COURSE SCHEME AND SYLLABUS

FOR

B.E. (Electrical and Computer Engineering)

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

2020

BE Electrical and Computer Engineering

SEMESTER-I

Sr. No.	Course No.	Course Title	Type of Course	L	T	P	Credits
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	Electronics 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
				16	**7**	**8**	**23.5**

SEMESTER-II

Sr. No.	Course No.	Course Title	Type of Course	L	T	P	Credits
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
				18	**4**	**10**	**25.0**

*** Each student will attend one Lab Session of 2 hrs in a semester for a bridge project in this course. (Mechanics)**

First Year Credit : 48.5

SEMESTER-III

Sr. No.	Course No.	Course Title	Type of Course	L	T	P	Credits
1	UCS405	Discrete Mathematical Structures	CF	3	1	0	3.5
2	UCS520	Computer Networks	CP	3	0	2	4.0
3	UCS301	Data Structures	CP	3	0	2	4.0
4	UEE409	Network Theory	CP	3	1	2	4.5
5	UEE505	Analog and Digital Systems	CP	3	1	2	4.5
5	UHU005	Humanities for Engineers	CF	2	0	2	3.0
6	UTA024	Engineering Design Project-II	PR	1	0	4	3.0
				18	**3**	**14**	**26.5**

SEMESTER-IV

Sr. No.	Course No.	Course Title	Type of Course	L	T	P	Credits
1	UCS303	Operating Systems	CP	3	0	2	4.0
2	UCS310	Data Base Management Systems	CP	3	0	2	4.0
3	ULC401	Computer System Design	CP	3	0	2	4.0
4	ULC402	Fundamentals of Signal Processing	CP	3	0	2	4.0
5	UEE413	Electric Machinery	CP	3	1	2	4.5
6	UEE414	Principles of Power System Engineering	CP	3	1	2	4.5
				18	**2**	**12**	**25.0**

After Second year Credits=48.5+51.5=100

SEMESTER-V

Sr. No.	Course No.	Course Title	Type of Course	L	T	P	Credits
1	UMA028	Mathematics for Data Science	CF	3	0	2	4.0
2	UEE511	Embedded System Design and IoT	CP	3	0	2	4.0
3	UCS541	Foundations of Artificial Intelligence	CF	3	0	2	4.0
4	UEE512	Power Converters and Drives	CP	3	1	2	4.5
5	UEE508	Linear Control Systems	CP	3	1	2	4.5
6	UTA025	Innovation and Entrepreneurship (2 self-effort hours)	CF	1	0	2*	3.0
				16	**2**	**12**	**24.0**

SEMESTER-VI

Sr. No.	Course No.	Course Title	Type of Course	L	T	P	Credits
1	ULC601	Machine Learning Techniques	CP	3	0	2	4.0
2	UCS415	Design and Analysis of Algorithms	CP	3	0	2	4.0
3	UCS503	Software Engineering	CP	3	0	2	4.0
4	ULC602	Digital Measurement and Protection	CP	3	0	2	4.0
5	ULC603	Electric Vehicle and Real Time Systems	CP	3	0	2	4.0
6		Elective -1	PE	3/2	0	0/2	3.0
7	ULC691	Capstone Project (Starts)	PR	1*	0	2	--
				19/18	**0**	**12/14**	**23.0**

After third Year Credits= 100+47=147.0

SEMESTER-VII

Sr. No.	Course No.	Course Title	Type of Course	L	T	P	Credits
1	UCS701	Theory of Computation	CP	3	1	0	3.5
2	ULC701	Smart Electric Grid and Energy Management	CP	3	0	0	3.0
3		Elective -2	PE	2/3	0	2/0	3.0
4		Elective -3	PE	2/3	0	2/0	3.0
5		Generic Elective	GE	2	0	0	2.0
6	ULC691	Capstone Project	PR	0	0	2	8.0
				12/14	**1**	**6/2**	**22.5**

SEMESTER-VIII

Sr. No.	Course No.	Course Title	Type of Course	L	T	P	Credits	Remarks
1	ULC891	Project Semester	PR	- -	- -	- -	15.0	--
OR Alternate Project Semester								
1	ULC892	Design Project	PR	- -	- -	- -	8.0	PR
2	ULC802	Social Network Analysis	CP	2	0	2	3.0	
3	ULC803	Ethical Hacking	CP	3	0	2	4.0	
OR								
1	ULC893	Start-up Semester	PR				15.0	PR
							15.0	

After fourth year Credits= 147+37.5= 184.5

List of Professional Electives

Elective -1					
1	ULC641	Autonomous Mobility	3	0	0
2	UCS531	Cloud Computing	2	0	2
3	UCS653	Data Mining and Visualization	2	0	2
4	ULC643	Forecasting methods and applications	2	0	2
5	ULC664	Cyber and Network Security	2	0	2
6	ULC665	Deep Learning	2	0	2
7	UCS532	Computer Vision	2	0	2
Elective -2					
1	UCS635	GPU Computing	2	0	2
2	UMC622	Matrix Computation	2	0	2
3	ULC662	Charging Infrastructure	3	0	0
4	ULC663	Cyber Physical Systems	3	0	0

5	UEE525	Data Analytics Methods	2	0	2
6	ULC742	Digital Control Systems	3	0	0
7	UCS636	3D Modelling and Animation	2	0	2
8	ULC702	Industrial Communication Protocols and SCADA	3	0	0
Elective -3					
1	ULC741	Advanced Metering Infrastructure	3	0	0
2	ULC743	Electric Grid Security	2	0	2
3	ULC744	FACTS and Custom Power	3	0	0
4	ULC745	Modern Propulsion system and Robotics	2	0	2
5	UMA038	Optimisation and Heuristics	2	0	2
6	UCS751	Simulation and Modelling	2	0	2
7	UCS646	Game Design & Development	2	0	2
8	UCS754	Block Chain Technology and Applications	2	0	2

S.No.	**Course No.**	**Course Name**	**L**	**T**	**P**	**Cr**
1	UTD002	Employability Development Skills	2	0	0	2.0
2	UHU016	Introductory Course In French	2	0	0	2.0
3	UHU017	Introduction To Cognitive Science	2	0	0	2.0
4	UHU018	Introduction To Corporate Finance	2	0	0	2.0
5	UCS002	Introduction To Cyber Security	2	0	0	2.0
6	UPH064	Nanoscience And Nanomaterials	2	0	0	2.0
7	UEN006	Technologies For Sustainable Development	2	0	0	2.0
8	UMA069	Graph Theory And Applications	2	0	0	2.0
9	UBT510	Biology For Engineers	2	0	0	2.0

Total Credits : 184.5

UPH004: APPLIED PHYSICS

L	T	P	Cr
3	1	2	4.5

Course Objectives: To introduce the student to the basic physical laws of oscillators, acoustics of buildings, ultrasonics, electromagnetic waves, 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.

