COURSE SCHEME AND SYLLABUS

FOR

B.E. (ELECTRICAL ENGINEERING)

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

2022

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	UTA003	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	UTA016	ENGINEERING DESIGN PROJECT-I (2 self-effort hours)	PR	1	0	2	3.0
		TOTAL		18	4	8	25.0

*Student will attend one lab Session of 2 hours in a semester for a bridge project in this course.

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	UTA025	INNOVATION ANDENTREPRENEURSHIP	CF	1	0	2*	3.0
4	UEE505	ANALOG AND DIGITAL SYSTEMS	CP	3	1	2	4.5
5	UEE301	DIRECT CURRENT MACHINES AND TRANSFORMERS	CP	3	1	2	4.5
6	UTA024	ENGINEERING DESIGN PROJECT-II	PR	1	0	4	3.0
7	UHU005	HUMANITIES FOR ENGINEERS	CF	2	0	2	3.0
		TOTAL		16	3	14	26.5

*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	UEE304	TRANSMISSION AND DISTRIBUTION OF ELECTRIC POWER	CP	3	1	0	3.5
3	UMA035	OPTIMIZATION TECHNIQUES	CF	3	0	2	4.0
4	UEE409	NETWORK THEORY	CP	3	1	2	4.5
5	UEI610	FUNDAMENTALS OF MICROPROCESSORS AND MICROCONTROLLERS	CP	3	0	2	4.0
6	UEE411	MEASUREMENT AND TRANSDUCERS	CP	2	1	2	3.5
		TOTAL		**17**	**4**	**8**	**24.0**

SEMESTER-V

S No	Course No	Course Title	Code	L	T	P	Cr.
1	UEI501	CONTROL SYSTEMS	CP	3	1	2	4.5
2	UTA026	MANUFACTURING PROCESSES	CF	2	0	2	3.0
3	UEE509	POWER SYSTEM ANALYSIS	CP	3	1	2	4.5
4	UEE510	HIGH VOLTAGE ENGINEERING	CP	3	0	2	4.0
5	UEE504	POWER ELECTRONICS	CP	3	1	2	4.5
6		ELECTIVE-I	PE	2	0	2	3.0
7	UCS541	FOUNDATIONS OF ARTIFICIAL INTELLIGENCE	CF	3	0	2	4.0
		TOTAL		**19**	**3**	**14**	**27.5**

SEMESTER-VI

S No	Course No	Course Title	Code	L	T	P	Cr.
1	UCS540	DATA STRUCTURES AND ALGORITHMS	CP	3	0	2	4.0
2	UEE613	INDUSTRIAL DRIVES AND AUTOMATION	CP	3	1	2	4.5
3	UEE610	POWER SYSTEM PROTECTION	CP	3	0	2	4.0
4	ULC402	FUNDAMENTALS OF SIGNAL PROCESSING	CP	3	0	2	4.0
5	UEE612	MACHINE LEARNING TECHNIQUES	CP	3	0	2	4.0
6		ELECTIVE-II	PE	2	0	2	3.0
7	UEE795	CAPSTONE PROJECT (START)	PR	1*	0	2	--
		TOTAL		**17**	**1**	**12**	**23.5**

*Alternate week

SEMESTER-VII

S No	Course No	Course Title	Code	L	T	P	Cr.
1	UEE705	SUSTAINABLE ENERGY SYSTEMS	CP	2	0	2	3.0
2	UEE706	IoT AND REAL TIME SYSTEMS	CP	3	0	2	3.0
3		ELECTIVE-III	PE	2	0	2	3.0
4		GENERIC ELECTIVE	GE	2	0	0	2.0
5	UEE795	CAPSTONE PROJECT	PR	0	0	2	8.0
		TOTAL		**9**	**0**	**8**	**19.0**

*Alternate week

SEMESTER-VIII

S No	Course No	Course Title	Code	L	T	P	Cr.
1	UEE894	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	UEE895	DESIGN PROJECT	PR	-	-	-	8.0
		TOTAL		**6**	**2**	**0**	**15.0**
		OR					
1	UEE896	START- UP SEMESTER	PR	-	-	-	**15.0**

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

BASKETS OF SPECIALIZATION

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

ELECTIVE-I

S No	Course No	Course Title	Code	L	T	P	Cr.
1	UEE525	DATA ANALYTICAL METHODS	PE	2	0	2	3.0
2	UEE526	EMBEDDED SYSTEM DESIGN	PE	2	0	2	3.0
3	UEE527	RESTRUCTURED POWER SYSTEMS	PE	3	0	0	3.0
4	UEE406	POWER SYSTEM PRACTICES	PE	3	0	0	3.0
5	UEE528	POWER QUALITY MONITORING AND CONDITIONING	PE	3	0	0	3.0
6	UEE305	ELECTROMAGNETIC FIELDS AND WAVES	PE	2	2	0	3.0
7	UCS417	INTRODUCTION TO OPERATING SYSTEMS	PE	2	0	2	3.0

ELECTIVE-II

S No	Course No	Course Title	Code	L	T	P	Cr.
1	UCS653	DATA MINING AND VISUALIZATION	PE	2	0	2	3.0
2	UEE638	PLC AND SCADA	PE	2	0	2	3.0
3	UEE636	SMART GRID SYSTEMS	PE	2	0	2	3.0
4	UEE721	NONLINEAR AND DIGITAL CONTROL SYSTEMS	PE	3	0	0	3.0
5	UEE637	HIGH VOLTAGE TRANSMISSION SYSTEMS	PE	3	0	0	3.0
6	UEI625	ANALOG AND DIGITAL COMMUNICATION	PE	3	0	0	3.0
7	UCS312	INTRODUCTION TO DATABASE MANAGEMENT SYSTEMS	PE	2	0	2	3.0

ELECTIVE-III

S No	Course No	Course Title	Code	L	T	P	Cr.
1	UEE741	STOCHASTIC MODELING OF ELECTRICAL SYSTEMS	PE	3	0	0	3.0
2	UEE742	DIGITAL CONTROLLERS FOR POWER APPLICATIONS	PE	2	0	2	3.0
3	UEE743	CLOUD COMPUTING BASED ELECTRICAL SYSTEMS	PE	3	0	0	3.0
4	UEE744	INDUSTRIAL ELECTRONICS	PE	3	0	0	3.0
5	UEE601	FLEXIBLE AC TRANSMISSION SYSTEMS	PE	3	0	0	3.0
6	UCS414	COMPUTER NETWORKS	PE	2	0	2	3.0

GENERIC ELECTIVES

S No	Course No	Course Title	Code	L	T	P	Cr.
1	UTD001	EMPLOYABILITY DEVELOPMENT SKILLS	GE	2	0	0	2.0
2	UHU006	INTRODUCTORY COURSE IN FRENCH	GE	2	0	0	2.0
3	UHU009	INTRODUCTION TO COGNITIVE SCIENCE	GE	2	0	0	2.0
4	UHU008	INTRODUCTION TO CORPORATE FINANCE	GE	2	0	0	2.0
5	UCS001	INTRODUCTION TO CYBER SECURITY	GE	2	0	0	2.0
6	UPH063	NANOSCIENCE AND NANOMATERIALS	GE	2	0	0	2.0
7	UEN004	TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT	GE	2	0	0	2.0
8	UMA066	GRAPH THEORY AND APPLICATIONS	GE	2	0	0	2.0
9	UMA067	ADVANCED NUMERICAL METHODS	GE	2	0	0	2.0
10	UBT509	BIOLOGY FOR ENGINEERS	GE	2	0	0	2.0

TOTAL CREDITS: 184.0

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, waveoptics, 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, andopera;*Ultrasonics:*ProductionandDetectionofUltrasonicwaves,Applications-green energy, sound signaling, dispersion of fog, remote sensing, Car's airbagsensor.

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.

Approved in 102nd meeting of the Senate held on November 27, 2020

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) 6thed.*
2   *Griffiths, D.J., Introduction to Electrodynamics, Prentice Hall of India (1999) 3rded.*
3   *Jenkins, F.A. and White, H.E., Fundamentals of Optics, McGraw Hill (2001) 4thed.*

Reference Books
1   *Wehr,M.R,Richards,J.A.,Adair,T.W.,PhysicsofTheAtom,NarosaPublishingHouse (1990) 4thed.*
2   *Verma, N.K., Physics for Engineers, Prentice Hall of India (2014)1sted.*
3   *Pedrotti, Frank L., Pedrotti, Leno S., and Pedrotti, Leno M., Introduction to Optics, Pearson Prentice Hall^{TM} (2008) 3rded.*

Scheme of evaluation

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

Approved in 102nd meeting of the Senate held on November 27, 2020

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.

PartialDifferentiation: Functionsofseveralvariables,Limitsandcontinuity,Chainrule,Changeof 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, Taylorseries, 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.

Text Books:

1) Thomas,G.B.andFinney,R.L.,CalculusandAnalyticGeometry,PearsonEducation(2007), 9thed.
2) Stewart James, Essential Calculus; Thomson Publishers (2007), 6thed.
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, (7thedition)

Evaluation Scheme:

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

UTA003: 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 and Opening 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 BipolarJunctionTransistorandTransistorBiasing,CB,CE,CC(Relationshipbetweenα,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:
FamiliarizationwithCRO,DSOandElectronicComponents,Diodescharacteristics-Input-Output and Switching, BJT and MOSFET Characteristics, Zener diode as voltageregulator, Rectifiers, Clippers and Clampers, adder circuit implementation, Multiplexer & its application, Latches/Flip-flops, up/downcounters.

