3	0	0	3.0

ELECTIVE-III

S No	Course No	Course Title	Code	L	T	P	Cr.
1	UCS	DATA MINING AND VISUALIZATION	PE	3	0	0	3.0
2	UEE	ENERGY MANAGEMENT SYSTEMS AND SCADA	PE	3	0	0	3.0
3	UEE	SMART GRID SYSTEMS	PE	2	0	2	3.0
4	UEE	NONLINEAR AND DIGITAL CONTROL SYSTEMS	PE	3	0	0	3.0
5	UEE	HIGH VOLTAGE TRANSMISSION SYSTEMS	PE	3	0	0	3.0
6	UCS	COMPUTER NETWORKS	PE	2	0	2	3.0

ELECTIVE-IV

S No	Course	Course Title	Code	L	T	P	Cr.

	No						
1	UEE	STOCHASTIC MODELING OF ELECTRICAL SYSTEMS	PE	3	0	0	3.0
2	UEE	DIGITAL CONTROLLERS FOR POWER APPLICATIONS	PE	2	0	2	3.0
3	UEE	CLOUD COMPUTING BASED ELECTRICAL SYSTEMS	PE	3	0	0	3.0
4	UEE	INDUSTRIAL ELECTRONICS	PE	3	0	0	3.0
5	UCS	DATA BASE MANAGEMENT SYSTEM	PE	2	0	2	3.0

GENERIC ELECTIVE

S.NO.	COURSE NO.	TITLE	Code	L	T	P	CR
1	UHU007	EMPLOYABILITY DEVELOPMENT SKILLS	GE	3	0	0	3.0
2	UHU006	INTRODUCTORY COURSE IN FRENCH	GE	3	0	0	3.0
3	UHU009	INTRODUCTION TO COGNITIVE SCIENCE	GE	3	0	0	3.0
4	UHU008	INTRODUCTION TO CORPORATE FINANCE	GE	3	0	0	3.0
5	UCS001	INTRODUCTION TO CYBER SECURITY	GE	3	0	0	3.0
6	UPH063	NANOSCIENCE AND NANOMATERIALS	GE	3	0	0	3.0
7	UEN004	TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT	GE	3	0	0	3.0
8	UMA066	GRAPH THEORY AND APPLICATIONS	GE	3	0	0	3.0
9	UMA061	ADVANCED NUMERICAL METHODS	GE	3	0	0	3.0
10	UBTXXX	BIOLOGY FOR ENGINEERS	GE	3	0	0	3.0
11		YOGA AND SCIENCE	GE	3	0	0	3.0
12		MASS COMMUNICATION	GE	3	0	0	3.0

Semester	EL Activity**
I	Introduction to Embedded System

II	Smart House Wiring
III	Electric Cycle
IV	DC Motor Winding
V	Design of Protection Relay

**These EL activities can be changed in subsequent years, if required.

TOTAL CREDITS: 184.5

UPH004: APPLIED PHYSICS

L	T	P	Cr
3	1	2	4.5

Course Objectives: 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

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

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

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

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

Course Outcomes:
Upon completion of this course, 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.

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 Hall^{TM} (2008) 3rd ed.

Scheme of evaluation

Event	Weightage
Mid-Sem Test	25
End-Sem Test	45
Tut/Sessional/ Lab + Project/ Quiz	30
Total	100

UMA010-Mathematics - I

L	T	P	Cr
3	1	0	3.5

Course Objectives: 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.

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).

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.

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

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

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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 Chruchill R.V, Complex variables and applications, MacGraw Hill, (7th edition)

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessional (May include assignments/quizzes)	25

UTA017: COMPUTER PROGRAMMING

L   T   P   Cr
3   0   2   4.0

Course objective: This course is designed to explore computing and to show students the art of computer programming. Students will learn some of the design principles for writing good programs.

Computers Fundamentals: Binary Number System, Computer memory, Computer Software.

Algorithms and Programming Languages: Algorithm, Flowcharts, Generation of Programming Languages.

C Language: Structure of C Program, Life Cycle of Program from Source code to Executable, Compiling and Executing C Code, Keywords, Identifiers, Primitive Data types in C, variables, constants, input/output statements in C, operators, type conversion and type casting. Conditional branching statements, iterative statements, nested loops, break and continue statements.

Functions: Declaration, Definition, Call and return, Call by value, Call by reference, showcase stack usage with help of debugger, Scope of variables, Storage classes, Recursive functions, Recursion vs Iteration.

Arrays, Strings and Pointers: One-dimensional, Two-dimensional and Multi-dimensional arrays, operations on array: traversal, insertion, deletion, merging and searching, Inter-function communication via arrays: passing a row, passing the entire array, matrices. Reading, writing and manipulating Strings, understanding computer memory, accessing via pointers, pointers to arrays, dynamic allocation, drawback of pointers.

Structures and Union: Defining a Structure, Declaring a structure variables, Accessing Structure Elements, and Union.

File Handling: Defining andOpening a File, Closing a File, Reading from a File, Writing into a File.

Laboratory work:
To implement Programs for various kinds of programming constructs in C Language.

Course learning outcomes (CLOs):

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. Understanding of the fundamental data types, operators and console I/O functions

as an aspect of programs.
3. Design and create programs involving control flow statements, arrays, strings and implement the concept of dynamics of memory allocations.
4. Evaluate and analyze the programing concepts based on user define data types and file handling using C language.

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

Reference Books:
1. *Kanetkar Y., Let Us C, 16th ed.,2017*

Evaluation scheme

Sr. no.	Evaluation Elements	Weights (%)
1.	MST	25
2.	EST	45
3.	Sessional (May include Assignments/Projects/Tutorials/Quiz/Lab evaluations)	30

UEC001: Electronic Engineering

	L	T	P	Cr
	3	1	2	4.5

Course Objective: To enhance comprehension capabilities of students through understanding of electronic devices, various logic gates, SOP, POS and their minimization techniques, various logic families and information on different IC's and working of combinational circuits and their applications.

Semiconductor Devices: p- n junction diode: Ideal diode, V-I characteristics of diode, Diode small signal model, Diode switching characteristics, Zener diode
Electronics Devices and Circuits: PN Diode as a rectifier, Clipper and clamper, Operation of Bipolar Junction Transistor and Transistor Biasing, CB, CE, CC (Relationship between α, β, γ) circuit configuration Input-output characteristics, Transistor as a switch, as an Amplifier and its frequency Response, Introduction to Field Effect Transistor and its characteristics, N and P channel MOS transistors, CMOS inverter, NAND and NOR gates, General CMOS Logic, TTL and CMOS logic families,

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

Digital Systems and Binary Numbers: Introduction to Digital signals and systems, Number systems, Positive and negative representation of numbers, Binary arithmetic, Definitions and basic theorems of Boolean Algebra, Algebraic simplification, Sum of products and product of sums formulations (SOP and POS), Gate primitives, AND, OR, NOT and Universal Gate, Minimization of logic functions, Karnaugh Maps.

Combinational and Sequential Logic: Code converters, multiplexors, decoders, Addition circuits and priority encoder, Master-slave and edge-triggered flip-flops, Synchronous and Asynchronous counters, Registers, IEEE Representation of Digital ICs.

Laboratory Work:
Familiarization with CRO, DSO and Electronic Components, Diodes characteristics - Input-Output and Switching, BJT and MOSFET Characteristics, Zener diode as voltage regulator, Rectifiers, Clippers and Clampers, adder circuit implementation, Multiplexer & its application, Latches/Flip-flops, up/down counters.

Course learning outcomes (CLO): The student will be able to:
1. Demonstrate the use of semiconductor diodes in various applications.
2. Discuss and explain the working of transistors and operational Amplifiers, their configurations and applications.
3. Recognize and apply the number systems and Boolean algebra.
4. Reduce Boolean expressions and implement them with Logic Gates.
5. Analyze, design and implement combinational and sequential circuits.

Text Books:
1. *Boylestad, R.L. and Nashelsky, L., Electronic Devices & Circuit Theory, Perason (2009).*
2. *M. M. Mano and M.D. Ciletti, Digital Design, Pearson, Prentice Hall, 2013.*

Reference Books:

1. *Milliman, J. and Halkias, C.C., Electronic Devices and Circuits, Tata McGraw Hill, 2007.*
2. *Donald D Givone, Digital Principles and Design, McGraw-Hill, 2003.*
3. *John F Wakerly, Digital Design: Principles and Practices, Pearson, (2000).*
4. *N Storey, Electronics: A Systems Approach, Pearson, Prentice Hall, (2009).*

Evaluation Scheme:

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

UTA015 ENGINEERING DRAWING

	L	T	P	Cr
	2	4	0	4.0

Course Objectives: This module is dedicated to graphics and includes two sections: manual drawing and AutoCAD. This course is aimed at to make the student understand dimensioned projections, learn how to create two-dimensional images of objects using first and third angle orthographic projection as well as isometric, perspective and auxiliary projection, to interpret the meaning and intent of toleranced dimensions and geometric tolerance symbolism and to create and edit drawings using drafting software AutoCAD.

Engineering Drawing

1. Introduction
2. Orthographic Projection: First angle and third angle projection system
3. Isometric Projections
4. Auxiliary Projections
5. Perspective Projections
6. Introduction to Mechanical Drawing
7. Sketching engineering objects
8. Sections, dimensions and tolerances

AutoCAD

1. Management of screen menus commands
2. Introduction to 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

MicroProjects/Assignments:

1. Completing the views-Identification and drawing of missing lines in the projection of objects
2. Missing views – using two views to draw the projection of the object in the third view, primarily restricting to Elevation, Plan and Profile views
3. Projects related to orthographic and isometric projections
   a. Using wax blocks or soap bars to develop three dimensional object from given orthographic projections
   b. Using wax blocks or soap bars to develop three dimensional object, section it and color the section

    c. UseofAUTOCADasacomplementarytoolfordrawingtheprojectionsofthe objectscreatedin(1)and(2).
4. Developthelateralsurfaceofdifferentobjectsinvolvingindividualoracombination ofsolidslikePrism,Cone,Pyramid,Cylinder,Sphereetc.
5. Todrawthedetailedandassemblydrawingsofsimpleengineeringobjects/systems withduesectioning(whereeverrequired)alongwithbillofmaterials.
    e.g.Rivetjoints,simplebearing,woodenjoints,Twoplatesconnectedwithnutand boltetc.

CourseLearningOutcomes(CLO):

Uponcompletionofthismodule,studentswillbeableto:

1. creativelycomprehendgeometricaldetailsofcommonengineeringobjects
2. draw dimensioned orthographic and isometric projections of simple engineering objects
3. drawsectionalviewsofsimpleengineeringobjects.
4. interpret themeaning andintentoftoleranced dimensions andgeometric tolerance symbolism
5. createandeditdimensioneddrawingsofsimpleengineeringobjectsusingAutoCAD
6. organizedrawingobjectsusinglayersandsettingupoftemplatesinAutoCAD

TextBooks:

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

ReferenceBooks:

1. *Gill,P.S.,GeometricalDrawings,S.K.Kataria&Sons,Delhi(2008).*
2. *Gill,P.S.,MachineDrawings,S.K.Kataria&Sons,Delhi(2013).*
3. *Mohan,K.R.,EngineeringGraphics,DhanpatRaiPublishingCompany(P)Ltd,Delhi (2002).*
4.
    French,T.E.,Vierck,C.J.andFoster,R.J.,FundamentalofEngineeringDrawing&Gr aphicsTechnology,McGrawHillBookCompany,NewDelhi(1986).
5. *Rowan, J. and Sidwell , E. H., Graphics for Engineers, Edward Arnold, London (1968).*

EvaluationScheme:

Sr.No.	EvaluationElements	Weightage (%)
1	Midsemestertest(formalwrittentest)	30
2	Endsemestertest(formalwrittentest)	45
3	Sessional: (mayincludethefollowing) Continuousevaluationof drawingassignmentsintutorial/regular practiceof AutoCADtutorialexercises& Individualindependent projectwork/drawingandAutoCADassignment	25

UHU 003: Professional Communication

	L	T	P	Cr
	2	0	2	3.0

Course objective: To introduce the students to effective professional communication. The student will be exposed to effective communication strategies and different modes of communication. The student will be able to analyze his/ her communication behavior and that of the others. By learning and adopting the right strategies, the student will be able to apply effective communication skills, professionally and socially.