Course Outcomes:

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

1. Understand damped and simple harmonic motion, the role of reverberation in designing a hall and generation and detection of ultrasonic waves.
2. Use Maxwell's equations to describe propagation of EM waves in a medium.
3. Demonstrate interference, diffraction and polarization of light.
4. Explain the working principle of Lasers.
5. Use the concept of wave function to find probability of a particle confined in a box.

Text Books

1 *Beiser, A., Concept of Modern Physics, Tata McGraw Hill (2007) 6th ed.*

2 *Griffiths, D.J., Introduction to Electrodynamics, Prentice Hall of India (1999) 3rd ed.*

3 *Jenkins, F.A. and White, H.E., Fundamentals of Optics, McGraw Hill (2001) 4th ed.*

Reference Books

1 *Wehr,M.R,Richards,J.A.,Adair,T.W.,PhysicsofTheAtom,NarosaPublishingHouse (1990) 4th ed.*

2 *Verma, N.K., Physics for Engineers, Prentice Hall of India (2014)1st ed.*

3 *Pedrotti, Frank L., Pedrotti, Leno S., and Pedrotti, Leno M., Introduction to Optics, Pearson Prentice HallTM (2008) 3rd ed.*

Scheme of evaluation

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

UMA010: Mathematics - I

L	T	P	Cr
3	1	0	3.5

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

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, (7^{th}edition)

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, 16thed.,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.

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

   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).*

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)1st ed.*
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,1st ed*
2. *Sivasankar,B.,EngineeringChemistry,TataMcGraw-HillPub.Co.Ltd,NewDelhi(2008).*
3. *Shulz, M.J. Engineering Chemistry, Cengage Learnings (2007)1st ed.*

Evaluation Scheme

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

UEE001: ELECTRICAL ENGINEERING

L	T	P	Cr.
3	**1**	**2**	**4.5**

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

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

Steady state analysis of DC Circuits: The ideal capacitor, permittivity; the multi-plate capacitor,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

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.

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).

Reference Books:

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

Evaluation Scheme:

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

UES009: MECHANICS

L	T	P	Cr
2	1	2*	2.5

(*Two hours lab once in semester)

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

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

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

Course Learning Outcomes (CLO):
The students will be able to:
1. Determine resultants in plane 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).*

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	P	Cr
3	0	2	4.0

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

Object Oriented Programming with C++: Class declaration, creating objects, accessing objects members, nested member functions, memory allocation for class, objects, static data members and functions.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

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 Assessment of Mechanical contents in Lectures and Tutorials and Electronics contents in Lectures and Practical. Project (Assembly of the "Mangonel", innovative redesign with reflection, prototype competition, Final Presentation and viva-voce	30 30 10 30

UCS405: DISCRETE MATHEMATICAL STRUCTURES

L	T	P	Cr
3	1	0	3.5

Course Objectives: Detailed study of various discrete and algebraic structures, basic logic, basics of counting and proof techniques.

Syllabus

Sets, Relations, and Functions: Sets: Operations on set, Inclusion-exclusion principle, Representation of Discrete Structures, Fuzzy set, Multi-set, bijective function, Inverse and Composition of functions, Floor and Ceiling functions, Growth of functions: Big-O notation, Big-Omega and Big-Theta Notations, Determining complexity of a program, Hashing functions, Recursive function, Functions applications.

Relations: Reflexivity, symmetry, transitivity, Equivalence and partial-ordered relations, Asymmetric, Irreflexive relation, Inverse and complementary relations, Partition and Covering of a set, N-ary relations and database, Representation relation using matrices and digraph, Closure of relations, Warshall's algorithm, Lexicographic ordering, Hasse diagram, Lattices, Boolean algebra, Application of transitive closure in medicine and engineering. Application: Embedding a partial order.

Graphs Theory: Representation, Type of Graphs, Paths and Circuits: Euler Graphs, Hamiltonian Paths & Circuits; Cut-sets, Connectivity and Separability, Planar Graphs, Isomorphism, Graph Coloring, Covering and Partitioning, Max flow: Ford-Fulkerson algorithm, Application of Graph theory in real-life applications.

Basic Logic: Propositional logic, Logical connectives, Truth tables, Normal forms (conjunctive and disjunctive), Validity of well-formed formula, Propositional inference rules (concepts of modus ponens and modus tollens), Predicate logic, Universal and existential quantification.

Proof Techniques and counting: Notions of implication, equivalence, converse, inverse, contra positive, negation, and contradiction, The structure of mathematical proofs, Direct proofs, Disproving by counter example, Proof by contradiction, Induction over natural numbers, Structural induction, Weak and strong induction, The pigeonhole principle, Solving homogeneous and heterogeneous recurrence relations.

Algebraic Structures: Group, Semi group, Monoids, Homomorphism, Congruences, Ring, Field, Homomorphism, Congruences, Applications of algebra to control structure of a program, the application of Residue Arithmetic to Computers.

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

1. Perform operations on various discrete structures such as set, function, and relation.
2. Apply basic concepts of asymptotic notation in the analysis of the algorithm.

3. Illustrate the basic properties and algorithms of graphs and apply them in modelling and solving real-world problems.
4. Comprehend formal logical arguments and translate statements from a natural language into their symbolic structures in logic.
5. Identify and prove various properties of rings, fields, and groups.

Text Books:

1. Discrete Mathematics and its Applications, Rosen H. K., McGraw Hill, 7th ed., 2011
2. Discrete Mathematical Structures with Applications to Computer Science, Tremblay P. J. and Manohar, R., Tata McGraw Hill, 2008.

Reference Books:

1. Contemporary Abstract Algebra, Gallian A. J., Cengage Learning, 9th ed., 2017
2. Discrete Mathematics, Lipschutz S., Lipson M., McGraw-Hill, 3rd ed., 2007

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UCS520: COMPUTER NETWORKS

L	T	P	Cr
3	0	2	4.0

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

Syllabus

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 (Acknowledgments, 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) /Course Objectives (COs):
On completion of this course, the students 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, sub-netting and routing mechanism.
3. Demonstrate the operation of various routing protocols and their performance analysis.

4. Illustrate design and implementation of datalink, transport and network layer protocols within a simulated/real networking environment.

Text Books:

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

Reference Books:

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

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UCS301: DATA STRUCTURES

L	T	P	Cr
3	0	2	4.0

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

Syllabus

Analysing algorithms: Basics of algorithm and its analysis, Complexity classes, order arithmetic, Time and space trade-off in algorithms.

Linear Data Structures: Arrays, Records, Strings and string processing, References and aliasing, Linked lists (Singly, Doubly, Circular), Strategies for choosing the appropriate data structure, Abstract data types, their implementation and applications: Stacks (using Arrays and Linked-list), Queues (using Arrays and Linked-list), Hash tables, including strategies for avoiding and resolving collisions, Dictionaries, Sets, Maps.