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

Approved in 102nd meeting of the Senate held on November 27, 2020

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 McGrawHill, 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	0	4	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 menu 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

Micro Projects /Assignments:

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

Approved in 102nd meeting of the Senate held on November 27, 2020

b. Using wax blocks or soap bars to develop three-dimensional object, section it and color the section

c. Use of AUTOCAD as a complementary tool for drawing the projections of the objects created in (1) and (2).

4. Develop the lateral surface of different objects involving individual or a combination of solids like Prism, Cone, Pyramid, Cylinder, Sphere etc.

5. To draw the detailed and assembly drawings of simple engineering objects/systems with due sectioning (where ever required) along with bill of materials. e.g. Rivet joints, simple bearing, wooden joints, Two plates connected with nut and bolt etc.

Course Learning Outcomes (CLO):
On completion of the Course, the student would be able to:
1. creatively comprehend geometrical details of common engineering objects
2. draw dimensioned orthographic and isometric projections of simple engineering objects
3. draw sectional views of simple engineering objects.
4. interpret the meaning and intent of toleranced dimensions and geometric tolerance symbolism
5. create and edit dimensioned drawings of simple engineering objects using AutoCAD
6. organize drawing objects using layers and setting up of templates in AutoCAD

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

Reference Books:
1. *Gill, P.S., Geometrical Drawings, S.K. Kataria & Sons, Delhi(2008).*
2. *Gill, P.S., Machine Drawings, S.K. Kataria & Sons, Delhi(2013).*
3. *Mohan, K.R., Engineering Graphics, Dhanpat Rai Publishing Company (P) Ltd, Delhi(2002).*
4. *French, T. E., Vierck, C. J. and Foster, R. J., Fundamental of Engineering Drawing & Graphics Technology, McGraw Hill Book Company, New Delhi(1986).*
5. *Rowan, J. and Sidwell , E. H., Graphics for Engineers, Edward Arnold, London (1968).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST (formal written test)	25
2.	EST (formal written test)	40
3.	Sessional: (may include the following) Continuous evaluation of drawing assignments in tutorial/ regular practice of AutoCAD tutorial exercises & Individual independent project work/drawing and AutoCAD assignment	35

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 roleplays.
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).*

Approved in 102nd meeting of the Senate held on November 27, 2020

2. *Raman,M & Sharma, S.,Technical Communication Principles and Practice, Oxford University Press NewDelhi.(2011).*
3. *Mukherjee H.S.,Business Communication-Connecting at Work,Oxford UniversityPress New Delhi,(2013).*

Reference Books:

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

UCB008: 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 andinternalmethodsofsofteningofwater:carbonate,phosphate,calgonandcolloidalconditioning, lime-soda process, zeolite process, ion exchange process, mixed bed deionizer, desalination of brackish water.

Fuels: Classificationoffuels,calorificvalue,cetaneandoctanenumber,fuelquality,comparisonof solidliquidandgaseousfuels,propertiesoffuel,alternativefuels:biofuels,poweralcohol,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 conductometrictitrations.
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.,EngineeringChemistry,TataMcGraw-HillPub.Co.Ltd,NewDelhi(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

Approved in 102nd meeting of the Senate held on November 27, 2020

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,variablecapacitor;capacitorcharginganddischarging,current-voltagerelationship,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.andBrown,K.,ElectricalandElectronicTechnology,PHI (2008).*
2. *Nagrath, I.J. and Kothari, D.P., Basic Electrical Engineering, Tata McGraw Hill(2002).*
3. *Naidu,M.S.andKamashaiah,S.,IntroductiontoElectricalEngineering,TataMcGrawHill (2007).*

Reference Books:
1. *Chakraborti, A., Basic Electrical Engineering, Tata McGraw−Hill(2008).*
2. *Del Toro, V., Electrical Engineering Fundamentals,* Prentice−Hall of India PrivateLimited *(2004)*

Evaluation Scheme:

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

Approved in 102nd meeting of the Senate held on November 27, 2020

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 and sustainable use of natural resources, Pollution based environmental issues and case studies

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

Air Pollution: Origin, Sources and effects of air pollution; Primary and secondary meteorological parameters; Wind roses; Atmospheric Stability; Inversion; Plume behavior; Management of air pollution: Source reduction and Air Pollution Control Devices for particulates and gaseous pollutants in stationary and mobilesources.

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 management methods: Incineration, composting, Biomethanation, landfill, E-waste management, Basalconvention.

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 and biochemical conversion route; Generation of Biogas and biodiesel as fuels; Solar energy-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 units of an ecosystem; Food Chain, Food Web, Trophic Structures and Pyramids; Energy flow; Ecological Succession; Types, Characteristics, Biodiversity, Biopiracy.

Approved in 102nd meeting of the Senate held on November 27, 2020

Human Population and the Environment: Population growth, variation among nations; Population explosion – Family Welfare Programmes; Environment and human health; Human Rights; Value Education; Women and Child Welfare; Role of Information Technology in Environment and Human Health, Environmental Ethics.

Course Learning Outcomes (CLOs):
On the completion of course, students will be able to:
1. Comprehendtheinterdisciplinarycontextwithreferencetotheenvironmentalissuesand case studies
2. Assess the impact of anthropogenic activities on the various elements of environment and apply suitable techniques to mitigate their impact.
3. Conceptualise and explain the structural and functional features of ecological systems
4. Correlate environmental concerns with the conventional energy sources associated and assess the uses and limitations of non-conventional energy technologies

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 applicationproblems described by theseequations.
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 valueproblems.
3. Find the Fourier series expansions of periodic functions and subsequently will be able to solve heat and waveequations.
4. solve systems of linear equations by using elementary rowoperations.
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 matrixand find the eigen values and eigenvectors.

Text Books:

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

Approved in 102nd meeting of the Senate held on November 27, 2020

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	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

Approved in 102nd meeting of the Senate held on November 27, 2020

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 forcesystems
2.   Identify and quantify all forces associated with a staticframework
3.   Draw Shear Force Diagram and Bending Moment Diagram in various kindsof beams subjected to different kinds ofloads

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).*

Approved in 102nd meeting of the Senate held on November 27, 2020

Reference Books:

1. *Hibler, T.A., Engineering Mechanics: Statics and Dynamics, Prentice Hall(2012).*
2. *Timoshenko and Young, Engineering Mechanics, Tata McGraw HillEducation 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 PCr
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.Arrayofobjects,dynamicmemoryallocation,thispointer,nestedclasses,friendfunctions, constructors and destructors, constructor overloading, copy constructors, operator overloading and typeconversions.

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

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 andI/O function in a computerprogram.
2. Comprehend the concepts of classes, objects and apply basics of object oriented programming, polymorphism andinheritance.
3. Demonstrate use of filehandling.
4. Demonstrate use of templates and exceptionhandling.
5. Demonstrate use of windows programming concepts usingC++.

Evaluation scheme

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

Approved in 102nd meeting of the Senate held on November 27, 2020

UTA016: ENGINEERING DESIGN PROJECT-I

L	T	P	Cr
1	0	2	3.0

Course Objectives: To develop design skills according to a Conceive-Design-Implement- Operate (CDIO) compliant methodology. To apply engineering sciences through learning-by- doing project work. To provide a framework to encourage creativity and innovation. To develop team work and communication skills through group-based activity. To foster self- directed learning and critical evaluation.

To provide a basis for the technical aspects of the project a small number of lectures are incorporated into the module. As the students would have received little in the way of formal engineering instruction at this early stage in the degree course, the level of the lectures is to be introductory with an emphasis on the physical aspects of the subject matter as applied to the 'Mangonel' project. The lecture series include subject areas such as Materials, Structures, Dynamics and Digital Electronics delivered by experts in the field. This module is delivered using a combination of introductory lectures and participation by the students in 15 "activities". The activities are executed to support the syllabus of the course and might take place in specialised laboratories or on the open ground used for firing the Mangonel. Students work in groups throughout the semester to encourage teamwork, cooperation and to avail of the different skills of its members. In the end the students work in sub-groups to do the Mangonel throwing arm redesign project. They assemble and operate a Mangonel, based on the lectures and tutorials assignments of mechanical engineering they experiment with the working, critically analyse the effect of design changes and implement the final project in a competition. Presentation of the group assembly, redesign and individual reflection of the project is assessed in theend.

Breakup of lecture details to be taken up by MED:

Lec No.	Topic	Contents
Lec 1	Introduction	The Mangonel Project. History. Spreadsheet.
Lec 2	PROJECTILE MOTION	no DRAG, Design spread sheet simulator forit.
Lec 3	PROJECTILE MOTION	with DRAG, Design spread sheet simulatorfor it.

Lec 4	STRUCTURES FAILURE	STATIC LOADS
Lec 5	STRUCTURES FAILURE	DYNAMIC LOADS
Lec 6	REDESIGNING THE MANGONEL	Design constraints and limitations of materials for redesigning the Mangonelfor competition as a group.
Lec 7	MANUFACTURING	Manufacturing and assembling the Mangonel.
Lec 8	SIMULATION IN ENGINEERING DESIGN	Simulation as an Analysis Tool in Engineering Design.
Lec 9	ROLE OF MODELLING &	The Role of Modelling in Engineering Design.