Effective communication: Meaning, Barriers,Types of communication and Essentials.Interpersonal Communication skills.

Effective Spoken Communication: Understanding essentials of spoken communication,Public speaking, Discussion Techniques,Presentation strategies.

Effective Professional and Technical writing: Paragraph development, Forms of writing,Abstraction and Summarization of a text;Technicalities of letter writing,internal and external organizational communication.Technical reports and proposals.

Effective non verbal communication: Knowledge and adoption of the right non verbal cues of body language, interpretation of the body language in professional context. Understanding Proxemics and other forms of non verbal communication.

Communicating for Employment: Designing Effective Job Application letter and resumes.

Communication Networks in organizations: Types, barriers and overcoming the barriers.

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

Course learning outcome (CLO):
1. Apply communication concepts for effective interpersonal communication.
2. Select the most appropriate media of communication for a given situation.
3. Speak assertively and effectively.
4. Write objective organizational correspondence.
5. Design effective resumes,reports and proposals .

Text Books:

1. *Lesikar R.V and Flately M.E., Basic Business Communication Skills for the Empowering the Internet Generation. Tata Mc Graw Hill. New Delhi (2006).*
2. *Raman,M & Sharma, S.,Technical Communication Principles and Practice, Oxford University Press New Delhi.(2011).*

3. *Mukherjee H.S.,Business Communication-Connecting at Work,Oxford University Press New Delhi, (2013).*

Reference Books:

1. *Butterfield, Jeff.,Soft Skills for everyone,Cengage Learning New Delhi,(2013).*
2. *Robbins, S.P., & Hunsaker, P.L.,Training in Interpersonal Skills,Prentice Hall of India   New Delhi,(2008).*
3. *DiSianza,J.J & Legge,N.J.,Business and Prfofessional Communication,Pearson Education India New Delhi,(2009).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessionals (Group Discussions; professional presentations;poster presentations ,public speaking;technical reports)	30

APPLIED CHEMISTRY (UCB008)

	L	T	P	Cr
	3	1	2	4.5

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

Electrochemistry: Specific, equivalent and molar conductivity of electrolytic solutions, migration of ions, transference number and its determination by Hittorf's method, conductometric titrations, types of electrodes, concentration cells, liquid junction potential.

Phase Rule: States of matter, phase, component and degree of freedom, Gibb's phase rule, one component and two component systems.

Water Treatment and Analysis: Hardness and alkalinity of water: units and determination, external and internal methods of softening of water: carbonate, phosphate, calgon and colloidal conditioning, lime-soda process, zeolite process, ion exchange process, mixed bed deionizer, desalination of brackish water.

Fuels: Classification of fuels, calorific value, cetane and octane number, fuel quality, comparison of solid liquid and gaseous fuels, properties of fuel, alternative fuels: biofuels, power alcohol, synthetic petrol.

Chemistry of Polymers: Overview of polymers, types of polymerization, molecular weight determination, tacticity of polymers, catalysis in polymerization, conducting, biodegradable and inorganic polymers.

Atomic spectroscopy: Introduction to spectroscopy, atomic absorption spectrophotometry and flame photometry, quantitative methods.

Molecular Spectroscopy: Beer-Lambert`s Law, molecular spectroscopy, principle, instrumentation and applications of UV-Vis and IR spectroscopy.

Laboratory Work

Electrochemical measurements: Experiments involving use of pH meter, conductivity meter, potentiometer.

Acid and Bases: Determination of mixture of bases.

Spectroscopic techniques: Colorimeter, UV-Vis spectrophotometer.

Water and its treatment: Determination of hardness, alkalinity, chloride, chromium, iron and copper in aqueous medium.

Course Learning Outcomes: The students will be able to reflect on:
1. concepts of electrodes in electrochemical cells, migration of ions, liquid junction potential and conductometric titrations.
2. atomic and molecular spectroscopy fundamentals like Beer`s law, flame photometry, atomic absorption spectrophotometry, UV-Vis and IR.
3. water and its treatment methods like lime soda and ion exchange.
4. concept of phase rule, fuel quality parameters and alternative fuels.
5. polymerization, molecular weight determination and applications as biodegradable and conducting polymers.
6. laboratory techniques like pH metry, potentiometry, colourimetry, conductometry and volumetry.

Text Books
1. *Ramesh, S. and Vairam S. Engineering Chemistry, Wiley India (2012) 1ˢᵗed.*
2. *Puri, B.R., Sharma,L.R., and Pathania, M.S. Principles of Physical Chemistry, Vishal Publishing Co. (2008).*
3. *Aggarwal, S. Engineering Chemistry: Fundamentals and Applications, Cambridge University Press (2015).*

Reference Books
1. *Brown, H., Chemistry for Engineering Students, Thompson, 1ˢᵗed*
2. *Sivasankar, B., Engineering Chemistry, Tata McGraw-Hill Pub. Co. Ltd, New Delhi (2008).*
3. *Shulz, M.J. Engineering Chemistry, Cengage Learnings (2007) 1ˢᵗed.*

Evaluation Scheme

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

UEE001: ELECTRICAL ENGINEERING

	L	T	P	Cr.
	3	1	2	4.5

Course Objective: To introduce concepts of DC and AC circuits and electromagnetism. To make the students understand the concepts and working of single-phase transformers, DC motor and generators.

DC Circuits: Kirchhoff's voltage and current laws; power dissipation; Voltage source and current source; Mesh and Nodal analysis; Star-delta transformation; Superposition theorem; Thevenin's theorem; Norton's theorem; Maximum power transfer theorem; Millman's theorem and Reciprocity theorem; Transient response of series RL and RC circuits.

Steady state analysis of DC Circuits: The ideal capacitor, permittivity; the multi-plate capacitor, variable capacitor; capacitor charging and discharging, current-voltage relationship, time-constant, rise-time, fall-time; inductor energisation and de-energisation, inductance current-voltage relationship, time-constant; Transient response of RL, RC and RLC Circuits.

AC Circuits: Sinusoidal sources, RC, RL and RLC circuits, Concept of Phasors, Phasor representation of circuit elements, Complex notation representation, Single phase AC Series and parallel circuits, power dissipation in ac circuits, power factor correction, Resonance in series and parallel circuits, Balanced and unbalanced 3-phase circuit - voltage, current and power relations, 3-phase power measurement, Comparison of single phase and three phase supply systems.

Electromagnetism: Electromagnetic induction, Dot convention, Equivalent inductance, Analysis of Magnetic circuits, AC excitation of magnetic circuit, Iron Losses, Fringing and stacking, applications: solenoids and relays.

Single Phase Transformers: Constructional features of transformer, operating principle and applications, equivalent circuit, phasor analysis and calculation of performance indices.

Motors and Generators: DC motor operating principle, construction, energy transfer, speed-torque relationship, conversion efficiency, applications, DC generator operating principle, reversal of energy transfer, emf and speed relationship, applications.

Laboratory Work: Network laws and theorems, Measurement of R,L,C parameters, A.C. series and parallel circuits, Measurement of power in 3 phase circuits, Reactance calculation of variable reactance choke coil, open circuit and short circuit tests on single phase transformer, Starting of rotating machines.

Course Learning Outcome (CLO):
After the completion of the course the students will be able to:
- Apply networks laws and theorems to solve DC circuits.
- Analyse transient and steady state response of DC circuits.
- Signify AC quantities through phasor and compute single-phase series and parallel AC system behaviour during steady state.
- Elucidate the need of three phase system, calculations and power measurement in three-phase system.
- Analyse the operation of magnetic circuits and performance of single phase transformer.
- Elucidate the principle and characteristics of DC machine.

Text Books:
1. *Hughes, E., Smith, I.M., Hiley, J. and Brown, K., Electrical and Electronic Technology, PHI (2008).*
2. *Nagrath, I.J. and Kothari, D.P., Basic Electrical Engineering, Tata McGraw Hill (2002).*

3. *Naidu, M.S. and Kamashaiah, S., Introduction to Electrical Engineering, Tata McGraw Hill (2007).*

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)*

Evaluation Scheme:

S N	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	45
3	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEN002 Energy and Environment

	L	T	P	Cr
	3	0	0	3.0

Course Objectives:
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 value of regional and global natural and energy resources; and emphasize on need for conservation of energy and environment.

Introduction: Natural Resources & its types, Concept of sustainability andsustainable use of natural resources, Pollution based environmental issues and casestudies

Conventions on Climate Change: Origin of Conference of Parties (COPs), United Nations Framework Convention on Climate Change (UNFCCC) andIntergovernmental Panel on Climate Change (IPCC); Kyoto Protocol, instruments ofprotocol – CDM, JI and IET; Montreal Action Plan; Paris Agreement and post-Parisscenario.

Air Pollution: Origin, Sources and effects of air pollution; Primary and secondarymeteorological parameters; Wind roses; Atmospheric Stability; Inversion; Plumebehavior; Management of air pollution: Source reduction and Air Pollution ControlDevices for particulates and gaseous pollutants in stationary and mobile sources.

Water Pollution: Origin, Sources of water pollution, Category of water pollutants,Physico-Chemical characteristics, Components of wastewater treatment systems,Advanced treatment technologies.

Solid waste management: Introduction to solid waste management, Sources,characteristics of municipal and industrial solid waste, Solid waste managementmethods: Incineration, composting, Biomethanation, landfill, E-waste management,Basal convention.

Energy Resources: Classification of Energy Resources; Conventional energy, resources-Coal, petroleum and natural gas, nuclear energy, hydroelectric power; Non-conventional energy resources- Biomass energy, Thermo-chemical conversion andbiochemical conversion route; Generation of Biogas and biodiesel as fuels; Solarenergy-active and passive solar energy absorption systems; Type of collectors;Thermal and photo conversion applications; Wind energy.

Facilitated through Online Platforms

Ecology and Environment: Concept of an ecosystem; structural and functional unitsof an ecosystem; Food Chain, Food Web, Trophic Structures and Pyramids; Energyflow; Ecological Succession; Types, Characteristics, Biodiversity, Biopiracy.

Human Population and the Environment: Population growth, variation amongnations; Population explosion – Family Welfare Programmes; Environment andhuman health; Human Rights; Value Education; Women and Child Welfare; Role ofInformation Technology in Environment and Human Health, Environmental Ethics.

Course Learning Outcomes (CLOs):
On the completion of course, students will be able to:

1. Comprehend the interdisciplinary context with reference to the environmentalissues and case studies

2. Assess the impact of anthropogenic activities on the various elements ofenvironment

and apply suitable techniques to mitigate their impact.

3. Conceptualise and explain the structural and functional features of ecologicalsystems

4. Correlate environmental concerns with the conventional energy sourcesassociated and assess the uses and limitations of non-conventional energytechnologies

Recommended Books
1. *Moaveni, S., Energy, Environment and Sustainability, Cengage (2018)*

2. *Down to Earth, Environment Reader for Universities, CSE Publication (2018)*

3. *Chapman, J.L. and Reiss, M.J., Ecology- Principles and Application, Cambridge University Press (LPE) (1999).*

4. *Eastop, T.P. and Croft, D.R. Energy Efficiency for Engineers and Technologists, Longman and Harow (2006).*

5. *O'Callagan, P.W., Energy Management, McGraw Hill Book Co. Ltd. (1993).*

6. *Peavy H.S. and Rowe D.R. Environmental Engineering, McGraw Hill (2013).*

Evaluation Scheme:

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

UMA004-Mathematics - II

	L	T	P	Cr
	3	1	0	3.5

Course Objectives: 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.

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.

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 transformsand 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.

Course Learning Outcomes: Upon completion of this course, 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 eigen values and eigen vectors.

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).

Reference Books:

1) Kreyszig Erwin, Advanced Engineering Mathematics, John Wiley (2006), 8th ed.
2) Jain, R.K. and Iyenger, S.R.K , Advanced Engineering Mathematics, Narosa Publishing House(2011), 11th ed.