Searching and Sorting: Linear Search, Binary Search, Bubble Sort, Selection Sort, Insertion Sort, Shell Sort, Quick Sort, Merge Sort, Counting Sort, Radix Sort. Introduction to internal, external, and distribution sorting techniques.

Trees and their applications: Binary search trees, AVL Tree, Splay Tree, Red-Black Tree, B Tree and B+ Tree, Common operations on these trees such as select min, select max, insert, delete, traversals, iterate over tree. Heaps, Heap Sort Priority Queue, Fibonacci heaps and Binomial Heaps.

Graphs and their applications: Graphs and graph algorithms, Representations of graphs, Depth- and breadth-first traversals, Shortest-path algorithms (Dijkstra and Floyd), Data Structures for Disjoint Sets, Minimum spanning tree (Prim and Kruskal).

Problem Classes: Introduction to P, NP, NP- Hard and NP-complete

Laboratory Work

Implementation of Arrays, Recursion, Stacks, Queues, Lists, Binary trees, AVL trees, Splay trees, Sorting techniques, Searching techniques.

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

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

1. Understand the fundamental data structures, their implementation and some of their standard applications.
2. Select and implement appropriate searching and sorting techniques for solving a problem based on their characteristics.
3. Apply tree and graph data structures for specific applications.

4. Design and analyse algorithms using appropriate data structures for real-world problems.

Text Books:

1. Introduction to Algorithms, Cormen H. T., Leiserson E. C., Rivest L. R., and Stein C, MIT Press,3rd ed., 2009
2. Data Structures, Algorithms and Applications in C++, Sahni S., Universities Press 2nd ed. 2005

Reference Books:

1. Data Structures and Algorithms Made Easy, Karumanchi N., Career Monk Publications, 5th ed., 2017
2. Data structures and algorithms in C++, Adam Drozdek, 4th edition

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UEE409: NETWORK THEORY

L	T	P	Cr
3	1	2	4.5

Course Objectives: To make the students understand the concepts of graph theory, two port networks, filter design, attenuators, oscillator and network synthesis.

Syllabus

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

Network Theorems: Superposition Theorem, Thevenin's theorem, Norton's theorem, and Maximum power transfer theorem as applied to A.C. circuits, Tellegen's theorem and their applications.

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

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

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

Filters and Attenuators: Classification of filters, Analysis of a prototype low pass, High pass, Band pass, Band stop and Mderived 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 Outcomes (CLOs) /Course Objectives (COs):
On completion of this course, the students will be able to:

1. Apply various laws and theorems to solve electric networks.
2. Analyse the behaviour of two port networks.
3. Apply graph theory concept to solve electrical networks

4. Realize one-port network parameters
5. Design different filter and attenuator configurations.

Text Books:

1. Hayt, W., Engineering Circuit Analysis, Tata McGraw-Hill (2006).
2. Hussain, A., Networks and Systems, CBS Publications (2004).
3. Valkenberg, Van, Network Analysis, Prentice-Hall of India Private Limited (2007).
4. Gayakwad, A. Op-Amps and Linear Integrated Circuits, Prentice-Hall of India (2006).

Reference Books:

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

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UEE505: ANALOG AND DIGITAL SYSTEMS

L	T	P	Cr
3	1	2	4.5

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

Syllabus

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

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

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

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

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

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

Laboratory Work

RC coupled amplifier in CE mode, Use of Bi-stable, A-stable and mono-stable multi-vibrator, Hartley and Colpitts Oscillator, Combinational circuits, Flip Flops, shift register and binary counters, asynchronous/synchronous up/down counters, Variable modulus counters, Usage of IC tester,

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

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

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

1. Design different types of transistor biasing circuits and elucidate basics of FET and MOSFET.

2. Demonstrate general applications of op amp such as comparator, summing amplifier, differentiator and integrator.
3. Design Butterworth active filters using op amp and oscillator circuits.
4. Design combinational and sequential circuits.
5. Demonstrate the concept of ADC and DAC.

Text Books:

1. Boylestad R. L., Electronic Devices and Circuit Theory, Pearson Education(2007).
2. Millman, J. and Halkias, C.C., Integrated Electronics, Tata McGraw Hill(2006).
3. Floyd, T.L. and Jain, R. P., Digital Fundamentals, Pearson Education (2008).
4. Tocci, R. and Widmer, N., Digital Systems: Principles and Applications, Pearson Education (2007).

Reference Books:

1. Neamen, Donald A., Electronic Circuit Analysis and Design, McGraw Hill(2006).
2. Sedra A. S. and Smith K. C., Microelectronic Circuits, Oxford University Press(2006).
3. Mano, M. M. and Ciletti, M., Digital Design, Pearson Education (2008).
4. Kumar, A., Fundamentals of Digital Circuits, Prentice Hall (2007).

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UHU005: HUMANITIES FOR ENGINEERS

L	T	P	Cr
2	0	2	3.0

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

Syllabus

Unit 1: Human Values and Ethics

Values: Introduction to Values, Allport-Vernon-Lindzey Study of Values, Rokeach Value Survey, Instrumental and Terminal Values.
Moral and Ethical Values: Types of Morality, Kant's Principles of Morality, Factors for taking ethical decisions, Kohlberg's Theory of Moral Development.
Professional Ethics: Profession: Attributes and Ethos, Whistle-blowing.

Unit 2: Organizational Behavior

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

Unit 3: Economics

Demand, Supply & Elasticity – Introduction to Economics, Demand & its Determinants, Elasticity 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.

Laboratory Work

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

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

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

1. Comprehend ethical principles and values and apply them as a guide to behavior in personal and professional life.

2. Apply tools and techniques to manage and motivate employees.
3. Analyse and apply conflict management strategies that managers can use to resolve organizational conflict effectively.
4. Devise pricing strategy for decision-making.
5. Apply techniques for project evaluation.

Text Books:

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

Reference Books:

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

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UTA024: ENGINEERING DESIGN PROJECT-II

L	T	P	Cr
1	0	4	3.0

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

Syllabus

Hardware overview of Arduino:

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

Sensors and selection criterion:

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

Active and passive components:

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

Programming of Arduino:

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

Basics of C#:

- Introduction: MS.NET Framework Introduction, Visual Studio Overview and Installation
- Programming Basics: Console Programming, Variables and Expressions, Arithmetic Operators, Relational Operators, Logical Operators, Bitwise Operators, Assignment Operators,

Expressions, Control Structures, Characters, Strings, String Input, serial port communication: Read and write data using serial port.

- Software code optimization, software version control.