Breakup of lecture details to be taken up by ECED:

Lec No.	Topic	Contents
Lec 1-5	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 spread sheet 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

Approved in 102nd meeting of the Senate held on November 27, 2020

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 inter group competition to assess best redesign and understanding of the "Mangonel".	W5

Project: The Project will facilitate the design, construction and analysis of a "Mangonel".Inadditiontosomeintroductorylectures,thecontentofthestudents'work during the semester will consistof:

2. the assembly of a Mangonel from a Bill Of Materials (BOM), detailed engineering drawings of parts, assembly instructions, and few prefabricatedparts;
3. the development of a software tool to allow the trajectory of a "missile" to bestudied as a function of various operating parameters in conditions of no-drag and drag due toair;
4. a structural analysis of certain key components of the Mangonel for static and dynamic stresses using values of material properties which will be experimentally determined;
5. the development of a micro-electronic system to allow the angular velocity of the throwing arm to be determined;
6. testing the Mangonel;
7. redesigning the throwing arm of the Mangonel to optimise for distance without compromising its structural integrity;
8. an inter-group competition at the end of the semester with evaluation of the group redesign strategies.

Course Learning Outcomes (CLO):
On completion of the Course, the student would be able to:

1. simulate trajectories of a mass with and without aerodynamic drag using a spreadsheet based software tool to allow trajectories beoptimized;
2. perform a test to acquire an engineering material property of strength in bending and analyze the throwing arm of the "Mangonel" under conditions of static and dynamic loading;
3. develop and test softwarecode to process sensor data;
4. design, construct and test an electronic hardware solution to process sensordata;
5. construct and operate a Roman catapult "Mangonel" using tools, materials and assembly instructions, in a group, for acompetition;
6. operate and evaluate the innovative redesign of elements of the "Mangonel" for functional and structuralperformance;

Text Books:
1. *Michael Mc Roberts, Beginning Arduino, Technology in actionpublications.*
2. *Alan G. Smith, Introduction to Arduino: A piece of cake, Create Space Independent Publishing Platform(2011)*

Reference Book:
1. *John Boxall, Arduino Workshop - A Hands-On Introduction with 65 Projects, No Starch Press(2013)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	-
2	EST	-
3	Sessional: (may include the following) Mechanical Tutorial Assignments	
	Electronics Hardware and software Practical work in Laboratory	30
	Assessment of Mechanical contents in Lectures and Tutorials and Electronics contents in Lectures and Practical.	30
		10
	Project (Assembly of the "Mangonel", innovative redesign with reflection, prototype competition, Final Presentation and viva-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-propertyrelationship 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 surfacedefects.

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 Curietemperature.
2. To study cooling curve of a binaryalloy.
3. Determination of the elastic modulus and ultimate strength of a given fiberstrand.
4. To determine the dielectric constant of a PCBlaminate.

Approved in 102ⁿᵈ meeting of the Senate held on November 27, 2020

5. Detection of flaws using ultrasonic flaw detector(UFD).
6. To determine fiber and void fraction of a glass fiber reinforced compositespecimen.
7. To investigate creep of a given wire at room temperature.
8. To estimate the Hall coefficient, carrier concentration and mobility in a semiconductorcrystal.
9. To estimate the band-gap energy of a semiconductor using four probetechnique.
10. To measure grain size and study the effect of grain size on hardness of the given metallicspecimens.

Course Outcomes: Student will be able to:
1. classify engineering materials based on itsstructure.
2. draw crystallographic planes anddirections.
3. distinguish between elastic and plastic behavior ofmaterials.
4. distinguish between isomorphous and eutectic phasediagram.
5. classify materials based on their electrical and magneticproperties.
6. propose a solution to preventcorrosion.

Text Books:
1. W.D. Callister , Materials Science and Engineering; John Wiley & Sons, Singapore, 2002.
2. W.F.Smith,PrinciplesofMaterialsScienceandEngineering:AnIntroduction;TataMc-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

EvaluationScheme

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

Approved in 102nd meeting of the Senate held on November 27, 2020

UMA033: Numerical and Statistical Methods
(Only for BE-Electrical and BE-Electronics (Instrumentation and Control))

	L	T	P	Cr
	3	0	2	4.0

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

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 backwarddifferences, **L**agrange (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.

ProbabilityDistribution: Mathematicalexpectations,Definitionofprobabilitydistribution (Probability Mass Function and Probability Density Function), Poisson, Geometric, Binomial, Uniform and Normaldistributions

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

LaboratoryWork: Labexperimentswillbesetinconsonancewithmaterialscoveredinthe 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 usingbisection, Newton, and fixed-point iterationmethods.
2. solve system of linear equations numerically using direct and iterativemethods.
3. analyze the correlated data using the least square and regressioncurves.
4. solve integration and initial value problemsnumerically.
5. Solve real life problems using various probabilitydistributions.
6. Approximate the data and functions using interpolatingpolynomials

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, 7thEdition, Pearson,2003.
2. Walpole, Ronald E., Myers, Raymond H., Myers, Sharon L., and Keying, Ye, ProbabilityandStatisticsforEngineersandScientists,8theditionPearsonEducation, 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	Weightage (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	15
4.	Laboratory evaluation	20

UTA025: 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.

CraftingbusinessmodelsandLeanStart-ups:Introductiontobusinessmodels;Creatingvalue 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; organizationalstructures;Evolutionoforganization,sourcesandselectionofventurefinanceoptions 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 theirintentions
2. Discover/create and evaluateopportunities.
3. Identify various stakeholders for the idea and develop value proposition for thesame.
4. Describe various Business Models and design a business modelcanvas.
5. Analyse and select suitable finance and revenue models for start-upventure.

Text Books:
1. *Ries, Eric(2011), The lean Start-up: How constant innovation creates radically successful businesses, Penguin BooksLimited.*
2. *Blank, Steve (2013), The Startup Owner's Manual: The Step by Step Guide for Building a Great Company, K&SRanch.*
3. *S.CarterandD.Jones-Evans,Enterpriseandsmallbusiness-PrincipalPracticeandPolicy, 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 ModelGeneration.*
3. *Kachru, Upendra, India Land of a Billion Entrepreneurs,Pearson*

Approved in 102ⁿᵈ meeting of the Senate held on November 27, 2020

4. *Bagchi, Subroto, (2008), Go Kiss the World: Life Lessons For the Young Professional, PortfolioPenguin*
5. *Bagchi, Subroto, (2012). MBA At 16: A Teenager's Guide to Business, PenguinBooks*
6. *Bansal, Rashmi, Stay Hungry Stay Foolish, CIIE, IIMAhmedabad*
7. *Bansal, Rashmi, (2013). Follow Every Rainbow,Westland.*
8. *Mitra, Sramana (2008), Entrepreneur Journeys (Volume 1), BooksurgePublishing*
9. *Abrams, R. (2006). Six-week Start-up, Prentice-Hall ofIndia.*
10. *Verstraete,T.andLaffitte,E.J.(2011).ABusinessModelofEntrepreneurship,EdwardElgar Publishing.*
11. *Johnson, Steven (2011). Where Good Ideas comes from, Penguin BooksLimited.*
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, PanMacmillan*
14. *Kelley, Tom (2011),The ten faces of innovation, CurrencyDoubleday*
15. *Prasad, Rohit (2013), Start-up sutra: what the angels won't tell you about business and life, HachetteIndia.*

Evaluation scheme:

Sr. No.	Evaluation Elements	Weightage (%)
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 analyse BJT biasing circuits and working of FET, understand multi-stage and power amplifications, working of active filters and oscillators, and to design combinational and sequential digital circuits.

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

Transistor at Low and High Frequencies: Low frequency h-parameter model of BJT, The Hybrid-pi (II) Common-emitter Transistor Model, Hybrid-II conductances, The Hybrid-II Capacitances, variation of Hybrid-II parameters, The CE short-circuit current gain, The gainbandwidth product.

Amplifiers: review of op amp and its applications; classification, distortion and frequency response of an amplifier, applications of amplifiers for multi-stage and power amplifications.

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

Digital Electronics: Boolean expressions (SOP and POS forms); combinational logic circuits: Adders, Subtractors, Encoders, Decoders, Multiplexers, Demultiplexers; Sequential logic circuits: Flip-flops, registers and counters.

Logic Families: TTL, MOS, CMOS logic families their comparison, Fan-in, Fan-out, Unit load, Propagation delay, Power dissipation, Current and voltage parameters, Tristate Logic, Interfacing of TTL and CMOS logic families.

Converters: Analog to digital conversion (flash type, dual slope, successive approximation), digital to analog conversion (binary weighted resistor, binary ladder or R-2R ladder).

Laboratory work: RC coupled amplifier in CE mode, application of bistable, astable and monostable multivibrators, Hartley and Colpitts oscillator, combinational circuits, flip flops, shift register and binary counters, asynchronous and synchronous up/down counters, variable modulus counters, usage of IC tester.

Course Learning Outcomes (CLO):
After the completion of the course, the students will be able to:
1. Design different types of transistor biasing circuits
2. Design Butterworth active filters and oscillator circuits
3. Design combinational and sequential logic circuits
4. 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.andWidmer,N.,DigitalSystems:PrinciplesandApplications,PearsonEducation (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

Evaluation Elements	% Weightage
Mid Semester Test	25
End Semester Examination	45
Sessional (may include Tutorial, Assignment, Lab work, Quizzes, Project as applicable)	30
Total	100

UEE301: DIRECT CURRENT MACHINES AND TRANSFORMERS

L   T   P   Cr.
3   1   2   4.5

CourseObjective: Tointroducethefundamentalsofdcmachines,transformer,3-phasetransformer and special purposetransformer.

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 ofDC machines: Brake test, Swinburne's test, Hopkinson's test or back to back test, Retardation test or Running test, Field's test, Applications of DCmotors.

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, Convertertransformer.