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

UES009: MECHANICS

L T P Cr

2 1 2* 2.5

(*:Two hours Lab Once In Semester)

Course Objectives: The objective of this module is to help students develop the techniques needed to solve general engineering mechanics problems. Students will learn to describe physical systems mathematically so that their behavior can be predicted.

Review of Newton's law of motion and vector algebra.
Equilibrium of Bodies: Free-body diagrams, conditions of equilibrium, torque due to a force, statical determinacy.
Plane Trusses: Forces in members of a truss by method of joints and method of sections.
Friction: Sliding, belt, screw and rolling.
Properties of Plane Surfaces: First moment of area, centroid, second moment of area etc.
Shear Force and Bending Moment Diagrams: Types of load on beams, classification of beams; axial, shear force and bending moment diagrams: simply supported, overhung and cantilever beams subjected to any combination of point loads, uniformly distributed and varying load and moment.
Virtual Work: Principle of virtual work, calculation of virtual displacement and virtual work.

Experimental Project Assignment/ Micro Project: Students in groups of 4/5 will do project on Model Bridge Experiment: This will involve construction of a model bridge using steel wire and wood.

Course Learning Outcomes (CLO):
The students will be able to:
1.   Determine resultants in plane force systems
2.   Identify and quantify all forces associated with a static framework
3.   Draw Shear Force Diagram and Bending Moment Diagram in various kinds of beams subjected to different kinds of loads

Text Books:
   1. *Shames, I. H. Engineering Mechanics: Dynamics, Pearson Education India (2006).*
   2. *Beer, Johnston, Clausen and Staab, Vector Mechanics for Engineers, Dynamics, McGraw-Hill Higher Education (2003).*
Reference Books:
   1. *Hibler, T.A., Engineering Mechanics: Statics and Dynamics, Prentice Hall (2012).*

2. *Timoshenko and Young, Engineering Mechanics, Tata McGraw Hill Education Private Limited, (2006).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weights (%)
1.	MST	25
2.	EST	45
3.	Sessional (May include Assignments/Projects/Tutorials/Quiz	30

UTA018: OBJECT ORIENTED PROGRAMMING

L	**T**	**P**	**Cr**
3	**0**	**2**	**4.0**

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

Object Oriented Programming with C++: Class declaration, creating objects, accessing objects members, nested member functions, memory allocation for class, objects, static data members and functions. Array of objects, dynamic memory allocation, this pointer, nested classes, friend functions, constructors and destructors, constructor overloading, copy constructors, operator overloading and type conversions.

Inheritance and Polymorphism: Single inheritance, multi-level inheritance, multiple inheritance, runtime polymorphism, virtual constructors and destructors.

File handling: Stream in C++, Files modes, File pointer and manipulators, type of files, accepting command line arguments.

Templates and Exception Handling: Use of templates, function templates, class templates, handling exceptions.

Introduction to Windows Programming in C++: Writing program for Windows, using COM in Windows Program, Windows Graphics, User Input

Laboratory work:
To implement Programs for various kinds of programming constructs in C++ Language.

Course learning outcomes (CLOs):

On completion of this course, the students will be able to:
1. Write, compile and debug programs in C++, use different data types, operators and I/O function in a computer program.
2. Comprehend the concepts of classes, objects and apply basics of object oriented programming, polymorphism and inheritance.
3. Demonstrate use of file handling.
4. Demonstrate use of templates and exception handling.
5. Demonstrate use of windows programming concepts using C++.

Evaluation scheme

Sr. no.	Evaluation Elements	Weights (%)
1.	MST	25
2.	EST	45
3.	Sessionals (May include Assignments/Projects/Tutorials/Quiz/Lab evaluations)	30

UTA013:ENGINEERINGDESIGNPROJECT-I
(including 4 self-effort hours)

L	T	P	Cr
1	0	2	4.0

CourseObjectives: Todevelopdesignskillsaccordingtoa Conceive-Design-Implement-Operate(CDIO)compliantmethodology.Toapplyengineeringsciencesthroughlearning-by-doing project work. Toprovide aframework toencourage creativity andinnovation. To developteamworkandcommunicationskillsthroughgroup-basedactivity.To fosterself-directedlearningandcriticalevaluation.

Toprovidea basisforthetechnicalaspectsoftheprojecta smallnumberoflecturesare incorporatedintothemodule.Asthestudentswouldhavereceivedlittleinthewayofformal engineeringinstructionatthisearlystageinthedegreecourse,thelevelofthelecturesisto beintroductorywithanemphasisonthephysicalaspectsofthesubjectmatterasappliedto the 'Mangonel'project.Thelectureseriesincludesubjectareassuchas Materials,Structures, DynamicsandDigitalElectronicsdeliveredbyexpertsinthefield.

Thismoduleisdeliveredusingacombinationofintroductorylecturesandparticipationby thestudents in15"activities". Theactivities areexecuted tosupport thesyllabus ofthe courseandmighttakeplaceinspecialisedlaboratoriesorontheopengroundusedforfiring the Mangonel.Studentsworkin groupsthroughoutthe semesterto encourageteamwork, cooperationandtoavailofthedifferentskillsofitsmembers.Intheendthestudentsworkin sub-groupstodotheMangonelthrowingarmredesignproject.Theyassembleandoperatea Mangonel,basedonthelecturesandtutorialsassignmentsof mechanicalengineeringthey experimentwiththeworking,criticallyanalysetheeffectofdesignchangesandimplement thefinalprojectina competition.Presentationofthegroupassembly,redesignandindividual reflectionoftheprojectisassessedintheend.

BreakupoflecturedetailstobetakenupbyMED:

LecNo.	Topic	Contents
Lec1	Introduction	TheMangonelProject.History.Spreadsheet.
Lec2	PROJECTILE MOTION	noDRAG,Designspreadsheetsimulatorforit.
Lec3	PROJECTILE MOTION	withDRAG,Designspreadsheetsimulatorforit.
Lec4	STRUCTURES FAILURE	STATICLOADS
Lec5	STRUCTURES FAILURE	DYNAMICLOADS
Lec6	REDESIGNINGTHE MANGONEL	Design constraints and limitations of materials for redesigningtheMangonelforcompetitionasagroup.
Lec7	MANUFACTURING	ManufacturingandassemblingtheMangonel.
Lec8	SIMULATIONIN ENGINEERING DESIGN	SimulationasanAnalysisToolinEngineeringDesign.

Lec9	ROLE OF MODELLING & PROTOTYPING	The Role of Modelling in Engineering Design.

Breakup of lecture details to be taken up by ECED:

LecNo.	Topic	Contents
Lec1-5	Digital Electronics	Prototype, Architecture, Using the Integrated Development Environment (IDE) to Prepare an Arduino Sketch, structuring an Arduino Program, Using Simple Primitive Types (Variables), Simple programming examples. Definition of a sensor and actuator.

Tutorial Assignment/Laboratory Work:
Associated Laboratory/Project Program: T-Mechanical Tutorial, L-
Electronics Laboratory, W-
Mechanical Workshop of "Mangonel" assembly, redesign, operation and reflection.

Title for the weekly work in 15 weeks	Code
Using a spreadsheet to develop a simulator	T1
Dynamics of projectile launched by a Mangonel - No Drag	T2
Dynamics of projectile launched by a Mangonel - With Drag	T3
Design against failure under static actions	T4
Design against failure under dynamic actions	T5
Electronics hardware and Arduino controller	L1
Electronics hardware and Arduino controller	L2
Programming the Arduino Controller	L3
Programming the Arduino Controller	L4
Final project of sensors, electronics hardware and programmed Arduino controller based measurement of angular velocity of the "Mangonel" throwing arm.	L5
Assembly of the Mangonel by group	W1
Assembly of the Mangonel by group	W2
Innovative redesign of the Mangonel and its testing by group	W3
Innovative redesign of the Mangonel and its testing by group	W4
Final intergroup competition to assess best redesign and understanding of the "Mangonel".	W5

Project: The Project will facilitate the design, construction and analysis of a "Mangonel". In addition to some introductory lectures, the content of the students' work during the semester will consist of:
1. the assembly of a Mangonel from a Bill Of Materials (BOM), detailed engineering drawings of parts, assembly instructions, and few prefabricated parts;

2. thedevelopmentofasoftwaretooltoallowthetrajectoryofa"missile"tobestudiedasa functionofvariousoperatingparametersinconditionsofno-draganddragduetoair;
3. astructuralanalysisofcertainkeycomponentsoftheMangonelforstaticanddynamic stressesusingvaluesofmaterialpropertieswhichwillbeexperimentallydetermined;
4. the development of a micro-electronic system to allow the angular velocity of the throwingarmtobedetermined;

5. testingtheMangonel;
6. redesigning the throwing arm of the Mangonel to optimise for distance without compromisingitsstructuralintegrity;
7. an inter-group competition at the end of the semester with evaluation of the group redesignstrategies.

CourseLearningOutcomes(CLO):
Uponcompletionofthismodule,studentswillbeableto:
1. simulatetrajectoriesofamasswithandwithoutaerodynamicdragusingaspreadsheet basedsoftwaretooltoallowtrajectoriesbeoptimized;
2. performatesttoacquireanengineeringmaterialpropertyofstrengthinbendingand analyzethethrowingarmofthe"Mangonel"underconditionsofstaticanddynamic loading;
3. developandtestsoftwarecodetoprocesssensordata;
4. design,constructandtestanelectronichardwaresolutiontoprocesssensordata;
5. construct and operate a Roman catapult "Mangonel" using tools, materials and assemblyinstructions,inagroup,foracompetition;
6. operate and evaluate the innovative redesign of elements of the "Mangonel" for functionalandstructuralperformance;

TextBooks:
1. *MichaelMcRoberts,BeginningArduino,Technologyinactionpublications.*
2. *AlanG.Smith,IntroductiontoArduino:Apieceofcake,CreateSpaceIndependent PublishingPlatform(2011)*

ReferenceBook:
1. *JohnBoxall, Arduino Workshop -AHands-On Introduction with65Projects, No StarchPress(2013)*

EvaluationScheme:

Sr.No.	EvaluationElements	Weightage(%)
1	MST	-
2	EST	-

3	Sessional: (mayincludethefollowing)	
	MechanicalTutorialAssignments	30
	ElectronicsHardwareandsoftwarePracticalworkin Laboratory	30
	AssessmentofMechanicalcontentsinLecturesand TutorialsandElectronicscontentsinLecturesand Practical.	10
	Project(Assemblyofthe"Mangonel",innovative redesignwithreflection,prototypecompetition,Final Presentationandviva-voce	30

UES012 – ENGINEERING MATERIALS

L	T	P	Cr
3	1	2	4.5

Course Objective: To provide basic understanding of engineering materials, their structure and the influence of structure on mechanical, chemical, electrical and magnetic properties.

Structure of solids: Classification of engineering materials, Structure-property relationship in engineering materials, Crystalline and non-crystalline materials, Miller Indices, Crystal planes and directions, Determination of crystal structure using X-rays, Inorganic solids, Silicate structures and their applications. Defects; Point, line and surface defects.

Mechanical properties of materials: Elastic, Anelastic and Viscoelastic behaviour, Engineering stress and engineering strain relationship, True stress - true strain relationship, review of mechanical properties, Plastic deformation by twinning and slip, Movement of dislocations, Critical shear stress, Strengthening mechanism, and Creep.

Equilibrium diagram: Solids solutions and alloys, Gibbs phase rule, Unary and binary eutectic phase diagram, Examples and applications of phase diagrams like Iron - Iron carbide phase diagram.

Electrical and magnetic materials: Conducting and resister materials, and their engineering application; Semiconducting materials, their properties and applications; Magnetic materials, Soft and hard magnetic materials and applications; Superconductors; Dielectric materials, their properties and applications. Smart materials: Sensors and actuators, piezoelectric, magnetostrictive and electrostrictive materials.

Corrosion process: Corrosion, Cause of corrosion, Types of corrosion, Protection against corrosion.

Materials selection: Overview of properties of engineering materials, Selection of materials for different engineering applications.