Laboratory Work

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

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

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

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

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

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

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

Text Books:

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

Reference Books:

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

UCS303: OPERATING SYSTEMS

L	T	P	Cr
3	0	2	4.0

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

Syllabus

Introduction and System Structures: Computer-System Organization, Computer-System Architecture, Operating-System Structure, Operating-System Operations, 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, Interprocess 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 Learn and practice basic Linux/Unix commands to Create and manipulate files and directories; Explore about Vi Editor environment; Build .C program related to fork (), exec (), wait (), sleep () functions at Linux/Unix platform; Write .C program for message passing and shared memory; Simulate CPU scheduling algorithms using either C or C++

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

1. Explain the basic of an operating system viz. system programs, system calls, user mode and kernel mode.
2. Select a 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. Operating System Concepts, Silberschatz A., Galvin B. P. and Gagne G., John Wiley & Sons Inc., 9th ed, 2013.
2. Operating Systems Internals and Design Principles, Stallings W., Prentice Hall 9th ed, 2018

Reference Books:

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

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UCS310: DATABASE MANAGEMENT SYSTEMS

L	T	P	Cr
3	0	2	4.0

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.

Syllabus

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

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

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

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

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

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

Database Implementation: Introduction to SQL, DDL 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):

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 Denormalization 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

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC401: COMPUTER SYSTEM DESIGN

L	T	P	Cr
3	0	2	4.0

Course Objectives: To introduce the concept of instruction level parallelism followed in the modern RISC based computers by introducing the basic RISC based DLX architecture. To make the students understand and implement various performance enhancement methods like memory optimization, Multiprocessor configurations, Pipelining and the performance evaluation. To enhance the coding skills and interfacing of I/O devices using interrupts to the processor.

Syllabus

Fundamentals of Computer Design: Evolution of Computer systems, Functional Units, Basic Operational Concepts, Bus Structures, Historical Perspective, Von-Neuman Architecture, Harvard Architecture. CISC and RISC architectures, CPU Performance metrics, choice of benchmarks, Control Unit; Hardwired and micro-programmed Control unit design

Instruction Set Principles: Classification of Instruction set architectures, Instruction format and Addressing modes, Program Execution, Role of registers, Evaluation stacks and data buffers, The role of compilers, MIPS32 Instruction set and programming examples, The DLX Architecture, Addressing modes, Instruction format, DLX operations, Effectiveness of DLX.

Memory Hierarchy Design: Introduction, Cache memory, Cache Organization, multilevel memories, Write Policies, Reducing Cache Misses, Cache Associativity Techniques, Reducing Cache Miss Penalty, Reducing Hit Time, Main Memory Technology, Fast Address Translation, Translation Lookaside buffer, Virtual memory, Crosscutting issues in the design of Memory Hierarchies, Cache Coherence.

Input / Output Organization and Buses: Accessing I/O Devices, Interrupts, Handling Multiple Devices, Controlling device Requests, Exceptions, Direct Memory Access, Bus arbitration policies, Synchronous and Asynchronous buses, Parallel port, Serial port, Standard I/O interfaces, Peripheral Component Interconnect (PCI) bus and its architecture, SCSI Bus, Universal Synchronous Bus (USB) Interface.

CPU Performance Enhancement: Idea of pipelining and parallelism, Stages of pipeline for DLX, Pipeline Hazards, Data hazards, Control Hazards, Design issues of Pipeline Implementation, Multicycle operations, The MIPS pipeline, Parallel Processing Concepts - Flynn's classifications, Instruction level parallelism, Pipeline Scheduling and Loop Unrolling, Data, Branch Prediction, Name and Control Dependences, Overcoming data hazards with dynamic scheduling, Superscalar DLX Architecture, The VLIW Approach.

Multiprocessors: Characteristics of Multiprocessor Architectures, Centralized Shared and Distributed Shared Memory Architectures, Synchronization, Models of Memory Consistency. Multicore processors and GPU.

Laboratory Work Use of assembler, Use of arithmetic and logic circuit board for integer and floating point data operations, microprogramming of control unit, pipelining processors, use of MIPs simulator, parameter assessment of Cache, input/output interface circuits

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

1. Display a understanding of the instruction set and coding of a RISC based processor.
2. Evaluate the performance of a RISC based machine with an enhancement applied and make a decision about the applicability of that respective enhancement .
3. Display wide understanding of how memory is organized and managed in a modern digital computer, including cache, virtual and physical memory and address translation.
4. Understand the concept of multiple processors, cache coherence and I/O device interfacing
5. Display an understanding of the concept of pipelining and parallelism pipelining in a modern RISC processor and describe how hazards are resolved.

Text Books:

1. Hennessy, J. L., Patterson, D. A., Computer Architecture: A Quantitative Approach, Elsevier (2009), 4th ed..
2. Hamacher, V., Carl, Vranesic, Z.G. and Zaky, S.G., Computer Organization, McGrawHill (2002), 2nd ed.
3. Hayes John P., Computer Architecture and Organization, McGraw Hill, (1988), 3rd ed..

Reference Books:

1. David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface (2010), Morgan Kaufmann ARM Edition.
2. Murdocca, M. J. and Heuring, V.P., Principles of Computer Architecture, Prentice Hall (1999) 3rd ed.
3. Stephen, A.S., Halstead, R. H., Computation Structure, MIT Press (1999) 2nd ed.
4. William Stallings, Computer Organization and Architecture: Designing for Performance, Pearson Education

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC402: FUNDAMENTALS OF SIGNAL PROCESSING

L	T	P	Cr
3	0	2	4.0

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

Syllabus

Introduction: Signals and Systems, Classification of signals, Continuous time signals and its classifications, Standard continuous time signals, Classification of continuous time systems, Discrete time signals and its classifications, Nyquist rate, Sampling theorem, Aliasing, Convolution, Correlation, Linear time invariant (LTI) system concepts.

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: Introduction to Fourier Transform and its properties, Concept of Energy and Power spectral density, 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 zTransform 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 (CLOs) /Course Objectives (COs):

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

1. Explain the basics of signals and systems.
2. Solve different type of problems related to Fourier series and Fourier transforms.

3. Design digital filter and harmonic mitigation.
4. Carryout spectrum analysis using DFT.

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 Hallof 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 (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UEE413 : ELECTRICAL MACHINERY

L	T	P	Cr
3	1	2	4.5

Course Objectives: The course aims to introduce the concept of D.C. Machines, Transformers, Synchronous and Asynchronous AC machines, their construction and performance parameters.

Syllabus

Direct Current Machines: Basic concept and classification of dc machines as per type of excitation, circuit models and related equations of separately and self-excited dc generators and motors, armature reaction, characteristics of dc generators, characteristics of dc motors , speed control of dc motor, DC Motor starters, losses and efficiency in DC machines .

Transformers: Working principle of three phase transformers, construction, basic phasor groups and connections of three phase transformer, V-V and Scott-Connection, Electrical tests and performance metrics, parallel operation of transformers.

Induction (Asynchronous) Motor: Principle of operation and construction, calculation of slip, rotor frequency, rotor emf, current and power, losses and efficiency, induction motor phasor diagram and equivalent circuit, torque-slip and power-slip characteristics, determination of equivalent circuit parameters from no-load test and blocked-rotor test, starting methods of induction motor, methods of speed control.