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,ElectromechanicalDevicesforEnergyConversion,*PrenticeHallofIndia *(2004).*
3. *Fitzgerald, A.E., Kingsley, C. Jr. and Umans, Stephen, Electric Machinery, McGraw Hill (2002).*

Evaluation Scheme:

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

UTA024 Engineering Design Project-II (Buggy Lab)
(including 6 self effort hours)

	L	T	P	Cr
	1	0	4	6.0

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, theirtechnical specifications, selection criterion, working principle and applications suchas-
  - Active and passive components: Transistor (MOSFET), diode (LED), LCD, potentiometer, capacitors, DC motor, Breadboard, general PCBetc.
  - Instruments: CRO, multimeter, Logic probe, solder iron, desolderiron
  - Serial communication: Concept of RS232 communication ,Xbee
- ❖ Introduction of ATtiny microcontroller based PWM circuitprogramming.

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

Basics of C#:
- ❖ Introduction: MS.NET Framework Introduction, Visual Studio Overview and Installation
- ❖ ProgrammingBasics:Consoleprogramming,VariablesandExpressions,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 serialport.
- ❖ Software code optimization, software versioncontrol

Laboratory Work:

SchematiccircuitdrawingandPCBlayoutdesignonCADtools,implementinghardware module of IR sensor, Transmitter and Receiver circuit onPCB.

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.

SilverChallenge:Twobuggies,bothonelooparound,trackinoppositedirectionsunder   full supervisory, control. Able to detect an obstacle. Both park safely. Able to communicate state of the track and buggy at each gantry stop withconsole.

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. DrawtheschematicdiagramofanelectroniccircuitanddesignitsPCBlayoutusing CADTools.
3. Apply hands-on experience in electronic circuit implementation and itstesting.
4. Demonstrate programming skills by integrating coding, optimization anddebugging for differentchallenges.
5. Develop group working, including task sub-division and integration of individual contributions from theteam.

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

Approved in 102nd meeting of the Senate held on November 27, 2020

UHU005: Humanities for Engineers

L	T	P	Cr
2	0	2	3.0

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. SurveyAnalysis

4. Capital Budget in gassignment

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 fordecision-making.
5. apply techniques for projectevaluation.

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, NewDelhi, (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:

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

Approved in 102ⁿᵈ meeting of the Senate held on November 27, 2020

UEE401: ALTERNATING CURRENTMACHINES

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 revolvingfieldtheory,Equivalentcircuit,Determinationofequivalentcircuitparameters,Splitphase 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,EMFequation,Windingfactor,Harmonics,Armatureresistance,Armaturereaction: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,Paralleloperationandloaddivision,Suddenshortcircuitanalysisand 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.Threephaseinductionmotors:startingmethods,Equivalentcircuitparameters,Loadtest, 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 inparallel.
- 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.,andUmans,Stephen,ElectricMachinery,McGraw−Hill(2002).*

Evaluation Scheme:

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

Approved in 102ⁿᵈ meeting of the Senate held on November 27, 2020

UEE304: 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, Sizeof 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.

EHVtransmissionandHVDCtransmission: NeedofEHVtransmissionsystem,typesofDC links, advantages of DC transmission, EHVAC and HVDC systems in India andtrends.
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 performanceparameters.
- Design the transmission lines under various workingconditions.
- Select the configurations of different line insulators and evaluate theirperformance.
- Supervise the laying of cables and fault detection incables.
- Design the distribution systemnetwork.

Approved in 102nd meeting of the Senate held on November 27, 2020

Text Books:

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

Reference Books:

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

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 willbeonbasicstudyoflinearandnon-linearprogrammingproblems,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.

MultiobjectiveProgramming: Introductiontomultiobjectivelinearprogramming,efficient solution, efficientfrontier.

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

LaboratoryWork: Labexperimentswillbesetinconsonancewithmaterialscoveredinthe theory usingMatlab.

Course learning outcome: Upon Completion of this course, the students would be able to:

1) formulate the linear and nonlinear programmingproblems.
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.

Approved in 102nd meeting of the Senate held on November 27, 2020

Text Books:

1) Chandra,S.,Jayadeva,Mehra,A.,NumericalOptimizationandApplications,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.PhillipsandJamesJ.Solberg:OperationsResearch-Principlesand Practice, John Wiley & Sons, Second edn.(2005).

Evaluation Scheme:

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

UEE409: NETWORK THEORY

L T P Cr. 3
1 2 4.5

CourseObjective: 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 linearlyindependentnetworkvariables,Topological equations for loop current and for nodal voltage, Duality.

NetworkTheorems: Sourcetransformation,SuperpositionTheorem,Thevenin'stheorem,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 theirapplications.

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 itsapplications**.**

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.

FiltersandAttenuators: Classificationoffilters,Analysisofaprototypelowpass,Highpass,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 electricnetworks.
- Analyse the behaviour of two portnetworks.
- Apply graph theory concept to solve electricalnetworks
- Realise one-port networkparameters
- Design different filter and attenuatorconfigurations.

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. *RoyChowdhuary,D.,NetworksandSystems,NewAgeInternational(P)Limited,Publishers (2007).*
3. *Suresh Kumar, K.S. Electrical circuits and Networks, Pearson Education,(2009).*

Evaluation Scheme:

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

UEI610 : FUNDAMENTALS OF MICROPROCESSORS AND MICROCONTROLLERS

	L	T	P	Cr
	3	0	2	4.0

Course Objectives: The microprocessors and microcontrollers are an integral part of the embedded systems. The objective of this course is to expose the students to variety of processors and foster their skills to develop applications with microprocessor or microcontroller as the central element.

Introduction to Microprocessors and Microcontrollers: Evolution of microprocessor, Types of various architectures; Harvard and Von-Neumann, RISC and CISC architectures, Advantages of RISC architecture, Architecture of 8085 and 8086 microprocessor.

PIC Microcontroller Architecture and Programming: Introduction to 16 and 18F families, Architecture, Instruction Set, Op code Format, Directives, Bank selection, RAM architecture, Special Function Registers, Timers and counters, Interrupts, Analog to digital converters, Special operations such as compare and capture.

ARM Processor Fundamentals and Architecture: Architecture, ARM General purpose Register set and GPIO's, Architectural inheritance, ARM programmer's model, Current program status register, Exceptions, Interrupts, Vector Table, ARM processors family, Thumb Instruction set.

ARM programming in Assembly: Writing code in assembly, Instruction set coding, ARM addressing modes, Branch instructions: Branch and Branch with Link, Branch, Branch with Link and exchange, Data processing instructions, Load and store instructions, Load and store multiply instructions, Semaphore instructions, Coprocessor instructions, Register allocation, Conditional execution, Division, Square Roots, Transcendental functions, Endian reversal and bit operations, Exception and interrupt handling, Programming applications.

Pipeline structures: Introduction to pipeline, Classification, ARM 3 stage pipeline, ARM family attribute comparison. ARM 5 stage pipeline, Pipeline hazards, Classification of hazards, Data forwarding.

Hardware and sensor interfacing: ARM Development Environment, Interfacing of PIC and ARM processors with LEDs, Seven Segment, LCD, Relays, Motors, Temperature sensors and Pressure sensors, Programming of processors using C/C++.

Laboratory works: Programming examples of PIC and ARM based processors, Programming and Application development around PIC/ARM, Interfacing with peripherals etc.

Course Learning Outcomes (CLOs): After the completion of this course, the students will be able to
1. Elucidate the architecture of various types of processors.
2. Foster the ability to write programs using PIC microcontrollers.
3. Write ARM processor based programs.
4. Elucidate the pipeline structures and hazards
5. Interface peripherals and develop applications based on PIC/ARM processors

Approved in 102nd meeting of the Senate held on November 27, 2020

Text Books:
  1. *Mazidi M.A., "PIC Microcontroller and Embedded Systems: Using assembly and C for PIC", Pearson Publication, 2008*
  2. *Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian, "Computer Organization and Embedded Systems", Sixth Edition, McGraw Hill, 2012.*
  3. *Steve Furber, "ARM System-on-Chip Architecture", Second Edition, PEARSON, 2013.*

Reference Books:
  1. *Peatman J., "Embedded system Design using PIC18Fxxx", Prentice Hall, 2003.*
  2. *Stephen Welsh, Peter Knaggs, "ARM: Assembly Language Programming", Bourne Mouth University Publication, 2003.*
  3. *Andrew N. Sloss, Dominic Symes, Chris Wright "ARM System Developers Guide, Designing and Optimizing System Software", Elsevier Publication.*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessionals (May include Assignments/ Tutorials/ Quizes/ Lab Evaluations)	30

UEE411: 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:
1. select various types of instruments for measurement of variables.
2. select and use various types of sensors in different conditions.
3. select and use various types of bridge circuits with different sensors.
4. demonstrate the working of electronic instruments, working of sensors and transducers

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

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

Evaluation Scheme:

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

Approved in 102nd meeting of the Senate held on November 27, 2020

UCS541: FOUNDATIONS OF ARTIFICIAL INTELLIGENCE

L T P Cr

3 0 2 4.0

Course Objectives: The student should study the concepts of artificial intelligence and learn the methods of solving problems using artificial intelligence.

Overview: Definition, scope, foundations, approaches, and applications of AI; AI: past, present, and future.

Agents and Environments: agents; rationality; types of agents; properties of environments.

State Space Representation: State and operators; state space; representation real world problems as state space, problem characteristics.

Searching Strategies: uninformed searching methods (DFS, BFS, DFS-ID); informed searching methods such as best first search, hill climbing, A*, iterative deepening A*; problem reduction; constraint satisfaction problems; neural, stochastic, and evolutionary algorithms, local search and optimization problems in different environment.

Game Playing: Game theory and optimal decisions; Turn-taking games; Adversarial search; Minimax principle; Monte-Carlo tree search; Alpha-Beta pruning.