Laboratory Work and Micro-Project:
Note: The micro-project will be assigned to the group(s) of students at the beginning of the semester. Based on the topic of the project the student will perform any of the six experiments from the following list:

1. To determine Curie temperature of a ferrite sample and to study temperature dependence of permeability in the vicinity of Curie temperature.
2. To study cooling curve of a binary alloy.
3. Determination of the elastic modulus and ultimate strength of a given fiber strand.
4. To determine the dielectric constant of a PCB laminate.
5. Detection of flaws using ultrasonic flaw detector (UFD).
6. To determine fiber and void fraction of a glass fiber reinforced composite specimen.
7. To investigate creep of a given wire at room temperature.

8. To estimate the Hall coefficient, carrier concentration and mobility in a semiconductor crystal.
9. To estimate the band-gap energy of a semiconductor using four probe technique.
10. To measure grain size and study the effect of grain size on hardness of the given metallic specimens.

Course Outcomes: Student will be able to:
1. classify engineering materials based on its structure.
2. draw crystallographic planes and directions.
3. distinguish between elastic and plastic behavior of materials.
4. distinguish between isomorphous and eutectic phase diagram.
5. classify materials based on their electrical and magnetic properties.
6. propose a solution to prevent corrosion.

Text Books:
1. W.D. Callister , Materials Science and Engineering; John Wiley & Sons, Singapore, 2002.
2. W.F. Smith, Principles of Materials Science and Engineering: An Introduction; Tata Mc-Graw Hill, 2008.
3. V. Raghavan, Introduction to Materials Science and Engineering; PHI, Delhi, 2005.

Reference Books:
1. S. O. Kasap, Principles of Electronic Engineering Materials; Tata Mc-Graw Hill, 2007.
2. L. H. Van Vlack, Elements of Material Science and Engineering; Thomas Press, India, 1998.
3. K. G. Budinski, Engineering Materials – Properties and selection, Prentince Hall India, 1996

Evaluation Scheme

Event	Weightage
Mid-Sem Test	25
End-Sem Test	45
Tut/Sessional/ Lab + Project/ Quiz	30
Total	100

UMA033-Numerical and Statistical Methods
(Only for Electrical and Electrical Instrumentation and Control (ELE & EIE) branches)

	L	T	P	Cr
	3	0	2	4.0

Prerequisite(s): None

Course Objective: The main objective of this course is to understand and implement various numerical and statistical methods to solve engineering, physical and real life problems.

Basic of Errors: Floating-point representation, rounding and chopping errors.

Non-Linear Equations: Bisection, fixed-point iteration, Newton - Raphson's method for simple and multiple roots and order of convergence.

Linear Systems and Eigen-Values: Gauss elimination method using partial pivoting, Gauss--Seidel method, Rayleigh's power method for eigen-values and eigen-vectors.

Interpolation and Approximations: Newton's forward and backward differences, Lagrange (with error analysis) and Newton's divided difference interpolation formulas.

Numerical Integration: Newton-Cotes quadrature formulae (Trapezoidal and Simpson's rules) and their error analysis, Gauss - Legendre quadrature formulae.

Differential Equations: Solution of initial value problems using Euler's, Modified Euler's and Runge-Kutta methods (fourth-order).

Curve Fitting: Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves.

Probability Distribution: Mathematical expectations, Definition of probability distribution (Probability Mass Function and Probability Density Function), Poisson, Geometric, Binomial, Uniform and Normal distributions

Correlation and Regression: Bivariate distribution, correlation coefficients, regression lines, formula for regression coefficients.

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

Course Outcomes: Upon successful completion of the course, the students will be able to
1. learn how to obtain numerical solution of nonlinear equations using bisection, Newton, and fixed-point iteration methods.
2. solve system of linear equations numerically using direct and iterative methods.
3. analyze the correlated data using the least square and regression curves.
4. solve integration and initial value problems numerically.
5. Solve real life problems using various probability distributions.
6. Approximate the data and functions using interpolating polynomials

Texts books:
1. K. Atkinson and W. Han, Elementary Numerical Analysis, 3rd Edition, John Willey &Sons, 2004.
2. Brian Bradie, A friendly Introduction to Numerical Analysis, prentice Hall, 2007
3. Richard L. Burden and J. Douglas Faires, Numerical Analysis, 8th edition, Brooks Cole, 2004
4. Richards A. Johnson, Probability and Statistics for Engineers, 8th edition, PHI

learning, 2011.
5. Meyer, P. L., Introductory Probability and Statistical applications, 2nd edition, Oxford, 1970

References:
1. Curtis F. Gerald and Patrick O. Wheatley, Applied Numerical Analysis, 7th Edition, Pearson, 2003.
2. Walpole, Ronald E., Myers, Raymond H., Myers, Sharon L., and Keying, Ye, Probability and Statistics for Engineers and Scientists, 8th edition Pearson Education, 2007
3. Steven C. Chapara, Applied Numerical Methods with MATLAB for Engineers and Scientist, 2nd edition, McGraw Hill publishing, 2007

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	15
4.	Laboratory evaluation	20

UTA012: INNOVATION AND ENTREPRENEURSHIP

	L	T	P	Cr.
	1	0	2	3.0

Course Objectives: 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 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):
Upon successful completion of the course, the students should 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*
4. *Bagchi, Subroto, (2008), Go Kiss the World: Life Lessons For the Young Professional, Portfolio Penguin*
5. *Bagchi, Subroto, (2012). MBA At 16: A Teenager's Guide to Business, Penguin Books*

6. *Bansal, Rashmi, Stay Hungry Stay Foolish, CIIE, IIM Ahmedabad*
7. *Bansal, Rashmi, (2013). Follow Every Rainbow, Westland.*
8. *Mitra, Sramana (2008), Entrepreneur Journeys (Volume 1), Booksurge Publishing*
9. *Abrams, R. (2006). Six-week Start-up, Prentice-Hall of India.*
10. *Verstraete, T. and Laffitte, E.J. (2011). A Business Model of Entrepreneurship, Edward Elgar Publishing.*
11. *Johnson, Steven (2011). Where Good Ideas comes from, Penguin Books Limited.*
12. *Gabor, Michael E. (2013), Awakening the Entrepreneur Within, Primento.*
13. *Guillebeau, Chris (2012), The $100 startup: Fire your Boss, Do what you love and work better to live more, Pan Macmillan*
14. *Kelley, Tom (2011),The ten faces of innovation, Currency Doubleday*
15. *Prasad, Rohit (2013), Start-up sutra: what the angels won't tell you about business and life, Hachette India.*

Evaluation scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

UEE505: ANALOG AND DIGITAL SYSTEMS

L	T	P	Cr.
3	1	2	4.5

Course Objective: To introduce the analysis of BJT biasing circuits and working of FET, general applications of op amp, working of active filters and oscillators, to understand the design concept of combinational and sequential digital circuits.

Bipolar Junction Transistor and Field Effect Transistor: Biasing and load line analysis of BJT, CE configuration as two port network: h–parameters, h–parameter equivalent circuit; Structure and working of JFET and MOSFET; output and transfer characteristics, Applications of JFET and MOSFET.

Introduction to Op Amp: Introduction, Ideal Voltage Transfer Curve, Open loop op amp configurations, Summing, Scaling and Averaging Amplifier, Differentiator, Integrator, Comparator.

Active filters and Oscillators: Condition for sustained oscillation, R-C phase shift, Hartley, Colpitts, Crystal and Wien Bridge Oscillators, Negative Resistance oscillator; first order High pass and low pass Butterworth filters using op amp; Multi-vibrators.

Simplification of Boolean Expressions: Quine-McClusky method in SOP and POS forms, determination of prime implications, simplification using Map-entered variables.

Combinational and Sequential Circuits: Introduction, Adders: BCD adder, Code converters, Magnitude comparators, Parity Generators/checkers, Encoders, Decoders, Multiplexers, Demultiplexer; Introduction of sequential circuits, Flip-flops, Registers: Serial/Parallel in/out, Bi-directional, Counters: Synchronous, Asynchronous, Decade, Binary, Modulo-n, Shift register counters, Introduction to memory, Memory Expansionusing IC's.

Converters: Digital to Analog conversion, R2R ladder DAC, Weighted Resistor DAC, Analog-Digital conversion, Flash type, Counter type ADC, Dual-slope ADC, Successive approximation type ADC.

Laboratory Work: RC coupled amplifier in CE mode, Use of Bistable, Astable and monostablemultivibrator, Hartley and Colpitts Oscillator, Combinational circuits,Flip Flops, shift register and binary counters, asynchronous/synchronous up/down counters, Variable modulus counters, Usage of IC tester,

Minor Project: Design of LED lighting system for household application; street lighting system; soft starting of DC machine.

Course Learning Outcome (CLO):
After the completion of the course the students will be able to:
- Design different types of transistor biasing circuits and elucidate basics of FET and MOSFET.
- Demonstrate general applications of op amp such as comparator, summing amplifier, differentiator and integrator.
- Design Butterworth active filters using op amp and oscillator circuits.
- Design combinational and sequential circuits.
- Demonstrate the concept of ADC and DAC.

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).*
3. *Floyd, T.L. and Jain, R. P., Digital Fundamentals, Pearson Education (2008).*
4. *Tocci, R. and Widmer, N., Digital Systems: Principles and Applications, Pearson Education (2007).*

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).*
3. *Mano, M. M. and Ciletti, M., Digital Design, Pearson Education (2008).*
4. *Kumar, A., Fundamentals of Digital Circuits, Prentice Hall (2007).*

Evaluation Scheme:

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

UEEXXX: ELECTRO-MECHANICAL ENERGY CONVERSION

	L	T	P	Cr.
	3	1	2	4.5

Course Objective: To introduce the fundamentals of dc machines, transformer, 3-phase transformer and special purpose transformer.

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 the completion of the course the students will be able to:
- Analyse the performance of single phase and three phase transformers under various operating conditions
- Analyse the load sharing with parallel connected single phase/three phase transformers.
- Use and analyse special purpose transformer (s) for measurement and protection.
- Analyse the performance characteristics of DC motors and DC generators
- Use different methods for starting and speed control of DC motors.
- Elucidate the advantages of parallel operation of DC generators.

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. *Toro, Vincert, Electromechanical Devices for Energy Conversion,* Prentice Hall of India *(2004).*
3. *Fitzgerald, A.E., Kingsley, C. Jr. and Umans, Stephen, Electric Machinery, McGraw Hill (2002).*

Evaluation Scheme:

S N	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	45
3	Sessional (Assignments/Tutorials/Quizzes/Lab Evaluations)	30

UTA014 Engineering Design Project-II (Buggy Lab)
(including 2 self effort hours)

	L	T	P	Cr
	1	0	4	4.0

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.

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

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

Laboratory Work:

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

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

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

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

Course learning outcome (CLO): The student 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, CreateSpace Independent Publishing Platform (2011).*

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

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	Evaluation-1 (ECE lab)	20
2.	Evaluation-2 (CSE lab)	20
3.	Quiz	10
4.	Evaluation-3 (ECE+CSE lab)	50

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.

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 X_d and X_q, Parallel operation of alternators, Synchronising procedures, Synchronising power and Torque co–efficient, 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: Voltage regulation, Direct and quadrature axis reactances, Operating characteristics, Synchronizing, Parallel operation and load division, Sudden short circuit analysis and 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 and performance indices.

Course Learning Outcomes (CLO):
After the completion of the course the students will be able to:
- Analyse tests, characteristics and steady state performance of Three-phase induction motor
- Validate and identify the three-phase induction machine parameters
- Comprehend the performance and test of synchronous machines.
- Analyse performance of single machine – infinite bus system and number of alternators connected in parallel.
- Performance analysis of fractional kW induction motors.