Synchronous Machines: Operating principle and construction, phasor diagrams of cylindrical and salient pole synchronous generators/alternator, Open circuit and short circuit test of synchronous machine, voltage regulation of an alternator, active and reactive power equations of synchronous machine-power-angle characteristics, synchronizing power and synchronizing torque, Parallel Operation and Synchronisation of generator with infinite bus, operating principle and application of synchronous motor.

Single-phase motors: Basic concept of single-phase induction motor, starting methods, comparison between single and poly-phase induction motors, basic working principle and application of universal motor, single-phase reluctance motor, sub-synchronous motor, hysteresis motor.

Laboratory Work

Open short and short circuit tests on transformer, parallel operation of transformer, measurements of harmonics in inrush current, Scott connection and load sharing, no load, and external characteristics of self and separately excited DC generators, Speed control of DC shunt motor, open circuit and blocked rotor test on induction motor, speed control of induction motor, motor starting methods, voltage regulation of synchronous generator, V and inverted V curves of Synchronous generator, active and reactive power control of synchronous generator.

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

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

1. Analyse the performance of three phase transformers.

2. Analyse the load sharing with parallel connected single phase/three phase transformers.
3. Analyse the performance characteristics of DC motors and DC generators
4. Use different methods for starting and speed control of DC motors.
5. Analyse tests, characteristics and steady state performance of Three-phase induction motor.
6. Comprehend the performance and test of synchronous machines.
7. Analyse performance of single machine – infinite bus system and number of alternators connected in parallel.

Text Books:

1. D.P. Kothari and I.J. Nagrath, Electric Machines, 4e, Tata McGraw Hill Education Private Limited, New Delhi.
2. P.S. Bimbhra, Electrical Machinery, 7ed., Khanna Publishers, New Delhi.
3. P.S. Bimbhra, Generalized Theory of Electrical Machines, 5e, Khanna Publishers, New Delhi.

Reference Books:

1. Toro, Vincert, Electromechanical Devices for Energy Conversion, Prentice Hall of India.
2. Fitzgerald, A.E., Kingsley, C. Jr., and Umans, Stephen, Electric Machinery, 6e, McGraw Hill, USA.

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UEE414 : PRINCIPLES OF POWER SYSTEM ENGINEERING

L	T	P	Cr
3	1	2	4.5

Course Objectives: The course aims to impart a critical theoretical and practical introduction to electrical, mechanical design of transmission system and steady state analysis of network.

Syllabus

Introduction to Power System: Structure of power systems, Growth of power systems-Indian overview, Interconnections and their advantages. Power Supply Systems and their comparison, High voltage Transmission Systems.

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

Mechanical Design of Transmission line: Tension and sag calculations, Factors affecting Sag, Sag template, Stringing charts, Vibrations and vibration damper.

Insulators: Insulator types, String efficiency and its Improvement.

Performance of Transmission Lines: Characteristics and performance of power transmission lines: Short, Medium, Long lines, Generalized constants, Power flow, regulation, Power circle diagrams, Series and shunt compensation, Corona, Ferranti Effect, Electrostatic and Electromagnetic interference with communication lines.

Transmission network Calculations: Single line diagram of power system, Per Unit System and its advantages, Admittance model, Modelling of regulating transformer, Bus admittance matrix assemble, Bus impedance matrix assembly.

Load Flow Studies: Load flow problem, Power flow equations, Load flow solution using Gauss Seidal and Newton Raphson methods, Decoupling between real and reactive power control, Decoupled and fast decoupled methods, Comparison of load flow methods.

Laboratory Work

The instructor may add experiments related to the implementation of R, L, C parameters on transmission line bench, Measurement of ABCD parameters of line, String efficiency of insulator. MATLAB simulation of Ybus, Zbus assembly of IEEE data, Load flow solution. Use of application specific s/w.

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

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

1. Design the electrical parameters of transmission lines and insulated cables under various working conditions.

2. Describe the mechanical design (sag and tension) of transmission line under various environment and geographical conditions .
3. Develop and analyse the transmission line models and evaluate its performance.
4. Develop an appropriate mathematical model of power system
5. Formulate power system network matrices
6. Carry out load flow analysis of practical power system for balanced system.

Text Books:

1. Nagrath, I.J. and Kothari, D.P., Power System Engineering, Tata McGraw Hill (2007).
2. Stevenson, W.D., Power System Analysis, McGraw Hill (2007).
3. Gupta, B.R., Power System Analysis and Design, S. Chand and Company Limited (2009)

Reference Books:

1. M. Pai, Copmuter Techniques in Power System analysis, Tata McGraw Hill, 2nd ed., (2005).
2. 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).
3. Elgard, O.L. , Electric Energy Systems Theory, McGraw Hill Publications , 2nd ed., (2017).

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UMA028: MATHEMATICS FOR DATA SCIENCE

L	T	P	Cr
3	0	2	4.0

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

Syllabus

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

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

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

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

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

Hypothesis: Introduction to Sampling Distribution (standard normal, chi-square, T& F distributions), Critical regions, Neyman-Pearson lemma (without proofs). Parametric & Non-parametric tests: Tests for Goodness of fit: Based on Chi-square Test, one sample and paired sample tests; Sign Test, Signed-rank Test, Kolmogorov Smirnov Test.

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

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

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

1. Compute probabilities of composite events along with an understanding of random variables and distribution functions.

2. Understand the convergence of sequence in probabilities
3. Analyse the correlated data and fit the linear regression models.
4. Make statistical inferences using principles of hypothesis tests.

Text Books:

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

Reference Books:

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

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UEE511: EMBEDDED SYSTEM DESIGN and IoT

L	T	P	Cr
3	0	2	4.0

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

Syllabus

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

ARM embedded application development: ARM Architecture, ARM programmer's model, Hardware and Software Requirements, Embedded Control Application Development Case study: Open Loop and Closed Loop Control and Coding of PID Controller for washing machine as an example.

Embedded application with programmable digital signal processors: Commercial digital signal processing devices, data addressing modes, memory space, program control, on chip peripherals, interrupts and pipeline operations of TMS320C54XX DSPs. Networked Embedded Systems: Distributed Embedded Architectures, Protocol Design issues, wireless network.
Internet of Things (IoT) and enabling Technologies: Introduction to Internet of Things (IoT), vision and challenges for realizing the Internet of Things, IoT architecture, design. IoT and Interoperability: Communication Protocol, Physical/Link Layer, IEEE 802.3 (Ethernet), Network Layer, Transport Layer, Application Layer, Interoperability in IoT, Interoperable communication standards: IEC 61850.
IoT Sensors modules and Actuators: Introduction to IoT based measurements, Smart sensors, MEMS etc., Case Study: Solid state relay, and Motor application.

Laboratory Work
Programming examples of ARM based processors, Programming and Application development around ARM, Interfacing with peripherals etc., IoT application programs.
Minor Project: Development of IoT based application such as: Home and Building Automation, Smart Grid, Smart City, Smart Farming, Smart Healthcare. Temperature Monitoring over the Internet, Smart Lighting, Voice-Controlled Door Access, RFID Reader, Cloud Example with IBM Watson Bluemix.