Reasoning: Representation, Inference, Propositional Logic, predicate logic (first order logic), syntax and semantics, logical reasoning, forward chaining, backward chaining.

Dealing with uncertainty: probability, connection to logic, independence, Bayes rule, Bayesian networks, probabilistic inference; time and uncertainty, hidden Markov model; Decision making- Utility theory, utility functions, Decision theoretic expert systems

Fuzzy Systems: Fuzzy sets, Operation on fuzzy sets, Fuzzy relations, Fuzzy measures, Fuzzy reasoning, Fuzzy controller,

Neural Network as Learning Machine : Mathematical model of neuron, activation functions, types of learning, learning methods, classification of neural networks, perceptron and multilayer perceptron, gradient and error back-propagation learning algorithms, typical applications of feedforward neural network, recurrent and temporal neural network, recurrent network use for optimization, Neuro-Fuzzy hybrid system; Engineering Applications

Course Learning Outcomes (CLO): At the end of the course, the student should be able to:
1. Identify appropriate AI methods to solve a given problem that are amenable to solution by AI.
2. Formalize a given problem in the language/framework of different AI methods.
3. Implement basic Fuzzy operations for engineering applications.
4. Implement neural network as learning machine for engineering applications.

Approved in 102^(nd) meeting of the Senate held on November 27, 2020

Text Books:

1. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)", Mc Graw Hill- 2008. (Units-I,II,VI & V).
2. Dan W. Patterson, "Introduction to AI and ES", Pearson Education, 2007. (Unit-III).
3. *Ross, J. T., Fuzzy Logic with Engineering Applications, McGraw–Hill (1995).*
4. *S. Haykin, Neural Network: A Comprehensive Foundation, Pearson Education (2003).*

References Books

1. Peter Jackson, "Introduction to Expert Systems", 3rd Edition, Pearson Education, 2007.
2. Stuart Russel and Peter Norvig "AI – A Modern Approach", 2nd Edition, Pearson Education 2007.
3. Deepak Khemani "Artificial Intelligence", Tata Mc Graw Hill Education 2013.

Evaluation Scheme:

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

Approved in 102nd meeting of the Senate held on November 27, 2020

UEI501: CONTROL SYSTEMS

L   T   P   Cr
3   1   2   4.5

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

Basic Concepts: Historical review, Definitions, Classification, Relative merits and demerits of open and closed loop systems, Linear and non-linear systems, Transfer function, , Block diagrams and signal flow graphs.
Components: D.C. and A.C. Servomotors, D.C. and A.C. Tach generators, Potentiometers and optical encoders, Synchro and stepper motors
Analysis: Steady-state errors and error constants, Concepts and applications of P, PD, PI and PID types of control.
Stability: Definition, Routh-Hurwitz criterion, Root locus techniques, Nyquist criterion, Bode plots, Relative stability, Gain margin and phase margins.
Compensation: Lead, Lag and lag-lead compensators, Design of compensating networks for specified control system performance.
State Space Analysis: Concepts of state, State variables and state models, State space equations, Transfer function, Transfer model, State space representation of dynamic systems, State transition matrix, Decomposition of transfer function, Controllability and observability.

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

Course Learning Outcomes (CLO): After the completion of the course student will be able to:
1. Develop the transfer function of the physical systems
2. Analyze the response of the closed and open loop systems
3. Analyze the stability of the closed and open loop systems
4. Design the various kinds of compensator
5. Develop and analyze state space models

Text Books:
1. *Gopal, M., Digital Control System, Wiley Eastern (1986).*
2. *Nagrath, I.J. and Gopal, M., Control System Engineering, New Age International (P) Limited, Publishers (2003).*
3. *Ogata, K., Modern Control Engineering,* Prentice–Hall of India Private Limited *(2001).*

Reference Books:
1. *Kuo, B.C., Automatic Control System, Prentice–Hall of India Private Limited (2002).*
2. *Sinha, N.K., Control System, New Age International (P) Limited, Publishers (2002).*

Evaluation Scheme:

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

UTA026: MANUFACTURINGPROCESSES

	L	T	P	Cr.
	2	0	2	3.0

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 ofparts.

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:

1. develop simple CNC code, and use it to produce components while working in groups.
2. analyse various machining processes and calculate relevant quantities such as velocities,forces.

3. recognise cutting tool wear and identify possible causes andsolutions.
4. understand the basic principle of bulk and sheet metal forming operations for analysis offorces.
5. analyse various shearing operations for toolingdesign.
6. apply the knowledge of metal casting for differentrequirements.

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 thed.
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) 4thed.

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

Approved in 102nd meeting of the Senate held on November 27, 2020

UEE509: 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 Security: Factors affecting security, Contingency analysis, Network sensitivity, correcting the generation dispatch by using sensitivitymethod.

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 powersystem.
- Analyse the stability of single machine-infinite bussystem.
- Decide the scheduling of thermal units and hydro-thermal units for overalleconomy.
- Design and apply control for frequency and voltage of power system represented bymulti-area.
- Carryout voltage stability and contingencyanalysis.

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. No.	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,steadystatetimedomainanalysiswithR,L,andEtypeloads,voltage,currentandloadcommutated choppers.

Inverters: Single phase voltage source bridge inverters and their steady state analysis, modified Mcmurray halfbridgeinverter,seriesinverters,threephasebridgeinverterswith180^0and120^0modes.single-phasePWM inverters, current source inverters, CSI with R load (qualitativeapproach).

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

Cycloconverters: Principlesofoperation,singlephasetosinglephasestepupandstepdowncycloconverters, three phase to single phase cycloconverters, output voltage equation for acycloconverter.

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 powerapplications.
- 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, KhannaPublishers(2012).*

Reference Books:
1. *Mohan, N., Underland, T. and Robbins, W. P., Power Electronics: Converter Applications and Design, John Wiley (2007)3rded.*
2. *Bose, B.K., Handbook of Power Electronics, IEEEPublications*

Evaluation Scheme:

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

Approved in 102nd meeting of the Senate held on November 27, 2020

UEE510: HIGH VOLTAGE ENGINEERING

L T P Cr.

3 0 2 4.0

Course Objective: To introduce the concepts of breakdown of gaseous, solid, and liquid insulations including generation and measurement of high voltage DC, AC and HV Impulse.

Introduction: Basic concept of high voltage engineering, need for higher voltages in power systems, classification of levels of voltage, concept of electrical insulation or dielectric materials, importance of high voltage measurement and testing, safety measures for high voltage systems.

Effects of Electric Field and Electric Stress: Concept of uniform and non-uniform electric field, electric stress control in dielectrics, electric strength of dielectric, types of breakdowns, estimation of electric field intensity.

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

Breakdown in Liquid Insulations: Breakdown in liquids, fundamentals of insulating oils, conduction and breakdown in pure and commercial liquids, properties of liquid insulation-transformer oil, testing of insulating oils/fluids, effect of moisture on dielectric properties of liquid insulation, alternative liquid insulations, applications.

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

Generation of High Voltages and Currents: Generation of HVDC, half and full wave rectifier circuits, voltage doubler and cascaded circuits, electrostatic machines, Generation of HVAC, cascade transformers, resonant transformer, generation of high frequency ac high voltage, high voltage impulse, circuits for impulse waves, characteristics parameters of impulse voltages, single stage impulse generator circuits, multistage impulse generation circuits, generation of impulse current.

Measurement of High Voltages: Principles, classification and applications of potential dividers, generating voltmeters, Measurement of HVDC, HVAC and HV impulse, electrostatic voltmeters, peak voltage measurement with sphere gaps, ammeter in series with high voltage resistors and voltage divider, capacitive voltage transformer (CVT), potential transformer, peak reading voltmeter for ac voltage, impulse voltage.

Overvoltage Phenomenon and Insulation Coordination: Causes of overvoltages in power system: lightning, switching surges, travelling waves, lattice diagram, insulation coordination in high voltage systems, surge arresters, BIL, equipment insulation level and insulation coordination of sub-stations

Non-Destructive Tests: Measurement of dc resistivity, dielectric constant and loss factor, measurement of dielectric properties by Schering bridge, partial discharge measurement, partial discharge detection in power cables.

High Voltage Testing: Testing of power system component such as insulators, circuit breakers, cables and transformers, testing of surge arresters, radio interference measurement.

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

Course Learning Outcomes (CLO):

After the completion of the course the students will be able to:
1. Analyze the breakdown mechanism of solids, liquids and gases.
2. Calculate the circuit parameters involved in generation of high voltages.
3. Measure direct, alternating and impulse high voltage signals.
4. Analyze application of insulation coordination for high voltage power system.
5. Perform non-destructive tests and high voltage tests on electrical apparatus.

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

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

Evaluation Scheme:

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

UEE795: CAPSTONE PROJECT

	L	T	P	Cr
UEE795: SemesterVI(starts)	1*	0	2	--
UEE795: SemesterVII(Completion)	1*	0	2	8.0

Course Objective: To facilitate the students learn and apply an engineering design process in electrical engineering,includingprojectresourcemanagement.Asapartofateam,thestudentswillmakeaproject,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 specificproblem.