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).*

Reference Books:
1.   *Bimbhra, P.S., Generalized Theory of Electrical Machines, Khanna Publishers (2007).*
2.   *Toro, Vincert, Electromechanical Devices for Energy Conversion, Prentice Hall of India (2004).*
3.   *Fitzgerald, A.E., Kingsley, C. Jr., and Umans, Stephen, Electric Machinery, McGraw−Hill (2002).*

Evaluation Scheme:

S N	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessional(Assignments/Tutorials/Quizzes/Lab Evaluations)	30

UEEXXX: TRANSMISSION AND DISTRIBUTION OF ELECTRIC POWER

	L	T	P	Cr.
	3	1	0	3.5

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

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

Transmission Line Parameters: Choice of voltage and frequency, Types of conductor, Size of conductor, Resistance, Inductance and capacitance of single phase and three phase transmission lines, Effect of ground on capacitance.

Mechanical design of overhead transmission lines: Tension and sag calculations, Factors affecting Sag, Sag template, Stringing charts, Vibrations and vibration damper.

Insulators: Insulator types, String efficiency, Improvement of String Efficiency Grading rings, Insulator Failure, Arcing horns, Armored rods and Bushing.

Transmission Line Performance: Characteristics and performance of power transmission lines: Short, Medium, Long lines, Generalized constants, Power flow, Regulation, Power circle diagrams, Series and shunt compensation, Corona visual and disruptive, Critical voltage, Phenomenon of Corona, Corona loss, Factors affecting Corona, Ferranti Effect, Electrostatic and Electromagnetic interference with communication lines.

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

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, EHVAC and HVDC systems in India and trends.
Standards: Indian Electricity Rules 1956 amended in 2000.

Course learning Outcomes (CLO):
After the completion of the course the students will be able to:
- Analyse the transmission line models and evaluate its performance parameters.
- Design the transmission lines under various working conditions.
- Select the configurations of different line insulators and evaluate their performance.
- Supervise the laying of cables and fault detection in cables.
- Design the distribution system network.

Text Books:
1. *Chakrabarti, A., Soni, M.L., Gupta, P.V. and Bhatnagar, U.S., A Text Book on Power System Engineering, Dhanpat Rai (2008).*

2. *Wadhwa, C.L., Electrical Power Systems, New Age International (P) Limited, Publishers (2008).*

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

Evaluation Scheme:

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

UMA035 OPTIMIZATION TECHNIQUES (all branches except for Mechanical)

	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.

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 linear 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 outcome: Upon Completion of this course, the students would 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., Numerical Optimization and Applications, Narosa Publishing House, (2013).

2) Taha H.A., Operations Research-An Introduction, PHI (2007).

Recommended Books:

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

2) BazaarraMokhtar S., Jarvis John J. and ShiraliHanif D., Linear Programming and Network flows, John Wiley and Sons (1990)

3) Swarup, K., Gupta, P. K., Mammohan, Operations Research, Sultan Chand & Sons, (2010).

4) H.S. Kasana and K.D. Kumar, Introductory Operations research, Springer publication, (2004)

5) Ravindran, D. T. Phillips and James J. Solberg: Operations Research- Principles and Practice, John Wiley & Sons, Second edn. (2005).

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessional (May include assignments/quizzes/projects)	25

UEEXXX: 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.

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 A.C. 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 filter, 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 Outcome (CLO):
After the completion of the course the students will be able to:
- Apply various laws and theorems to solve electric networks.
- Analyse the behaviour of two port networks.
- Apply graph theory concept to solve electrical networks
- Realise one-port network parameters
- 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 Chowdhuary, D., Networks and Systems, New Age International (P) Limited, Publishers (2007).*

3. *Suresh Kumar, K.S. Electrical circuits and Networks, Pearson Education, (2009).*

Evaluation Scheme:

S N	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	45
3	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UHU005: Humanities for Engineers

L	T	P	Cr
2	0	2	3

Course Objectives (COs): 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.

Detailed Content:

 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 and its types

Production & Cost Analysis – Short run & Long Run Production Functions, Short run & Long run cost functions, Economies & 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.

Practical:

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 Budgeting assignment

Course learning Outcomes (CLOs)

The student after completing the course will be able to:
1. comprehend ethical principles and values and apply them as a guide to behavior in personal and professional life.
2. apply tools and techniques to manage and motivate employees.
3. analyse and apply conflict management strategies that managers can use to resolve organizational conflict effectively.
4. devise pricing strategy for decision-making.
5. apply techniques for project evaluation.

Text Books

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

Mid Semester Exam	25
End Semester Exam	45
Sessional	30

UEEXXX: LINEAR CONTROL SYSTEMS

L T P Cr.
3 1 2 4.5

Course Objectives: To understand concepts of the mathematical modeling, feedback control, stability and analysis in time and frequency domains.

Basic Concepts: Open and closed loop control systems, mathematical modelling of electrical, mechanical, thermal, hydraulic and pneumatic systems, concept of transfer function, block diagrams and signal flow graphs.

Control hardware and their models: potentiometers, synchros, LVDT, dc and ac servomotors, tachogenerators, and stepper motors.

Analysis: Steady-state errors and error constants, Concepts of P, PD, PI and PID types of control and their realizations.

Stability: Definition, Routh-Hurwitz criterion, Root locus techniques, Nyquist criterion, Bode plots, Relative stability, concepts of gain 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, application of control in single area and two area power system network.

Laboratory: 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, simulation examples of control problems with MATLAB/Simulink software.

Course Learning Outcomes (CLO):
After the successful completion of the course the students will be able to:
- Develop the mathematical model of the physical systems.
- Analyse the response of the closed and open loop systems.
- Analyse the stability of the closed and open loop systems.
- Design the various kinds of compensator.
- Develop and analyse 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).*

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

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).*

Evaluation Scheme:

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

UTA002 MANUFACTURING PROCESSES

	L	T	P	Cr.
	2	0	3	3.5

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

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

Metal Casting: Principles of metal casting, Introduction to sand casting, Requisites of a sound casting, Permanent mold casting processes.

Metal Forming: Forging, Rolling, Drawing, Extrusion, Sheet Metal

operations. **Joining Processes:** Electric arc, Resistance welding,

Soldering, Brazing. **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.

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

Course Learning Outcomes (CLO):
After the completion of this module, students will be able to:

- develop simple CNC code, and use it to produce components while working in groups.
- analyse various machining processes and calculate relevant quantities such as velocities, forces.
- recognise cutting tool wear and identify possible causes and solutions.

- understand the basic principle of bulk and sheet metal forming operations for analysis of forces.
- analyse various shearing operations for tooling design.
- apply the knowledge of metal casting for different requirements.

Text books:

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

Reference Books:

1. Martin, S.I., Chapman, W.A.J. , *Workshop Technology*, Vol.1 & II, Viva Books (2006) 4 th 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) 4 thed.

Evaluation Scheme:

Sr. No.	Evaluation elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessional: (May include the following) Assignment, Sessionals (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.)	35

UEEXXX: POWER SYSTEM 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.

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, Hydro-scheduling, solution methods.

Power System Control: Ideas of load frequency and voltage control, Reactive power control, Block diagrams of P-f and Q-V controllers, ALFC control, Static and dynamic performance characteristics of ALFC and AVR controllers, Excitation systems model, concept of area and Tie-line operations.

Power System Security: Factors affecting security, Contingency analysis, Network sensitivity, correcting the generation dispatch by using sensitivity method.

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, realize ALFC and AVR control and bias control on Simulink.

Course Learning Outcomes (CLO):
After the completion of the course the students will be able to:
- Analyse power flow of balanced power system.
- Analyse the stability of single machine-infinite bus system.
- Decide the scheduling of thermal units and hydro-thermal units for overall economy.
- Design and apply control for frequency and voltage of power system represented by multi-area.
- Carryout voltage stability and contingency analysis.

Text Books:
1. *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).*
2. *Nagrath, I.J. and Kothari, D.P., Power System Engineering, Tata McGraw−Hill (2007).*
3. *Stevenson, W.D., Power System Analysis, McGraw−Hill (2007).*

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, IEEE Press (1995).*
4. *Jizhong Z., Optimization of power system operation, Edition Wiley (1996).*
5. *Elgerd, O. Electric Energy Systems Theory, McGraw Hill Education Private Limited (2001).*

Evaluation Scheme:

S N	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	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.

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.

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, modified Mcmurray half bridge inverter, 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 the completion of the course the students will be able to:
- Select the power devices as per the usage for energy conversion and control.
- Design of firing and commutation circuits for different converter configurations.
- Analyse various converter configuration / topology with different types of load.
- Identify converter configurations for various power applications.
- Exhibit the usage of power converters for harmonic mitigation, voltage and frequency control.

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 *(2006).*
3. *Bimbhra,P.S., Power Electronics, Khanna Publishers(2012).*

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, IEEE Publications*

Evaluation Scheme:

S N	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessional (Assignments/Tutorials/Quizzes/Lab Evaluations)	30

UEE502: HIGH VOLTAGE ENGINEERING

L T P Cr.
2 0 2 3.0

Course Objective: To introduce the concepts of breakdown in gases, solids, generation and measurement of high voltage and their tests.

Introduction: Introduction to AC and DC impulse voltages and their use, Problems in dealing with high voltages.

Breakdown in Gases: Elementary ideas on ionization by electron collision, Townsend mechanism, Townsend first and second ionization coefficients, Paschen law, breakdown in non-uniform fields and corona discharges, vacuum breakdown mechanisms, breakdown in liquids, fundamentals of insulating oils, conduction and breakdown in pure and commercial liquids.

Breakdown in Solids: Fundamentals of solid insulating materials intrinsic, electromechanical and thermal breakdown, breakdown in simple and composite dielectrics, types of insulating materials, temperature classification, factor affecting dielectric strength, insulation design of rotating machines, transformers, transmission lines, Switch gear, etc.

Generation of High Voltages: Generation of high voltages, testing transformers in cascade, series resonant circuits and their advantages, half and full wave rectifier circuits, voltage doubler and cascade circuits, electrostatic generator, characteristics parameters of impulse voltages, single stage impulse generator circuits, multistage impulse generation circuits.

Measurement of High Voltages: Measurement of direct, alternating and impulse voltages by electrostatic voltmeters, sphere gap, uniform field gap, ammeter in series with high voltage resistors and voltage divider

Non-Destructive High Voltage Tests: Loss in a dielectric and its measurement, dielectric loss measurement by Schering bridge, partial discharges at alternating voltages, external and internal partial discharges and discharge measurements.

Laboratory work: Voltage measurement by sphere gap and Chubb and Fortesque methods, Insulation resistance measurement using Meggar, Experimental setup for standard lightning wave, Efficiency and peak voltage measurement by sphere gap impulse voltage time curves, Breakdown voltage, Conductivity and dissipation factor measurement with Schering bridge, partial discharge measurements

Course Learning Outcomes (CLO):
After the completion of the course the students will be able to:
- Conceptualize the idea of high voltage and safety measures involved.
- Analyse the breakdown mechanism of solids, liquids and gases.
- Calculate the circuit parameters involved in generation of high voltages.
- Measure direct, alternating and impulse high voltage signals.
- Measure the dielectric loss and partial discharge involved in non-destructive high voltage tests.

Text Books:
1. *Khalifa, M., High Voltage Engineering: Theory and Practice, Marcel Dekker Inc. (2000).*
2. *Naidu, M.S. and Kamraju, V., High Voltage Engineering, Tata McGraw–Hill (2008).*
3. *Wadhwa, C .L., High Voltage Engineering, New Age International (P) Limited, Publishers (2006).*

Reference Books:
1. *Dass, R., Extra High Voltages, Tata McGraw–Hill (2006).*
2. *Kind, D. and Feser, K, High Voltage Test Techniques, Reed Educational and Professional Publishing Limited (2001).*

Evaluation Scheme:

S N	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

CAPSTONE PROJECT

	L	T	P	Cr
UEE793: Semester VI (starts)	0	0	2	--
UEE793: Semester VI (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.

Course Description: Capstone Project is increasingly interdisciplinary, and requires students to function on multidisciplinary 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 fulfillment 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 the completion of the course, the students will be able to:
- Identify design goals and analyse possible approaches to meet given specifications with realistic engineering constraints.
- Design an electrical engineering project implementing an integrated design approach applyingknowledge accrued in various professional courses.
- Perform simulations and incorporate appropriate adaptations using iterative synthesis.
- Use modern engineering hardware and software tools.
- Work amicably as a member of an engineering design team.
- Improve technical documentation and presentation skills.