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

1. Elucidate the architecture of ARM processors and write embedded program.

2. Interface peripherals and develop applications based on PIC/ARM processors.
3. Elucidate the IoT communication, protocols and platform properties.
4. Practice IoT applications for electrical systems.

Text Books:

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

Reference Books:

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

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

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.

Syllabus

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 feed-forward neural network, recurrent and temporal neural network, recurrent network use for optimization, Neuro-Fuzzy hybrid system; Engineering Applications.

Laboratory Work Programming in C/C++/Java/MATLAB: Programs for Search algorithms-Depth first, Breadth first, Hill climbing, Best first, A* algorithm, Implementation of games: 8-puzzle, Tic-Tac-Toe, tower of Hanoi and water jug problem using heuristic search, Implementing an intelligent agent, Fuzzy controller development, Optimisation problem using EBP learning, Decision making using Fuzzy models.

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

On completion of this course, the students will 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.

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 4th Ed., (2016)).
4. S. Haykin, Neural Network: A Comprehensive Foundation, Pearson Education (2003).

Reference 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

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UEE512: POWER CONVERTERS AND DRIVES

	L	T	P	Cr
	3	1	2	4.5

Course Objectives: The course aims at familiarizing the student with the principles and control of power electronics converters and their application in electric drives

Syllabus

Power Electronics Device as a Switch: Introduction to power electronics technology and its comparison with linear electronics; Ideal switches and their classification based on V-I characteristics; Static and dynamic Characteristics of semiconductor power devices: Diode, Thyristor, Triac, GTO, MOSFET, IGBT, Gate/Base drive circuits

(power circuits, working principle, waveforms and design): Buck, Boost and Buck-Boost converters. Harmonic analysis

AC to DC Conversion: 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. Harmonic analysis

DC to AC Conversion: Single phase voltage source bridge inverters and their steady state analysis; three-phase bridge inverters with 1800 and 1200 modes; single-phase and three- phase PWM inverters.

AC to AC Conversion: AC Voltage Controllers: Types , single-phase voltage controller with R and RL type of loads. Harmonic analysis Cyclo-converters: Principles of operation, single-phase to single-phase step-up and step- down cyclo-converters.

Drives Application of Power Electronics: Concept of electric drive and its classifications, Types of loads, Four-quadrant drive, Dynamics of motor-load combination, Steady state stability of an electric drive system, Load Equalization

Control of AC and DC motors: Staring and Speed Control of AC and DC motors fed through single-phase and three-phase controlled power converter configurations, Static Kramer and Scherbius drives, V/f and Vector control of AC Drives. Regeneration and braking of AC and DC motors through static power converters.

Laboratory Work SCR V-I characteristics, Gate firing circuit, DC -DC chopper, Semi converter and Full converter with R , RL and RLC type of loads, Single phase AC voltage controller with R load, three-phase PWM inverter, Simulation of power electronics converters using (Simulink/PLECS/ PSIM). Starting and running characteristics of converter fed AC and DC motor control, Harmonic analysis of AC and DC Drives, V/f based drive.

Minor Project: Drive simulation using multi-dimensional software such as ANSYS Maxwell/ PExprt.

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

1. Select the power devices as per the usage for energy conversion and control.
2. Analyse various converter configuration / topology with different types of load.
3. Identify converter configurations for various power applications.
4. Conceptualize the basic drive system and analyse it for different types of loads.

Text Books:

1. Rashid, M., Power Electronics, Prentice Hall of India (2006).
2. Bimbhra, P.S., Power Electronics, Khanna Publishers(2012).
3. Mohan, N., Underland, T. and Robbins, W. P., Power Electronics: Converter Applications and Design, John Wiley (2007) 3rded.
4. Vithayathil, J, Power Electronics: Principles and Applications, Tata McGraw Hill, Indian Edition.
5. Bose, B.K., Modern Power Electronics and AC Drives, Prentice-Hall of India Private Limited (2006).
6. Dubey, G.K., Fundamentals of Electric Drives, Narosa Publications (2001)

Reference Books:

1. Rashid, M.H., A Handbook of Power Electronics, Elsevier.
2. Krein, P.T., Elements of Power Electronics, Oxford University Press (2012).
3. Leonhard, W., Control of Electric Drives, Springer (2001).
4. Wang,L., Chai, S., Yoo, D., Gan, L., Ng, K., PID and Predictive Control of Electrical Drives and Power Converters using MATLAB / Simulink, IEEE-Wiley Press (2014)

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UEE508: LINEAR CONTROL SYSTEMS

L	T	P	Cr
3	1	2	4.5

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

Syllabus

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

Control hardware and their models: Potentiometers, Synchros, LVDT, DC and AC servomechanisms, Tacho-generators, and Stepper motors.

Analysis: Steady-state errors and error constants, transient accuracy, disturbance rejection, insensitivity and robustness

Basic Models of Feedback Control: Concepts of P, PD, PI and PID types of control and their realizations.

Stability: Definition, Routh-Hurwitz criterion, Root locus techniques, Bode plots, Nyquist criterion, Relative stability, concepts of gain and phase margins.

Compensation: Lead, Lag and lag-lead compensators, Design of compensating networks for specified control system performance. State Space Analysis: Concepts of state, State variables and state models, State space equations, transfer function, Transfer model, State space representation of dynamic systems, State transition matrix, Decomposition of transfer function, Controllability and observability.

Digital Linear Control : Time response analysis, Juri's Algorithm , Root-locus, Stability of linear systems in digital domains;, State variables analysis , Eigen value and Eigen vector of digital system, controller design for digital system, Application of automatic generation control in single area and two area power system network.

Laboratory Work Linear system simulator, Compensation design, D.C. position control and speed control, Synchro characteristics, Servo demonstration, Stepper motor, Potentiometer error detector, Rate control system, Series control system, Temperature control system, simulation examples of control problems with MATLAB/Simulink software.

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

1. Develop the mathematical model of the physical systems.
2. Analyse the response/stability of the closed and open loop systems.

3. Design the various kinds of compensators.
4. Develop and analyse state space models
5. Compare the Linear continuous time and Digital Control Systems

Text Books:

1. Gopal, M., Digital Control System, Wiley Eastern (1986).
2. Nagrath, I.J. and Gopal, M., Control System Engineering, New Age International (P) Limited, Publishers (2003).
3. Ogata, K., Modern Control Engineering, Prentice Hall of India Private Limited (2001).
4. Bishop & Dorf, Modern Control System, Addison Weseley, 13th Ed. (Pearson), (2022)

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

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

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 start- up venture finance.