CourseDescription: CapstoneProjectisincreasinglyinterdisciplinary,andrequiresstudentstofunctionon multidisciplinaryteams.Itistheprocessofdevisingasystem,componentorprocesstomeetdesiredneeds.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 analysisandsynthesisisperformedinaniterativecycle.Thus,studentsshouldexperiencesomeiterativedesign 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 have4-5students.Eachgroupshouldselecttheirteamleaderandmaintaindailydiary.EachGroupwillwork 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 wellasthesuccessfulcompletionoftheproject.Thefacultysupervisoroftheprojectwillcontinuouslyassess 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 engineeringconstraints.
- Design an electrical engineering project implementing an integrated design approach applying knowledge accrued in various professionalcourses.
- Perform simulations and incorporate appropriate adaptations using iterativesynthesis.
- Use modern engineering hardware and softwaretools.
- Work amicably as a member of an engineering designteam.
- Improve technical documentation and presentationskills.

Approved in 102nd meeting of the Senate held on November 27, 2020

UCS540: DATA STRUCTURES AND ALGORITHMS

	L	T	P	Cr
	3	0	2	4.0

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

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

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

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

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

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

Course learning outcomes (CLOs):
On completion of this course, the students will be able to
1. Implement the basic data structures and solve problems using fundamental algorithms.
2. Implement various search and sorting techniques.
3. Analyze the complexity of algorithms, to provide justification for that selection, and to implement the algorithm in a particular context.
4. Analyze, evaluate and choose appropriate data structure and algorithmic technique to solve real-world problems.

Text Books:
1. *Seymour Lipschutz Data Structures, TATA McGraw Hill (2016).*
2. *Corman, Leiserson&Rivest, Introduction to Algorithms, MIT Press (2009).*
3. *Narasimha Karumanchi, Data Structures and Algorithms Made Easy (2014).*

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

Evaluation Scheme:

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

Approved in 102nd meeting of the Senate held on November 27, 2020

UEE613: INDUSTRIAL DRIVES AND AUTOMATION

	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 power converter-controlled drives and automation.

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.

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

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

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

Special purpose drives: Synchronous motor drives, servo drives, Step motor and BLDC motor drives

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

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

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

Minor project:

Course Learning Outcomes (CLO):
After 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).

Approved in 102nd meeting of the Senate held on November 27, 2020

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

Approved in 102nd meeting of the Senate held on November 27, 2020

UEE610: POWER SYSTEM PROTECTION

	L	T	P	Cr.
	3	0	2	4.0

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

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

Fuses and Circuit Breakers: LV and MV fuses and their characteristics, Circuit breakers as a switch: Arc formation and its extinction (AC and DC), re-striking and recovery voltage, Current chopping, specifications of circuit breakers, types of circuit breakers like oil, Air, Vacuum and SF_6, comparative merits and demerits, HVDC circuit breaker system.

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

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

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

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

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).*

Approved in 102nd meeting of the Senate held on November 27, 2020

Reference Books:
1. *Deshpande, M.V., Switchgear and Protection, Tata McGraw☐Hill (2005).*
2. *Elmore, W.A., Protective Relaying Theory and Applications, ABB Power T and D Company Inc. (2003).*
3. *John D. McDonald, Electric Power Substations Engineering, Second Edition, CRC Press, (2007)*

Evaluation Scheme:

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

Approved in 102nd meeting of the Senate held on November 27, 2020

ULC402: FUNDAMENTALS OF 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, and to design digital filters.

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

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

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

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

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

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

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

Course Learning Outcomes (CLO):
After the completion of the course, the students will be able to:
1. Analyse the basics of signals and systems.
2. Solve different type of problems related to Fourier series and Fourier transforms
3. Carry out spectrum analysis using DFT.
4. Design digital filter and harmonic mitigation.

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

Evaluation Elements	% Weightage
Mid Semester Test	25
End Semester Examination	45
Sessional (may include Tutorial, Assignment, Lab work, Quizzes, Project as applicable)	30
Total	100

UEE612: 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 sub-gradients, 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, Generalization, Underfitting, overfitting, Cross-validation, Regularization, mixture of Gaussians

Support Vector Machines: Maximum margin linear separators, solution approach to finding maximum margin separators, Radial basis function network, 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 to energy pricing estimation, energy meter analytics, renewable generation forecasting, load profile and consumer classification, Controller design for ALFC, Filter design.

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

Course Learning Outcomes (CLO):
After the completion of the course the students will be able to:
1. Demonstrate the concept of optimization for various learning functions
2. Analyze the complexity of machine learning algorithms and their limitations
3. Realize learning algorithms as neural computing machine

Approved in 102nd meeting of the Senate held on November 27, 2020

4. Demonstrate the ability to evaluate and compare learning models and learning algorithms
5. 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. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEE705: 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 renewable energy resources and policies of renewable energy, Environmental issues, renewable sources integration – overcoming intermittence, centralized vs. distributed generation.

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

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

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

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

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

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

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

Course learning Outcomes (CLO):
After the completion of the course, the students will be able to:
1. Analyse the working of Wind and Solar energy systems.

Approved in 102nd meeting of the Senate held on November 27, 2020

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

Text Books:
1. *M.H.Rashid, Power Electronics, Prentice-Hall ofIndia.*
2. *Emadi,A.(Ed.),Miller,J.,Ehsani,M.,VehicularElectricPowerSystems,BocaRaton,CRC Press, 2003.*
3. *Larminie, James, and John Lowry, Electric Vehicle Technology Explained, John Wiley and Sons, 2012.*
4. *Simon,ChristopherA.,AlternateSourceofEnergy,RowmanandLittleFieldPublishersInc. (2007).*
5. *Patel, M. R., Wind and Solar Power Systems, Boca Raton, FL: CRC Press,(1999).*

Reference Books:
1. *P.S Bhimbra, Power Electronics, KhannaPublishers.*
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 McGrawHill, New Delhi,1997.*

Evaluation Scheme:

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

Approved in 102nd meeting of the Senate held on November 27, 2020

UEE706: IoT AND REAL TIME SYSTEMS

	L	T	P	Cr.
	3	0	2	4.0

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

Internet of Things

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

IoT in Power System

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

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

Data Acquisition System: Role of dedicated computers, analog and digital control, computer systems for real time applications,

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

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

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

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

Approved in 102nd meeting of the Senate held on November 27, 2020

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

Course learning Outcomes (CLO):
After the completion of the course, the students will be able to:

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

Text Books:
1. *IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro by Cisco Press, 2017.*

2. *Internet of Things: A Hands-on Approach, by Arshdeep Bahga and Vijay Madisetti Universities Press, 2014.*

3. *N. Hatziargyriou, Microgrids: Architectures and Control, Wiley-IEEE Press, January (2014).*

4. *Wood A. J. and Wollenberg B., Power generation operation and control, John Wiley.*

5. *Kusic C. L., Computer Aided Power System Analysis, TMH, New Delhi.*

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

Approved in 102nd meeting of the Senate held on November 27, 2020

Evaluation Scheme:

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

Approved in 102nd meeting of the Senate held on November 27, 2020

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 powerplant.

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.

PowerPlantEconomics: 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 relatedagencies.
- Harness power from conventional and renewablesources.
- Select the methods and size of plant generating power for overalleconomy.
- Decide the tariff structure for different type ofusers.

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).*

Approved in 102nd meeting of the Senate held on November 27, 2020

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-understandingenergycosts,Benchmarking,Energyperformance,Matchingenergy usetorequirement,Maximizingsystemefficiencies,Optimizingtheinputenergyrequirements,Fuel and energy substitution, Energy auditinstruments

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.

ElectricalSystem: Electricitytariff,Loadmanagementandmaximumdemandcontrol,T&Dlosses. 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 conservationavenues

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, Flowcontrol strategies and energy conservationopportunities.

Course Learning Outcomes (CLO):
After the completion of the course the students will be able to:
- Analyse energy scenario nationwide andworldwide
- Decide about energy management in more effectiveway.
- Analyse various energy related aspect of electricalsystem.
- Carry out financialmanagement.
- Conduct studies related to operational aspects of compressed air system and refrigerationsystem.

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).*

Approved in 102nd meeting of the Senate held on November 27, 2020

Evaluation Scheme:

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

Approved in 102nd meeting of the Senate held on November 27, 2020

UEE894: PROJECT SEMESTER

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 technicalactivityintheprojectsemestershouldberelatedtoboththestudent'sengineeringstudiesandtothe hostorganization'sactivitiesanditshouldconstituteasignificantbodyofengineeringworkattheappropriate level.Itshouldinvolvetasksandmethodsthataremoreappropriatelycompletedinaprofessionalengineering environment and should, where possible, make use of human and technology resources provided by the organization.Itconsolidatesthestudent'spriorlearningandprovidesacontextforlaterresearchstudies.The studentremainsafulltimeregisteredstudentatThaparUniversityduringtheprojectsemesterandthisactivity 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 interactswiththeindustrymentorduringhis/hervisittothehostorganizationtwice.ThisincludesaReflective 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:
1. acquire knowledge and experience of software and hardware practices in the area of project.
2. carry out design calculations and implementations in the area of project.
3. associate with the implementation of the project requiring individual and teamwork skills.
4. communicate their work effectively through writing and presentation.
5. demonstrate the knowledge of professional responsibilities and respect for ethics.

Approved in 102nd meeting of the Senate held on November 27, 2020

UEE896: 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
- BusinessDevelopmentProcessrelatedtothestartup,relatingtheoreticalframeworkwiththebusiness 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 managingandassessmentoftheStartupsemester.Thefacultysupervisormonitorsthestudent'sprogressina 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:
1. demonstrate an ability to develop a business plan.
2. carry out design calculations/simulations and implementations in the area of project.
3. develop a prototype/working model/software application.
4. comprehend the fundamentals of business pitching.
5. demonstrate the knowledge of professional responsibilities and respect for ethics.

Approved in 102nd meeting of the Senate held on November 27, 2020

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.

TimeVaryingFieldsandMaxwell'sEquations: Continuityofcharge,Conceptofdisplacementcurrent, 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 forconductors.