UEEXXX: INDUSTRIAL DRIVES

	L	T	P	Cr.
	3	1	2	4.5

Course objective: To introduce the concept of electric drives and it features. To get familiarize with estimation of motor rating and solid-state controlled drives.

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

Drive Features of Importance: Multi-quadrant operations of DC and AC motors, Energy relations during starting and braking.

Static Control of Motors: Contactors and relays for electric drives, Control circuits for automatic starters of DC and AC motors.

Estimation of Motors 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.

Solid State Controlled 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, 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, Energy efficient drives, losses in electrical drive system, Energy conservation in electric drives.

Drives for industrial applications: Drive considerations for textile mills, steel rolling mills, cranes and hoist drives, cement and sugar mills, paper and machine tool drives, pumps and compressors.

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.

Course Learning Outcomes (CLO):
After the completion of the course the students will be able to:
- Conceptualize the basic drive system and analyse it for different types of loads
- Analyse the motor situation during starting and braking
- Develop control circuitry and devices for control of motor
- Estimate the motor rating for different condition of load
- Develop the converter circuit for control purpose along with its different configuration

Text Books:

1. *Dubey, G.K., Power Semiconductor Controlled Drives, Prentice Hall Inc. (1989).*
2. *Pillai, S.K., A Course in Electric Drives, New Age International (P) Limited, Publishers (1989).*

Reference Books:
1. *Bose, B.K., Modern Power Electronics and AC Drives, Prentice-Hall of India Private Limited (2006).*
2. *Dubey, G.K., Fundamentals of Electric Drives, Narosa Publications (2001).*
3. *Sen, P.C., Thyristor DC Drives, John Wiley and Sons (1981).*

Evaluation Scheme:

S N	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEEXXX: 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.

Introduction:A protection system and its attributes, System transducers, duties of switchgear, various power system elements that needs protection, ratings and characteristics of fuses and MCBs,

Circuit Breakers: Theory of arc formation and its extinction (AC and DC), re-striking and recovery voltage, Current chopping, circuit breakers: specifications of circuit breakers, different types of circuit breakers like oil, Air, Vacuum and SF_6, comparative merits and demerits, HVDC circuit breaker system.

Earthing: Earthing requirements, Earthing practices, Earth resistivity and earth gradient, Neutral grounding and neutral shift.

Protective Relays: Functions, Constructional and operating principles of electromagnetic type like over-current, Directional, Differential and distance relays, Characteristics, General equation. Basic principles of static relaying, Phase and amplitude comparator, Microprocessor based relays.

Protection Schemes: Over–current and Over–voltage protection of transmission lines, differential protection, transformer protection, Bus bar protection, distance protection of transmission line, carrier aided protection of transmission lines, generator protection, induction motor protection.

Component Representation: Representation and sequence impedance of regulating transformer, generator, transmission line and loads; phase shift in star-delta transformer, sequence networks of power system, Y-Bus and Z-Bus building algorithm.

Fault Analysis: Symmetrical fault, algorithm for symmetrical fault analysis, unbalanced or unsymmetrical shunt faults, Z-bus method for the analysis of unsymmetrical shunt faults.

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 co-ordination.

Course Learning Outcomes (CLO):
After the completion of the course the students will be able to:
- Demonstrate various protection strategies applied for power system protection.
- Design the basic earthing requirement for residential and other purposes.
- Select required protection measures against overcurrent, overvoltage in transmission lines and other power system equipment.
- 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).*

Evaluation Scheme:

S N	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessional (Assignments/Tutorials/Quizzes/Lab Evaluations)	30

UEEXXX: PRINCIPLES OF DIGITAL SIGNAL PROCESSING

L	**T**	**P**	**Cr.**
3	**0**	**2**	**4.0**

Course objective: To explain the concepts of Fourier analysis, digital signal processing, stability analysis of digital system, digital filter design and application of DSP for specific protection and drive.

Introduction: Definition, conversion from analog signal to digital signal, advantages and disadvantages of digital signal processing, Basic Terminologies.

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, Implementation of digital filter, Types of filters, LTI systems as filters, Design of IIR filters from analog filters, IIR filter design using Butterworth Approximation, Frequency transformation, 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.

Hardware Architecture of DSP Processor: Desirable features of DSP processors, Types of architectures, Internal architecture, Features, System interface and Instruction set of ADSP-21xx, ADSP-21xxDevelopment tools, TMS DSP processor.

Applications: Dual-tone multi frequency signal detection, Spectral analysis using DFT, Short term DFT, oversampling, Protection.

Course Learning Outcomes (CLO):
After the completion of the course the students will be able to:
- Demonstrate the digital signal processing concepts and stability analysis of digital system.
- Analyze the hardware architecture of DSP processor.
- Design digital filterand harmonic mitigation.
- Carryout spectrum analysis using DFT.
- Apply DSP concepts for power system applications such as relaying, protection and metering.

Text Books:
1. *Proakis, J.G. and Manolakis, D.G., Digital Signal Processing, Prentice Hall of India (1996).*
2. *Rabiner, C.R. and Gold, B., Theory and Applications of Digital Signal Processing, Prentice Hall of India (2000)*

Reference Books:
1. *Antonion, A., Digital Filters: Analysis Design and Application, Prentice-Hall of India (1999).*
2. *Oppenhein, A.V. and Schafer, R.W., Digital Signal Processing, Prentice-Hall of India (1998).*
3. *Helmut, U. and Willibald, W., Protection Techniques in Electrical Engg. Systems,Marcel Dekker Inc. (2001)*

Evaluation Scheme:

S N	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	30

UEEXXX: 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

Introduction Definition of learning systems, machine learning, training data, concept representation, function approximation for learning system; Objective functions for classification, regression, and ranking.

Concept of Optimization: Convex function, gradients and subgradients, Unconstrained smooth convex minimization, gradient descent, Constrained optimization, Stochastic gradient descent

Regression and Supervised learning Linear regression and LMS algorithm, Perceptron and logistic regression, Nonlinear function estimation, Multilayer perceptron and backpropagation, recurrent networks, Overfitting, Regularization

Support Vector Machines 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

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

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

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

Dimension Reduction Techniques Feature selection, Principle Component Analysis (PCA), Linear Discriminant Analysis (LDA)

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

Laboratory work: Thelaboratory work includes supervised learning algorithms, linear regression,logistic regression, decision trees, k-nearest neighbour, Bayesian learning and the naïve Bayesalgorithm, support vector machines and kernels and neuralnetworks with an introduction to Deep Learning and basic clustering algorithms.

Course Learning Outcomes (CLO):
After the completion of the course the students will be able to:
- Demonstrate the concept of optimization for various learning functions
- Analyse the complexity of machine learning algorithms and their limitations
- Realize learning algorithms as neural computing machine
- Demonstrate the ability to evaluate and compare learning models and learning algorithms
- Realize algorithms on power system 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 N	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEEXXX: ELECTRIC VEHICLE AND SUSTAINABLE ENERGY SYSTEMS

	L	T	P	Cr.
	2	0	2	3.0

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

Introduction to Electric vehicles: History of Electric vehicles, importance of electric vehicles in environment and society, types of EVs, architecture of electric vehicles, basic working of electric vehicles, integration of EVs in smart grid, economic advantages and challenges in installation of EVs.

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

Battery based energy storage and its analysis, Battery systems, Battery management system, battery management electronics, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices, Sizing the drive system, Design of Plug-in Electric Vehicle, Energy Management Strategies, Automotive networking and communication, EV and EV charging standards, V2G, G2V concepts.

Introduction to renewable energy resources: solar, wind, hydropower, biomass, geothermal, ocean wave, benefits, costs, and policies of renewable energy, Environmental issues, renewable sources integration – overcoming intermittence, centralized vs. distributed generation.

Wind Energy: Speed and Power Relations, Power Extracted from the Wind, Horizontal- and Vertical-Axis Wind Turbines, Fixed-and Variable-Speed Turbine, Aerodynamic Power Control: Passive Stall, Active Stall, and Pitch Control, Tip Speed Ratio, Wind Generators, Wind Energy System Configurations, Fixed Speed Induction Generator WECS, Variable-Speed Wind Energy Systems with Squirrel Cage Doubly Fed Induction Generator Based WECS, Variable-Speed Wind Energy Systems with Synchronous, Permanent Magnet Generator (PMG), Control of DFIG & PMG.

Solar energy: Solar Cell Physics – P-N junction, Metal-semiconductor interface, Figure of merits of solar cell, Efficiency limits, Variation of efficiency with band-gap and temperature, Efficiency measurements, High efficiency cells, Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication, Solar PV cell panel, Operation and design of solar thermal System, Parabolic trough concentrators, Solar Heating & Cooling System, Solar furnaces, Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping, power generation schemes, Stand-alone & Grid connected systems: PV Inverters, Optimal economic coordinated operation of conventional and renewable sources, Operational issues and challenges.

Laboratory work: Experiments involving simulation and hardware which will involve working of Electric vehicle using DC-DC buck-boost converter, hardware involving Renewable energy sources like Solar and Wind energy systems, Demonstration of I-V and P-V characteristics of PV module with varying radiation and temperature level, Demonstration of I-V and P-V characteristics of series and parallel combination of PV modules, Study of effect of variation in tilt angle on PV module power, Demonstration of the effect of shading on module output power, Demonstration of diode as bypass diode and blocking diode, Study of charging and discharging characteristics of battery,

Analysis of Maximum Power Point (MPPT) manually by varying the resistive load across the PV panel.

Course learning Outcomes (CLO):
After the completion of the course, the students will be able to:
- Explain the basic working of Electric vehicle.
- Demonstrate the energy storage capability of electric vehicles.
- Explain the Grid integration of Electric vehicles and its challenges.
- Explain the communication and networking in Electric vehicles.
- Describe the working of Wind and Solar energy systems.
- Demonstrate the concepts of Grid integration of Renewable energy sources and associated challenges.

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

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

Evaluation Scheme:

S N	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEEXXX: REAL TIME POWER SYSTEMS

L	T	P	Cr.
2	0	2	3.0

Course objective: To introduce the students about important contemporary issues due to the integration of DG: technical challenges, benefits, and perspectives in real time environment. To make them familiar with hardware components including measurement and control in hardware in loop system.

Signal Conditioning: Amplifiers, multiplexers and dividers, timer multiplexers, Signal converters, ADC and DAC, Signal conditioning, digital signal conditioning, transmission of digital signals, Telemetry methods and errors, PLCC, AM, FM, PAM, PWM, PCM Techniques.

Data Acquisition System: Role of dedicated computers, analog and digital control, computer systems for real time applications, distributed and supervisory control, SCADA and its organization and structure, centralized, hierarchical and decentralized control schemes, man machine interface, energy management system.

Hardware-in-loop simulation systems, distributed control architecture, reliability enhancement by redundancy, Real time operating systems: Features, primary components, Structureddesign of real time systems.

Developing a mathematical model for Power system and control, Mathematical model of the real time environment, Design of hardware device meant to be used in HIL.

Testing and parameter adjustment for real time implementation of real-time simulator, Design of desired control schemes for AC and DC electrical machine drives and other applications: Micro-grid and renewable and its testing in HIL. Real time control strategy based on FPGA, dSpace, Understanding four-quadrant amplifier for HIL system.

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

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

Course learning Outcomes (CLO):
After the completion of the course, the students will be able to:
- Analyze Signal conditioning and Data acquisition system.
- Demonstrate about Hardware-in-loop simulation systems.
- Develop the mathematical modelling of power system and control in real time environment.

- Design control schemes for AC and DC electrical machine drives.
- Demonstrate the concepts of real time control strategy based on FPGA, dSpace.
- Demonstrate the various Real time control applications.