Syllabus

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

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

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

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

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

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

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

Text Books:

1. Ries, Eric, The lean Start-up: How constant innovation creates radically successful businesses, Penguin Books Limited. (2011)

2. Blank, Steve , The Startup Owner's Manual: The Step by Step Guide for Building a Great Company, K&S Ranch. (2013)
3. S. Carter and D. Jones-Evans, Enterprise and small business- Principal Practice and Policy, Pearson Education (2006)

Reference Books:

1. T. H. Byers, R. C. Dorf, A. Nelson, Technology Ventures: From Idea to Enterprise, McGraw Hill (2013)
2. Osterwalder, Alex and Pigneur, Yves , Business Model Generation. (2010)
3. Kachru, Upendra, India Land of a Billion Entrepreneurs, Pearson
4. Bagchi, Subroto, (2008), Go Kiss the World: Life Lessons For the Young Professional, Portfolio Penguin
5. Bagchi, Subroto, (2012). MBA At 16: A Teenager's Guide to Business, Penguin Books
6. Bansal, Rashmi, Stay Hungry Stay Foolish, CIIE, IIM Ahmedabad
7. Bansal, Rashmi, (2013). Follow Every Rainbow, Westland.
8. Mitra, Sramana (2008), Entrepreneur Journeys (Volume 1), Booksurge Publishing
9. Abrams, R. (2006). Six-week Start-up, Prentice-Hall of India.
10. Verstraete, T. and Laffitte, E.J. (2011). A Business Model of Entrepreneurship, Edward Elgar Publishing.
11. Johnson, Steven (2011). Where Good Ideas comes from, Penguin Books Limited.
12. Gabor, Michael E. (2013), Awakening the Entrepreneur Within, Primento.
13. Guillebeau, Chris (2012), The $100 startup: Fire your Boss, Do what you love and work better to live more, Pan Macmillan
14. Kelley, Tom (2011),The ten faces of innovation, Currency Doubleday
15. Prasad, Rohit (2013), Start-up sutra: what the angels won't tell you about business and life, Hachette India.

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC601: MACHINE LEARNING TECHNIQUES

L	T	P	Cr
3	0	2	4.0

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

Syllabus

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, Overfitting, Regularization

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

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

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

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

Data Pre-processing: Methods: Data Cleaning, Data Integration, Data Transformation, Data Reduction; Feature Scaling (Normalization and Standardization), Splitting dataset into Training and Testing set. Principle Component Analysis (PCA), Linear Discriminant Analysis (LDA), Correlation based feature selection.

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

Laboratory Work The laboratory work includes supervised learning algorithms, linear regression, logistic regression, decision trees, k-nearest neighbour, 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 (CLOs) /Course Objectives (COs):
On completion of this course, the students will be able to:

1. Analyse the complexity of machine learning algorithms and their limitations
2. Realize learning algorithms as neural computing machine
3. Demonstrate the ability to evaluate and compare learning models and learning algorithms
4. 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	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UCS415: DESIGN AND ANALYSIS OF ALGORITHMS

L	T	P	Cr
3	0	2	4.0

Course Objectives: The objective of the course is to teach techniques for effective problem solving in computing. It covers good principles of algorithm design, elementary analysis of algorithms, and advanced data structures.

Syllabus

Introduction and Complexity Analysis: Basics of data structures such as stacks, queues, trees, heaps, Algorithm Definition, Analysing algorithms, Complexity classes, order arithmetic, Time and space trade-offs in algorithms, Recurrence relations, Analysis of iterative and recursive algorithms, Analysis of Search and Traversal in trees, graphs etc., Amortized Analysis.

Algorithm Design Techniques and Analysis
Divide and Conquer: General method, Applications such as binary search, merge sort, quick sort etc.
Greedy algorithms: General method, Elements of greedy strategy, Applications such as activity selection, job sequencing, fractional knapsack problem etc.
Dynamic Programming: General method, Elements of dynamic programming, Use of table instead of recursion, Applications such as matrix multiplication, 0/1 knapsack, optimal binary search tree, longest common subsequence etc.
Backtracking: General method, Applications such as N queen problem, sum of subsets, graph coloring, knapsack problem etc.
Branch and Bound Algorithm: General method, Applications such as0/1 knapsack problem, Traveling salesperson problem etc.

Graphs & Algorithms: Introduction to graphs, Paths and Circuits: Euler Graphs, Hamiltonian Paths & Circuits; Cut-sets, Connectivity and Separability, Planar Graphs, Isomorphism, Covering and Partitioning, Strongly connected component, Topological sort, Max flow: Ford Fulkerson algorithm, max flow- min cut, Dynamic Graphs.

String Matching Algorithms: Suffix arrays, Suffix trees, tries, Rabin-Karp, Knuth-MorrisPratt, Boyer Moore algorithm.

Lower Bound Theory: Comparison trees for sorting and searching, Oracles and adversary arguments, techniques for algebraic problems.

Problem Classes: P, NP, NP-Hard and NP-complete, deterministic and non deterministic polynomial time algorithm approximation, solutions for some NP complete problems using Approximation, Randomized, Online, and Genetic Algorithms.

Laboratory Work Implementation of various advanced data structures and algorithms techniques for solving common engineering problems.

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

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

1. Analyze the complexity of algorithms, to provide justification for the selection, and to implement the algorithm in a particular context.
2. Apply various algorithmic design paradigms such as greedy, dynamic, backtracking etc. to solve common engineering problems.
3. Identify basic properties of graphs and apply their algorithms to solve real life problems.
4. Demonstrate the application of algorithms and selection of appropriate data structures under several categories such as string matching, randomized algorithms and genetic algorithms.

Text Books:

1. Cormen H. T., Leiserson E. C., Rivest L. R., and Stein C., Introduction to Algorithms, MIT Press (2009) 3rd ed.
2. Horwitz E., Sahni S., Rajasekaran S., Fundamentals of Computers Algorithms, Universities Press (2008) 2nd ed.

Reference Books:

1. Levitin A., Introduction to the design and analysis of algorithms, Pearson Education (2008) 2nd ed.
2. Aho A.V., Hopcraft J. E., Dulman J. D., The Design and Analysis of Computer Algorithms, Addsion Wesley (1974) 1st ed.
3. Sedgewick R. and Wayne K., Algorithms, Addison-Wesley Professional (2011), 4th ed.

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UCS503: SOFTWARE ENGINEERING

L	T	P	Cr
3	0	2	4.0

Course Objectives: To plan and manage large scale software and learn emerging trends in software engineering

Syllabus

Software Engineering and Processes: Introduction to Software Engineering, Software Evolution, Software Characteristics, Software Crisis: Problems and Causes, Software process models -Waterfall, Iterative, Incremental and Evolutionary process models

Requirements Engineering: Problem Analysis, Requirement Elicitation and Validation, Requirement Analysis Approaches- Structured Analysis Vs Object Oriented Analysis, Flow modeling through Data Flow Diagram and Data Dictionary, Data Modeling through E-R Diagram, Requirements modeling through UML, based on Scenario, Behavioral and Class modeling, documenting Software Requirement Specification (SRS)

Software Design and construction: System design principles like levels of abstraction, separation of concerns, information hiding, coupling and cohesion, Structured design (topdown or functional decomposition), object-oriented design, event driven design, componentlevel design, test driven design, data design at various levels, architecture design like Model View Controller, Client – Server architecture. Coding Practices: Techniques, Refactoring, Integration Strategies, Internal Documentation.