Uniform Plane Waves: Introduction, Uniform plane wave propagation: Wave equations, Transverse nature of uniform plane waves, Perpendicular relation between $\dot{E}$ and $\overset{.}{H}$, EM waves in charge free, Current free dielectric,Reflectionbyidealconductor:Normalincidence,reflectionandtransmissionwithnormalincidence 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, waveimpedances.

Course learning Outcomes (CLO):

After the completion of the course, the students will be able to:
1. calculateelectricandmagneticfieldsindifferentcoordinatesforvariouschargeandcurrentconfigurations
2. exhibit the concept of time varying fields and Maxwell'sequations
3. demonstrate different aspects of plane wave in dielectric and conductingmedia
4. realize the analogy of wave with transmission line andwaveguides

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).*

Approved in 102nd meeting of the Senate held on November 27, 2020

Evaluation Scheme:

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

UEI625: ANALOG AND DIGITAL COMMUNICATION

	L	T	P	Cr
	3	1	0	3.5

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

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

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

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

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

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

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

Course Learning Outcomes (CLOs):

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

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

Text Book:

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

Reference Books:

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

UCS417 INTRODUCTION TO OPERATING SYSTEMS

	L	T	P	Cr
	2	0	3	3.5

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

Introduction and System Structures: Computer-System Organization, Computer-System Architecture, Operating-System Structure, Operating-System Operations, Process Management, Memory Management, Storage Management, Protection and Security, Computing Environments, Operating-System Services, User and Operating-System Interface, System Calls, Types of System Calls, System Programs, Operating-System Design and Implementation, Operating-System Structure.

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

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

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

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

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

Protection and Security: Goals of Protection, Principles of Protection, Domain of Protection, Access Matrix, Implementation of the Access Matrix, Access Control, Revocation of Access Rights, Capability-Based Systems, The Security Problem, Program Threats, System and Network Threats, User Authentication, Implementing Security Defenses, Firewalling to Protect Systems and Networks.

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

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

Approved in 102nd meeting of the Senate held on November 27, 2020

Course learning outcome (CLO) / Course Objectives (COs):

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

1. Explain the basic of an operating system viz. system programs, system calls, user mode and kernel mode.
2. Select particular CPU scheduling algorithms for specific situation, and analyze the environment leading to deadlock and its rectification.
3. Explicate memory management techniques viz. caching, paging, segmentation, virtual memory, and thrashing.
4. Understand the concepts related to file systems, disk-scheduling, and security, protection.
5. Comprehend the concepts related to concurrency.

Text Books:

1. Silberschatz A., Galvin B. P. and Gagne G., Operating System Concepts, John Wiley & Sons Inc (2013) 9th ed.
2. Stallings W., Operating Systems Internals and Design Principles, Prentice Hall (2018) 9th ed.

Reference Books:

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

Evaluation Scheme:

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

UCS312: DATABASE MANAGEMENT SYSTEMS

	L	T	P	Cr
	2	0	2	3.0

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

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

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

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

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

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

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

Database Implementation: Introduction to SQL, DDL aspect of SQL, DML aspect of SQL – update, insert, delete & various form of SELECT- simple, using special operators, aggregate functions, group by clause, sub query, joins, co-related sub query, union clause, exist operator. PL/SQL - cursor, stored function, stored procedure, triggers, error handling, and package.

Laboratory work:

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

Project:

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

Course Learning Outcomes (CLOs) / Course Objectives (COs):

Approved in 102nd meeting of the Senate held on November 27, 2020

On completion of this course, the students will be able to:
1. Analyze the Information Systems as socio-technical systems, its need and advantages as compared to traditional file-based systems.
2. Analyze and design database using E-R data model by identifying entities, attributes and relationships.
3. Apply and create Relational Database Design process with Normalization and De- normalization of data.
4. Comprehend the concepts of transaction management, concurrence control and recovery management.
5. Demonstrate use of SQL and PL/SQL to implementation database applications.

Text Books:
1. Silverschatz A., Korth F. H. and Sudarshan S., Database System Concepts, Tata McGraw Hill (2010) 6th ed.
2. Elmasri R. and Navathe B. S., Fundamentals of Database Systems, Pearson (2016) 7th ed.

Reference Books:
1. Bayross I., SQL, PL/SQL the Programming Language of Oracle, BPB Publications (2009) 4th ed.
2. Hoffer J., Venkataraman, R. and Topi, H., Modern Database Management, Pearson (2016) 12th ed.

Evaluation Scheme:

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

Approved in 102nd meeting of the Senate held on November 27, 2020

UEE525: DATA ANALYTICAL METHODS

	L	T	P	Cr.
	2	0	2	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.

DataCleaning: Organizing,mergingandmanagingthedata,Obtainusabledatafromtheweb,APIs, and databases, Understand common data storage systems.

StatisticalInterference: Reviewofprobability,randomvariables,expectations,Measuresofcentral 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.

Data Visualization: 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.

Laboratory Work: Fundamentals of Python and associated Libraries NumPy, Pandas, Matplotlib; Implement central tendency measures, Analysis of Variance - one-way and two-way ANOVA, Hypothesis testing; Implement linear regression, K-means clustering, Binary classification; Visualization of data; different plots including density plots, box-plot, heat map, area plot.

Course Learning Outcomes

After the completion of the course the students will be able to:
- Analyze data by utilizing clustering and classification algorithms
- Analyze 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. Anand Rajaraman 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

Sr. No.	Evaluation Elements	Weightage (%)

UEE526: EMBEDDED SYSTEM DESIGN

L T P Cr
2 0 2 3.0

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)anditstypes,Task,process&threads,interruptroutinesinRTOS,Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Concurrency, Reentrancy, Intertask communication, Implementation of RTOS with some case studies.

Laboratory Work:
ProgrammingofmicrocontrollerwithIntegrateddevelopmentenvironment(IDE),UseofJTAGand 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.

Course Learning Outcomes (CLO)
After the completion of the course the students will be able to:
1. Acquire a basic knowledge about programming and system control to perform a specific task.
2. Acquire knowledge about devices and buses employed in embedded networking
3. Develop programming skills in embedded systems for various applications.
4. Acquire knowledge about the basic concepts of circuit emulators.
5. Acquire knowledge about the life cycle of embedded design and its testing.

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).*

Approved in 102nd meeting of the Senate held on November 27, 2020

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

UEE527: RESTRUCTURED POWER SYSTEMS

	L	T	P	Cr
	3	0	0	3.0

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 - entitiesinvolved,thelevelsofcompetition,themarketplacemechanisms,sector-wisemajorchanges required, Issues involved in deregulation, Reasons and objectives of deregulation of various power systems across the world, US and European market evolution

FundamentalsofEconomics:Consumerbehaviour–(a)Totalutilityandmarginalutility(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),Marginalcost(MC);Relationshipbetweenshort-runandlong-runaveragecosts,Perfectly competitive market, The firm's supply decision under perfect competition.

ThePhilosophyofMarketModels: Marketmodelsbasedoncontractualarrangements–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 TSOmodel.

Transmission Congestion Management: Definition of congestion; Reasons for transfer capability limitation;Importanceofcongestionmanagementinderegulatedenvironment;Effectsofcongestion, 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 TransmissionRights, Risk Hedging Functionality Of financial TransmissionRights.

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.

Approved in 102nd meeting of the Senate held on November 27, 2020

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 imperfectcompetition;Marketpower:Sourcesofmarketpower,Effectofmarketpower,Identifying
market power: HHI Index, Entropy coefficient, Lerner index; Market power mitigation - Effects of contractfordifferences,Roleofdemandsidebidding,Introductiontooptimalbiddingbyagenerator
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:
1. develop the concept of power system restructuring and integrated generation.
2. conceptualize the impact of bidding and pricing in competitive electricity markets.
3. demonstrate the different electricity market mechanisms
4. analyze market power
5. 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: TradingPerformanceand Information Technology*, Lai, L.L., John Wiley and Sons,2001.

Evaluation Scheme:

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

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 sectorreforms,Energyandenvironment:Airpollution,Climatechange,Energysecurity,Energyconservation and its importance, Energy strategy for the future, Energy conservation Act-2001 and itsfeatures.

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:
1. analyze about energy scenario nationwide and worldwide
2. decide about energy management in more effective way.
3. carry out financial management.
4. analyze about deregulation of power industry.
5. 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. *ShahedepourM.,YaminH.,ZuyiLi.,Marketoperationsinpowersystems:Forecasting,Scheduling,and Risk Management, John Wiely& Sons, NewYork.*
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).*

Approved in 102nd meeting of the Senate held on November 27, 2020

Evaluation Scheme:

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

Approved in 102nd meeting of the Senate held on November 27, 2020

UEE528: POWER QUALITY MONITORING AND CONDITIONING

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

Courseobjective: Tounderstandtheaspectsofpowerqualityindistributionsystemandvariousindicesto estimate the power quality. To get familiarize with power conditioningstandards.

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 faultclearing,Sagmitigation,Sagmagnitudeanddurationcalculations,RMSvoltage,Calculationin1-phase systems, Equipment performance in presence of sag, Computers, AC and DCdrives.

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:
1. Reliably identify the sources of various power qualityproblems.
2. Analyse the causes of harmonic and its distortioneffect.
3. Estimate the impact of various power quality problems onappliances.
4. Educate the harmful effects of poor power quality andharmonics.
5. Decide the compensators and filters to keep the power quality indices within thestandards.