Text Books:
1. *N. Hatziargyriou, Microgrids: Architectures and Control, Wiley-IEEE Press, January (2014).*
2. *Wood A. J. and Wollenberg B., Power generation operation and control, John Wiley.*
3. *Kusic C. L., Computer Aided Power System Analysis, TMH, New Delhi.*

Reference Books:
1. *HIL System catalogues, Opal-RT, RTDS and Typhoon.*
2. *Torsten Cegrell, Power System Control Technology, PHI, India.*
3. *Cerni R.H and Foster L.E., Instrumentation for Engineering Management, John Wiley and Sons.*

Evaluation Scheme:

S N	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	45
3	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEE604: FLEXIBLE AC TRANSMISSION SYSTEMS

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**.**

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 the completion of the course the students will be able to:
- Characterise the converter configuration for different power systems applications such as HVDC, FACTS etc.
- Evaluate the converters, harmonics on AC and DC side and filtering.
- Classify various compensators suited for various power system purposes.
- Analyse power system behaviour with different shunt compensators.
- Appraise series compensated power system behaviour with different series compensators.
- 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 Book:

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

Evaluation Scheme:

S N	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizzes)	25

UEE632: POWER GENERATION AND ECONOMICS

L T P Cr.
3 1 0 3.5

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

Introduction: Energy sources and their availability, Principle types of power plants, their special features and applications, Present status and future trends.

Hydro Electric Power Plants: Essentials, Classifications, Hydroelectric survey, Rainfall run-off, Hydrograph, Flow duration curve, Mass curve, Storage capacity, Site selection, Plant layout, various components, Types of turbines, Governor and speed regulation, Pumped storage, Small scale hydro−electric plants (mini and micro).

Thermal Power Plant: General developing trends, Essentials, Plant layout, Coal−its storage, Preparation, Handling, Feeding and burning, Cooling towers, Ash handling, Water treatment plant, High pressure boilers and steam turbines, Components of thermal power plant.

Gas Turbine Power Plants: Field of use, Components, Plant layout, Comparison with steam power plants, combined steam and gas power plants.

Nuclear Power Plant: Nuclear fuels, Nuclear energy, Main components of nuclear power plant, Nuclear reactors types and applications, Radiation shielding, Radioactive and waste disposal safety aspect.

Non-Conventional Power Generation: Geothermal power plants, Electricity from biomass, Direct energy conversion systems (Solar and Wind) Thermo-electric conversion system, Fuel cells, Magneto Hydro dynamic system.

Cogeneration: Definition and scope, Cogeneration technologies, Allocation of costs, Sale of electricity and impact on cogeneration.

Power Plant Economics: Cost of electrical energy, Selection of type of generation and generation equipment, Performance and operating characteristics of power plants, Economic scheduling principle, Load curves, Effect of load on power plant design, Load forecasting, electric tariffs, Peak load pricing.

Course learning Outcomes (CLO):
After the completion of the course the students will be able to:
- Apply knowledge of India's power scenario, power system structure and related agencies.
- Harness power from conventional and renewable sources.
- Select the methods and size of plant generating power for overall economy.
- Decide the tariff structure for different type of users.

Text Books:

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

Reference Books:

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

Evaluation Scheme:

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

UEE522: ENERGY AUDITING AND MANAGEMENT

	L	T	P	Cr.
	3	1	0	3.5

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

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

Energy Management and Audit: Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, 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, efficientcompressor 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 the completion of the course the students will be able to:
- Analyse energy scenario nationwide and worldwide
- Decide about energy management in more effective way.
- Analyse various energy related aspect of electrical system.
- Carry out financial management.
- Conduct studies related to operational aspects of compressed air system and refrigeration system.

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

Reference Book:

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

Evaluation Scheme:

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

UEE891: PROJECT

L	T	P	Cr
-	-	-	15.0

Course Objectives: 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 University for placement or are forming new relationships of mutual benefit. The project semester gives the student 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 a 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 full time registered student at Thapar University 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):
Upon completion of project semester, the students will be able to:
- Acquire knowledge and experience of software and hardware practices in the area of project.
- Carry out design calculations and implementations in the area of project.
- Associate with the implementation of the project requiring individual and teamwork skills.
- Communicate their work effectively through writing and presentation.
- Demonstrate the knowledge of professional responsibilities and respect for ethics.

UEE893: STARTUP SEMESTER

L	T	P	Cr.
-	-	-	15.0

Course Objective: This course provides the students with competence building workshops and need based skill trainings that enable them to develop their prototype/working model/software application, which is supported by a Business Plan. This semester long interaction with entrepreneurial ecosystem, will provide ample opportunity to students to lay a strong foundation to convert their idea into a startup immediately or in the near future.

This course would include a practical training in a professional set up (a startup or a company, Business incubator, Startup Accelerator etc.) hereafter referred to as host "organization" as deemed appropriate.

Activities during the Startup semester

- Fundamentals of 'Entrepreneurship & Innovation'
- Opportunity identification and evaluation, Customer validation
- Developing a Business Model Canvas
- Business Development Process related to the startup, relating theoretical framework with the business idea, Industry dynamics, opportunity canvas and regulatory aspects related to the business idea.
- Design thinking
- Technical development
- Financial management
- Entrepreneurial Marketing
- Interaction with existing Startups and pitching of projects,
- Presentation of Prototype/Working model/useful App or a working Software

Assessment Details

Each student is assigned a faculty supervisor and industry mentor. Faculty supervisor is responsible for managing and assessment of the Startup 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.

The semester includes maintenance of a Reflective Diary, which is updated throughout the startup 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 the assessment on a designated form. The faculty supervisor is responsible for managing and performing the assessment of the startup semester experience.

Course learning outcome (CLO):

Upon successful completion of the startup semester, the students should be able to:

- Demonstrate an ability to develop a business plan.
- Carry out design calculations/simulations and implementations in the area of project.
- Develop a prototype/working model/software application.
- Comprehend the fundamentals of business pitching.
- Demonstrate the knowledge of professional responsibilities and respect for ethics.

UEE305: ELECTROMAGNETIC FIELDS AND WAVES

L T P Cr.
3 1 0 3.5

Course objective: To provide the basic skills required to understand, develop and design various engineering applications involving electromagnetic fields.

Vector Analysis: Review of vector algebra, Review of Cartesian, Cylindrical and Spherical coordinate systems, Introduction to del∇ (operator, Use of del operator as gradient, divergence,curl).

Electrostatic fields: Introduction to coulomb's law, Gaussian law and it's applications in determination of field of spherical and cylindrical geometries, Laplace's and Poisson's equation in various coordinate systems, effect of dielectric on capacitance, boundary conditions at electric interfaces, method of images and its applications.

Magnetostatics: Introduction to Ampere's law, Magnetic vector potential, Magnetic forces, Boundary conditions at magnetic interfaces.

Time Varying Fields andMaxwell'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 $\vec{E}$ and $\vec{H}$, 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, Application of EM propagation through Transmission Lines, 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 the completion of the course the students will be able to:
- Calculate electric and magnetic fields in different coordinates for various charge and current configurations
- Exhibit the concept of time varying fields and Maxwell's equations
- Demonstrate different aspects of plane wave in dielectric and conducting media
- Realize 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:

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

UEEXXX: MEASUREMENT AND TRANSDUCERS

	L	T	P	Cr.
	2	1	2	3.5

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.

Units, Systems and Standards: SI units, Classification of standards, Time and frequency standards, Electrical standard.

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.

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.

Course Learning Outcomes (CLO):
After the completion of the course the students will be able to:
- Select various types of instruments for measurement of variables.
- Select and use various types of sensors in different conditions.
- Select and use various types of bridge circuits with different sensors.
- Demonstrate the working of electronic instruments, working of sensors and transducers

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

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

Evaluation Scheme:

S N	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessional(Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEEXXX: DATA ANALYTICAL METHODS

L	**T**	**P**	**Cr.**
3	**0**	**0**	**3.0**

Course Objective: Data Analytics is the science of analysing data to convert information to useful knowledge. This knowledge could help the students understand our world better, and in many contexts enable us to make better decisions. This course seeks to present the students with a wide range of data analytic techniques and is structured around the broad contours of the different types of data analytics, namely, descriptive, inferential, predictive, and prescriptive analytics.

Introduction: Data definitions and Analysis techniques, Elements, Variables, and Data categorization, Levels of Measurement, Data management and indexing.

Data Cleaning: Organizing, merging and managing the data, Obtain usable data from the web, APIs, and databases, Understand common data storage systems

Statistical Interference: Review of probability, random variables, expectations, Measures of central tendency, Measures of location of dispersions, Statistical hypothesis generation and testing, Correlation analysis, Maximum likelihood test, confidence intervals.

Exploratory Data Analytics: Regression analysis, Classification techniques, Clustering, Multivariable regression, Investigate analysis of residuals and variability, Understand ANOVA and ANCOVA model cases.

DataVisualization: Dimension reduction, graphical displays of very high dimensional data, Understand analytic graphics and Visualization.

Advancement in Data Analytics: Big data storage, bog data warehouse, big data on cloud, Scalable and parallel computing concept, advanced graphing systems such as the Lattice system.

Course Learning Outcomes

After the completion of the course the students will be able to:
- Analyze data by utilizing clustering and classification algorithms
- Analyse big data and create statistical models
- Explore advanced level of understanding of the usage of big data in real world
- Comprehend the concepts of advancement in big data analytics.

Text Books:
1. AnandRajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.
2. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", Morgan Kaufmann/El sevier Publishers, 2013.

Evaluation Scheme:

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

<center># UEEXXX: EMBEDDED SYSTEM DESIGN</center>

<div align="right">
L T P Cr
2 0 2 3.0
</div>

Introduction: Introduction to Embedded System and its Architecture and system Model, Introduction to the ARM Processor architecture, Embedded Hardware Building Block.

Microprocessor Architecture: Core Architecture, Reset, Power architecture, Low power modes, Clock Functions, Memory organization and system, addressing modes, instruction set, Input & Output port, Data Conversion, RAM & ROM Allocation, Timer programming, Exception Processing–Watch dog, Soft Resets and Interrupts, Communications-SPI, RS232, I2C, CAN and ADC.

Embedded Programming:C-language programming basics, declarations and expressions, arrays, qualifiers and reading numbers, decision and control statements.

Development tools and Programming: Hardware and Software development tools, Project IDE, Compiler, Assembler and Debugger, JTAG and Hardware Debuggers, Interfacing with LCD, Real Time Clock and Temperature Sensors with I2C and SPI bus.

Real-time Operating Systems in Embedded system: Basic concepts of Real-time Operating Systems (RTOS) and its types, Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Concurrency, Reentrancy, Intertask communication, Implementation of RTOS with some case studies.

Laboratory Work:
Programming of microcontroller with Integrated development environment (IDE), Use of JTAG and Hardware Debuggers, Input Devices and Output Devices with their Programming, programming for Interrupts, Clock Functions, LCD interfacing, Interfacing Keypad and Switch Debouncing, ADC, DAC, Real Time Clock, Temperature Sensors with I2C and SPI bus. Interfacing to Motor, LCDs, Transducer, RS-232 Interface and their examples.

Text Books:
1. *Barrett, S.F. and Pack, J.D., Embedded Systems, Pearson Education (2008).*
2. *Haung, H.W., The HCS12 / 9S12: An Introduction to Software and Hardware Interfacing, Delmar Learning (2007).*

Reference Books:
1. *Fredrick, M.C., Assembly and C programming for HCS12 Microcontrollers, Oxford University Press (2005).*
2. *Ray, A.K., Advance Microprocessors and Peripherals – Architecture, Programming and Interfacing, Tata McGraw Hill (2007)*

Evaluation Scheme:

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

UEEXXX: RESTRUCTURED POWER SYSTEMS

	L	T	P	Cr
	3	0	0	3.0

COURSE OUTLINE:

Since 1989, electrical power generation, transmission and distribution have profoundly changed due to efforts to introduce competition, energy price reduction and better use of assets. The restructuring of power industry has changed the operation and control practices in traditional power systems. Along with the secured and reliable operation of power systems, the economic efficiency has become an equally important consideration. Unlike the knowledge of conventional operation of power systems, understanding the restructured power systems requires basic knowledge of electrical engineering, power systems, and in addition the economics. This course is intended to provide the students an understanding of the differences between the conventional power system operation and the restructured one.

Course Objectives:
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

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, Reasons and objectives of deregulation of various power systems across the world, US and European market evolution

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); Relationship between short-run and long-run average costs, Perfectly competitive market, The firm's supply decision under perfect competition.