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

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

Evaluation Scheme:

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

Approved in 102nd meeting of the Senate held on November 27, 2020

UCS653: DATA MINING AND VISUALIZATION

L	**T**	**P**	**Cr**
2	**0**	**2**	**3.0**

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

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

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

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

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

Visualizing large data: Decision Tree Analysis.

Course Learning Outcomes (CLOs)

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

- Apply basic concepts and techniques of Data Mining.
- Develop skills of using data mining libraries for solving practical problems.
- Gain experience of doing independent study.
- Present the data traits through different visualization.

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

Reference Books:
1. G James, D. Witten, T Hastie, and R. Tibshirani, "An Introduction to Statistical Learning: with Applications in R", Springer, 2013
2. John M. Chambers, "Software for Data Analysis: Programming with R" (Statistics and Computing), Springer
3. Rahlf, Thomas, "Data Visualisation with R", Springer, 2019.

Approved in 102nd meeting of the Senate held on November 27, 2020

Evaluation Scheme:

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

Approved in 102nd meeting of the Senate held on November 27, 2020

UEE638: PLC AND SCADA

L T P Cr
2 0 2 3.0

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

Programmable Logic Controller (PLC)
Overview, Components of PLC, Principles of Operation, PLC and Computers, PLC Size and Applications, Input and Output hardware of PLC, CPU, Memory, PLC Programming Devices.

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

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

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

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

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

Course Learning Outcomes (CLOs)

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

- Design PLC based application by proper selection and sizing criteria
- Develop ladder program using PLC.
- Analyze communication in SCADA.
- Develop any application based on SCADA.

Approved in 102nd meeting of the Senate held on November 27, 2020

Text Books:

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

Reference Books:

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

Evaluation Scheme:

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

Approved in 102nd meeting of the Senate held on November 27, 2020

UEE636: SMART GRID SYSTEMS

L T P Cr.
2 0 2 3.0

Course objective: To explain general communication techniques used in smart grid power system communicationinfrastructureandinformationsystemforcontrolcenters.Tofamiliarizewithinterconnection issues related with integration of distributed generation technologies formicrogrid.

IntroductiontoSmartGrid:EvolutionofElectricGrid,ConceptofSmartGrid,Definitions,NeedofSmart Grid, Concept of Robust & Self-Healing Grid Present development & International policies in SmartGrid.

Communication Technologies for Smart Grid Power System: Fiber Optical Networks, WAN based on FiberOpticalNetworks,IPbasedRealTimedataTransmission,Substationcommunicationnetwork,Zigbee.

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

Smartgrid: Smartgridinfrastructure,Loaddispatchcenters,wide-areamonitoringsystem(WAMS),PMU; Smart sensors/telemetry, advanced metering infrastructure (AMI); smart metering; smart grid system monitoring; communication infrastructure and technologies;self-healing.

DistributedEnergyResources(DERs): DistributedGeneration(DG),DistributedGenerationTechnologies 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, storagedevices.

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, AdvantagesandchallengesinMicrogridsystem,Interconnectionissues,ACandDCMicrogrid,Comparison, Operation,ControlandProtectionIssuesofMicrogrid**;**NeedofCommunicationInfrastructureinMicrogrid, 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 smartgrid.
- illustrate various integration aspects of distributed energy resources andmicrogrid.
- demonstrate distributed generation coordination including monitoring of smart grid using modern communicationinfrastructure.
- analyse operation, control and protection issues in microgrid in the perspective of smartgrid.

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-IEEEPress*
4. *Microgrids and Active Distribution Networks, S. Chowdhury, S.P. Chowdhury and P. Crossley, The Institution of Engineering and Technology, London, U.K,2009.*

Approved in 102ⁿᵈ meeting of the Senate held on November 27, 2020

Reference Books:
  1. *Ekanayake J.,Jenkins N., Liyanage K., Wu, J., Yokoyama A., Smart Grid: Technology and applications, WileyPublications.*
  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. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

Approved in 102nd meeting of the Senate held on November 27, 2020

UEE721: NONLINEAR AND DIGITAL CONTROL SYSTEMS

L T P Cr.
3 0 0 3.0

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

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.

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

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

State-space analysis: Introduction, State-space representations of discrete-time systems, Solving discrete-time state-space equations, Pulse transfer function matrix, Discretization of continuous time statespaceequations,Lyapunovstabilityanalysis,ControllabilityandObservability,Designviapole placement, State observer design.

Course learning Outcomes (CLO):

After the completion of the course, the students will be able to:
1. demonstrate non-linear system behaviour by phase plane and describing functionmethods.
2. perform the stability analysis nonlinear systems by Lyapunovmethod
3. derive discrete-time mathematical models in both time domain (difference equations, state equations) and z-domain (transfer function usingz-transform).
4. predict and analyse transient and steady-state responses and stability linear, time-invariant, discrete-time controlsystems.

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.*Nonlinearsystems*(Vol.3).UpperSaddleRiver,NJ:Prentice hall(2002).
3. Ku, B. C. *Digital control systems*. HRW (1980).

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

Evaluation Scheme:

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

UEE637: HIGH VOLTAGE TRANSMISSION SYSTEMS

	L	T	P	Cr.
	3	0	0	3.0

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

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 withoutoverlap.

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, DCfilters.

Component models for the analysis of ac/dc systems: General, Converter model, Converter control, Modelling of DC network, Modelling of ACnetworks.

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 dedicatedapplication(s).
- Identify the suitable two-level/multilevel configuration for high powerconverters.
- Select the suitable protection method for various converterfaults.
- Identify suitable reactive power compensationmethod.
- Decide the configuration for harmonic mitigation on both AC and DCsides.

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

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

Evaluation Scheme:

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

Approved in 102nd meeting of the Senate held on November 27, 2020

UCS414: COMPUTER NETWORKS

	L	T	P	Cr
	2	0	2	3.0

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

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

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

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

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

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

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

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

Course learning outcomes (CLOs):

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

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

Text Books:

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

Reference Books:

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

Evaluation Scheme:

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

Approved in 102ⁿᵈ meeting of the Senate held on November 27, 2020

UEE741: 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,Probabilisticmodelofpowersystem components, Outage table of power systemcomponents

MonteCarlosimulation: Conceptofconstructingrandomwalk,fundamentaltheoryofMonteCarlo simulationmethod,Samplingofsystemoperationstate,Stateevaluationmodel,Indicesofreliability evaluation, Flowchart of composite system adequacy evaluation, Markov Chain Monte Carlo (MCMC) simulationmethod

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:

1. carryout sampling and Monte Carlosimulation.
2. find stochastic model of electrical systems and develop the solutionapproach.
3. compute the reliability indices of generating or transmissionsystems.
4. identify the expansion of generator as perLOLP.

TextBooks:

1. Anders, George J (1990). Probability concepts in electric power systems. Wiley, NewYork
2. R.L. Sullivan "Power System Planning", Tata McGraw Hill Publishing CompanyLtd.
3. Roy Billinton & Ronald N. Allan "Reliability Evaluation of Power System",Springer

Reference Books:

1. Rohatgi, V. K., & Saleh, A. M. E. *An introduction to probability and statistics*. John Wiley & Sons,(2015).
2. Ross, S. M. *Introduction to probability and statistics for engineers and scientists*. Academic Press,(2014).

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
4.	MST	30
5.	EST	45
6.	Sessional (Assignments/Projects/Tutorials/Quizzes)	25

UEE742: DIGITAL CONTROLLERS FOR POWER APPLICATIONS

L T P Cr
2 0 2 3.0

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

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

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

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

Open and closed loop control of digital power electronics: Stability analysis, step and impulse responses, PIcontrolforAC/DC,DC/ACandAC/ACconverters,PIDcontrolforDC/DCconverters.

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:
1. conceptualize sample and holdcircuit
2. develop mathematical model of different powerconverters
3. devise controller for different powerconverters.

Text Books:

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

Reference Books:

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

Evaluation Scheme:

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

Approved in 102nd meeting of the Senate held on November 27, 2020

UEE743: CLOUD COMPUTING BASED ELECTRICAL SYSTEMS

L T P Cr
3 0 0 3.0

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

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

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

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

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

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

Course learning 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. *Rajkumar Buyya, James Broberg and Goscinski, Cloud Computing Principles and Paradigms, John Wiley and Sons, Second Edition,2012.*
2. *GerardBlokdijk,IvankaMenken,TheCompleteCornerstoneGuidetoCloudComputingBestPractices, EmereoPvt Ltd, Second Edition,2009.*
Reference Books:
1. *Anthony Velte, Toby Velte and Robert Elsenpeter, Cloud Computing: A practical Approach, Tata McGrawHill, , Second Edition,2010.*

Evaluation Scheme:

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

Approved in 102nd meeting of the Senate held on November 27, 2020

UEE744: 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 tractiondriveratingandenergyconsumption.Importantfeaturesoftractiondrives,ConventionalDCandAC traction drives, Diesel electrictraction.

StaticconvertersforTraction: Semi-conductorconvertercontrolleddriveforactraction,Semiconductor chopper controlled dctraction.

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 andharmoniccontrolofconverterfedsystems,Methodsemployingnaturalandforcedcommutationschemes, Methods of implementation of forcedcommutation.

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:
1. simulate and analyse the semiconductor controlled ac and DC drivesystem
2. design and develop an illumination system for domestic, industry and commercialsites.
3. design an electric heating system for industrialpurposes.
4. equip the skill to design and develop a regulated powersupply.
5. 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. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessional (Assignments/Projects/Tutorials/Quizzes)	25

Approved in 102nd meeting of the Senate held on November 27, 2020

UEE601: 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, FACTSetc.
- 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. No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizzes)	25

Approved in 102nd meeting of the Senate held on November 27, 2020