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 – (i) Imbalance, (ii) Scheduling and Dispatch, (iii) Congestion Management, (iv) Ancillary 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; Models for trading arrangements – Integrated or centralized model, Decentralized model, Comparison between trading arrangement models, ISO or TSO model.

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, Non-market methods (technical methods – FACTS or phase shifting transformers), Market methods, Definition of various 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:

Concept, Illustrative examples, Generic formulation; Introduction to Financial Transmission Rights, Risk Hedging Functionality Of 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. How to obtain ancillary services?, Mandatory provision of ancillary services, Markets for ancillary services.

Pricing of transmission network usage: Introduction to transmission pricing, Power wheeling, Principles of transmission pricing, Classification of transmission pricing methods, Rolled-in transmission pricing methods - Postage stamp method, Incremental postage stamp method, Contract path method, MW-Mile method, (i) Distance based, (ii) Power flow based, Power flow tracing method, Z bus cost allocation method.

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 - Effects of contract for differences, 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, National and Transnational Grids, Reform initiatives during 1990-1995, The Independent Power Plants, Accelerated Power Development and Reforms Program (APDRP), 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.

Course Learning Outcomes (CLO):
On the completion of the course, the student will be able to:
- Develop the concept of power system restructuring and integrated generation.
- Conceptualize the impact of bidding and pricing in competitive electricity markets.
- Demonstrate the different electricity market mechanisms
- Analyze market power
- Choose appropriate congestion management mechanisms

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: Trading Performance and Information Technology*, Lai, L.L., John Wiley and Sons, 2001.

Evaluation Scheme:

S N	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizzes)	25

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.

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 the completion of the course the students will be able to:
- Analyze about energy scenario nationwide and worldwide
- Decide about energy management in more effective way.
- Carry out financial management.
- Analyze about deregulation of power industry.
- Explain about various pillars of electricity market design.

Text Books:

2. *Kothari D. P., NagrathI.J., Modern Power System Analysis, Tata McGraw Hill Education Private Limited (2009).*
3. *Shahedepour M.,Yamin H., Zuyi Li., Market operations in power systems: Forecasting, Scheduling, and Risk Management, John Wiely& Sons, New York.*
4. *Abbi, Y.P. and Jain, S., Handbook on Energy Audit and Environment Management, Teri Bookstore (2006).*
5. *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 N	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizzes)	25

UEE524: 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.

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.

Definitions Voltage sag 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.

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, Total harmonic distortion, rms and average value calculations, Effects of harmonic distortion.

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, Power acceptability curves, various standards.

Course learning Outcomes (CLO):
After the completion of the course the students will be able to:
- Reliably identify the sources of various power quality problems.
- Analyse the causes of harmonic and its distortion effect.
- Estimate the impact of various power quality problems on appliances.
- Educate the harmful effects of poor power quality and harmonics.
- 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 N	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizzes)	25

UEEXXX: ENERGY MANAGEMENT SYSTEMS AND SCADA

	L	T	P	Cr.
	3	0	0	3.0

Course Objective: The course provides an introduction to the Energy Management Systems (EMS) and Supervisory Control and Data Acquisition (SCADA)in Electrical Power Engineering.

Energy Management Functions: Need for energy management – energy management program; Energy accounting–Energy monitoring; targeting and reporting; Energy management centers and their functions, architectures, recent developments.

Economic Analysis and Energy Management Systems: Characteristics of power generating units, Unit commitment (Spinning reserve, Thermal, Hydro and Fuel constraints); Solution techniques of unit commitment; Generation scheduling with limited energy; Important concepts in an economic analysis; Electricity tariff, Electrical load management; Energy production cost – cost models, budgeting and planning, practical considerations;economic dispatch; Interchange evaluation for regional operations, types of interchanges; Exchange costing techniques; Forms of cogeneration – feasibility of cogeneration.

Supervisory Control and Data Acquisition: Introduction to Supervisory Control and Data Acquisition; SCADA Functional requirements and Components; General features, Functions and Applications, Benefits; Configurations of SCADA, RTU (Remote Terminal Units) Connections; Communication requirements, SCADA Communication protocols, Past Present and Future:Structure of a SCADA Communications Protocol.

Power Systems SCADA: Main task in power systems- Planning, operation, accounting, tasks of national control centre, regional control centre, Generating station control room, AGC-SCADA, SCADA in generation, power distribution and power grid; Introduction to wide area protection.

Course Learning Outcome (CLO):
After the completion of the course the students will be able to:
- Analyse the need of energy management system.
- Analyse the behaviour of the modern distribution grid management.
- Monitor the development and dynamics of computer operation and control of power systems.
- Illustrate the need of SCADA system.
- Analyse the working of SCADA system.

Text Books:
1. John D Mc Donald, "Electric Power Substation Engineering", CRC press, *(2001).*
2. Wood, A. J and Wollenberg, B. F, "Power Generation Operation and Control", 2nd Edition John Wiley and Sons, *(2003).*
3. Green, J. N, Wilson, R, "Control and Automation of Electric Power Distribution Systems", Taylor and Francis, *(2007).*
4. Turner, W. C, "Energy Management Handbook", 5th Edition, *(2004).*
5. Amit K. Tyagi, "Handbook on Energy Audits and Management", Tata Energy Research Institute, 2nd reprint, *(2003).*

6. SCADA: by Stuart A. Boyer: IAS *(1999).*
7. Power system Control Technology by Terson , Prentice Hall New Delhi.

Reference Books:
1. Handschin, E. "Energy Management Systems", Springer Verlag, *(1990).*
2. Planning For Demand Side Management in the Electric Sector by J. Parikh, B. Reddy & R. Benerjee:
3. Wayne C. Turner, Steve Doty "Energy Management Hand book", The Fairmont Press, 6th Edition, *(2007).*
4. *Stuart A. Boyer: "SCADA- Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA, The Instrumentation system and Automation Society, 4th Edition, (2010).*
5. Gordon Clarke, Deon Reynders" Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes An imprint of Elsevier Publications, 1st Edition, *(2004).*

Evaluation Scheme:

S N	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizzes)	25

UEEXXX: 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: Concept of Microgrid, Distributed Generation integration to power grid.

Microgrid: Integration of distributed energy sources; 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 the completion of the course the students will be able to:
- Interpret various aspects of the smart Grid, including technologies, components, architectures and applications.
- Suggest modern communication infrastructure and control centre components of smart grid.
- Illustrate various integration aspects of distributed energy resources and microgrid.
- Demonstrate distributed generation coordination including monitoring of smart grid using modern communication infrastructure.
- Analyse operation, control and protection issues in microgrid in the perspective of smart grid.

Text Books:

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

Reference Books:
1. *Ekanayake J.,Jenkins N., Liyanage K., Wu, J., Yokoyama A., Smart Grid: Technology and applications, Wiley Publications.*

2. *Momoh J., Smart Grid: Fundamentals of design and analysis, John Wiley & Sons.*
3. *Flick T., Morehouse J., Securing the smart grid: Next generation power grid security, paperback.*

Evaluation Scheme:

S N	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

	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.

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 samplingand data hold, Reconstructing original signal from sampled signals, conceptof pulse transfer function, Realizationof digital controllers.

Design of discrete-time control systems: Introduction, Stability analysisof closed-loop systemsin the z-plane, Transientand steady state response analysis, Design basedon the root-locus method, Design basedon the frequency-response method.

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

Course learning Outcomes (CLO):

After the completion of the course, the students will be able to:
- Demonstrate non-linear system behaviour by phase plane and describing function methods.
- Perform the stability analysis nonlinear systems by Lyapunov method
- Derive discrete-time mathematical models in both time domain (difference equations, state equations) and z-domain (transfer function using z-transform).
- Predict and analyse transient and steady-state responses and stability linear, time-invariant, discrete-time control systems.

Text Book:
1. Bandyopadhyay, M.N., Control Engineering: Theory and Practice, Prentice-Hall of India Private Limited (2003).
2. Khalil, H. K., & Grizzle, J. W. *Nonlinear systems* (Vol. 3). Upper Saddle River, 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 N	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizzes)	25

UEEXXX: 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.

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 the completion of the course the students will be able to:
- Choose intelligently AC and DC transmission systems for the dedicated application(s).
- Identify the suitable two-level/multilevel configuration for high power converters.
- Select the suitable protection method for various converter faults.
- Identify suitable reactive power compensation method.
- 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 N	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	25

UEEXXX: STOCHASTICMODELING 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.

Introduction: Basic concepts of probability theory, Probability of stochastic events, Random variables and its distribution, Numeral character of random variable, Convolution of random variables, Several usual random variable distributions, Markov process.

Probabilistic Component Models: Probabilistic model of load, Probabilistic model of power system components, Outage table of power system components

Monte Carlo simulation: Concept of constructing random walk, fundamental theory of Monte Carlo simulation method, Sampling of system operation state, State evaluation model, Indices of reliability evaluation, Flowchart of composite system adequacy evaluation, Markov Chain Monte Carlo (MCMC) simulation method

Stochastic load flow: Cumulants of random distribution, Linearization of load flow equation, Computing process of probabilistic load flow, Probabilistic

Stochastic models for electric systems: Introduction, Network-flow model, Lower boundary points of feasible flow solutions, power system protection, integrating the renewable energy systems.

Reliability of electrical systems: Reliability, FOR, Preventive maintenance, Generation expansion planning, Power pooling and power trading, Reliability of transmission system, Transmission planning under uncertainty.

Course Learning Outcome (CLO):
After completion of the course the students will be able to:

- Carryout sampling and Monte Carlo simulation.
- Find stochastic model of electrical systems and develop the solution approach.
- Compute the reliability indices of generating or transmission systems.
- Identify the expansion of generator as per LOLP.

Text Books:

1. Anders, George J (1990). Probability concepts in electric power systems. Wiley, New York
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 N	Evaluation Elements	Weightage (%)
4.	MST	30
5.	EST	45
6.	Sessional (Assignments/Projects/Tutorials/Quizzes)	25

UEEXXX: DIGITAL CONTROLLERS FOR POWER APPLICATIONS

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L  T  P  Cr
2  0  2  3.0
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Course Objective: To provide a deep insight into the various digital controller schemes used in power converters.

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: Detailedmathematical 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 Outcome (CLO):
After the completion of the course the students will be able to:
- Conceptualize sample and hold circuit
- Develop mathematical model of different power converters
- Devise controller for different power converters.

Text Books:

1. Luo, F. L., Ye, H., & Rashid, M. H. *Digital power electronics and applications*. Elsevier *(2010)*.
2. Buso, S., & Mattavelli, P. Digital control in power electronics. *Synthesis Lectures on Power Electronics*, *5*(1), 1-229, *(2015)*.

Reference Books:

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

Evaluation Scheme:

S N	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab evaluations)	30

UEEXXX: 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.

Introduction to CloudTechnologies: 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 outcome (CLOs):
Upon completion of this course, the student will be able to:
- Explain the cloud architectures and use the IoT technologies for cloud formulation.
- Explain the virtualization and resource management concepts in clouds.
- Confront storage, processing and security issues for cloud computing.
- Apply the cloud computing concept for electrical system application.

Text Books:
1. RajkumarBuyya, James Broberg and Goscinski, Cloud Computing Principles and Paradigms, John Wiley and Sons, Second Edition, 2012.
2. Gerard Blokdijk, Ivanka Menken, The Complete Cornerstone Guide to Cloud Computing Best Practices, 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:

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

UEEXXX: INDUSTRIAL ELECTRONICS

L	**T**	**P**	**Cr.**
3	**0**	**0**	**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.

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.

Course learning Outcomes (CLO):
After the completion of the course the students will be able to:
- Simulate and analyse the semiconductor controlled ac and DC drive system
- Design and develop an illumination system for domestic, industry and commercial sites.
- Design an electric heating system for industrial purposes.
- Equip the skill to design and develop a regulated power supply.
- Simulate and analyse the series and shunt compensators for power factor improvement in drive system.

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 N	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessional (Assignments/Projects/Tutorials/Quizzes)	25