Software Verification and Validation: Levels of Testing, Functional Testing, Structural Testing, Test Plan, Test Case Specification, Software Testing Strategies, Verification & Validation, Unit and Integration Testing, Alpha & Beta Testing, White box and black box testing techniques, System Testing and Overview of Debugging.

Agile Software Development: Agile Manifesto, Twelve Practices of eXtreme Programming (XP), XP values, XP practices, velocity, spikes, working of Scrum, product backlog, sprint backlog, Adaptive Software Development(ASD), Feature Driven Development (FDD), Test Driven Development, Dynamic System Development Method(DSDM), and Crystal Methodology,Agile Requirement and Design: User Stories, Story Boards, UI Sketching and Story Cards.

Software Project Management: Overview of Project Management: Scope, Time and Cost estimations.

Laboratory Work Implementation of Software Engineering concepts and exposure to CASE tools like Rational Software Suit through projects.

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

1. Analyze software development process models for software development life cycle.

2. Elicit, describe, and evaluate a system's requirements and analyze them using various UML models.
3. Demonstrate the use of design principles in designing data, architecture, user and component level design.
4. Test the system by planning appropriate test cases and applying relevant test strategies.
5. Comprehend the use of agile development methodologies including UI sketching, user stories, story cards and backlog management.

Text Books:

1. Pressman R., Software Engineering, A Practitioner's Approach, McGraw Hill International, 7th ed. (2010).
2. Sommerville I., Software Engineering, Addison-Wesley Publishing Company, 9th ed. (2011)

Reference Books:

1. Jalote P.,An integrated Approach to Software Engineering, Narosa, 3rd ed. (2005).
2. Booch G.,Rambaugh J.,Jacobson I.,The Unified Modeling Language User Guide, 2nd ed. (2005).

Evaluation Scheme

Evaluation Elements	Weightage %
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC602: DIGITAL MEASUREMENT AND PROTECTION

L	T	P	Cr
3	0	2	4.0

Course Objectives: The objective of this course is to provide a comprehensive up-to-date presentation of the fundamentals of digital measurement and digital protection through state-of-art theories and methods in digital relaying,

Syllabus

Fundamentals of Digital Measurement : Concept of sampling and aliasing, mean and RMS value theorem, power evaluation theorem, Time-division multiplexing, Quantization, A/D converters, digital instruments and their performance characteristics.

Digital Time and Frequency Measurement: Measurement of a Time Interval. Small Time Interval, Periodic Time; Phase Measurement. Measurement of R-L-C parameters.
Measurement of Frequency, ratio and multiplication of frequencies, high and low frequencies, average frequency difference. power system frequency deviation; Time reciprocating circuit; fast low-frequency measurement of sinusoidal signals, peak frequency measurement.

Estimation of phasors: Fourier transform, discrete Fourier transform, Discrete Cosine Transform; Estimation of phasors using Walsh function and Least Error Square techniques; estimation of frequency in digital relays.

Digital Relays: Fundamentals of digital relays; Basic layout and elements of the digital relays; Sliding window concept of digital relays. Digital Directional/Non-directional Overcurrent and Earth fault relays; relay coordination in an interconnected power system network: Digital distance relays.

Digital Protection of Power System equipment: Digital Differential Protection of Generator and Transformers and Busbar, Protection of transmission lines with digital distance relays; Power swing detection and blocking technique.

Frequency relaying: Load shedding, rate of frequency decline and frequency relays; Hazards and risk of islanding; Loss of coordination among protective devices: Advanced Metering: Introduction to Smart meters, Advanced metering infrastructure and phasor measurement unit (PMU)

Laboratory Work Time-current characteristics of different types of electromagnetic and digital overcurrent, differential relay, directional and distance relays, generator, transformer and transmission line protections, realisation of concept of grading of relays, relay co- ordination, and islanding, realisation of digital protection schemes using simulation software like MATLAB/DigSILENT.

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

1. Demonstrate various digital measurement modules, associated circuits and sampled measurements

:

2. Demonstrate protection strategies applied for power system protection.
3. Realize the various dynamic characteristics of digital relays for protection of transmission lines, transformers.
4. Identify the new developments in protective relaying and applications

Text Books:

1. Anderson, P.M., Power System Protection, IEEE Press, New York, 1999.
2. John A.T., Salman S.K., Digital protection for Power Systems, IEE Power Series: 15, 1995
3. Bhavesh Bhalja, R. P. Maheshwari, N. G. Chothani, Protection and Switchgear, Oxford University Press, 2nd ed., New Delhi, India, 2018.

Reference Books:

1. Blackburn, J.L., Applied Protective Relaying, Westinghouse Electric Corporation, New York, 1982.
2. Oza, B. A., Nair N. C., Mehta R.P., et al., Power System Protection & Switchgear, Tata McGraw Hill, New Delhi, 2010.
3. Bhavesh Bhalja and Vijay H. Makwana, Transmission Line Protection Using Digital Technology,Springer Science, Business Media Singapore Pvt. Ltd; Singapore, January 2016
4. Phadke, A.G. and Thorp J.S., Computer Relaying for Power Systems, Research Study Press Ltd, John Wiley & Sons, Taunton, UK, 1988.

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC603: ELECTRIC VEHICLE AND REAL TIME SYSTEMS

L	T	P	Cr
3	0	2	4.0

Course Objectives: To introduce the students about importance of Electric Vehicle: technical challenges, benefits, and perspectives in real time environment. To make familiar with hardware components including measurement and control in hardware in loop system.

Syllabus

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

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

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

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

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

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

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

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

1. Relate the importance of Electric Vehicle and its application

2. Describe the working of Motor and Controller used in EV
3. Demonstrate the battery construction and cell configuration
4. Explain the Hardware-in-loop simulation systems in Electrical and Computer Engineering.
5. Explain about the mathematical model for power system and control in a real environment

Text Books:

1. James Larminie, Electric Vehicle Technology, Wiley, A John Wiley & Sons, Ltd., Publication (2012)
2. Sunil R. Pawar, Electrical Vehicle Technology. The Future towards Eco-Friendly Technology. 2nd Edition, (2021)
3. Tom Denton, Electric and Hybrid Vehicles, 2nd Edition, (2016)
4. HIL System catalogues; Opal-RT, RTDS and Typhoon (2017)

Reference Books:

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

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC691: CAPSTONE PROJECT (STARTS)

L	T	P	Cr
1	0	2	8.0

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

Course Description:

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

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

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

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

UCS701: THEORY OF COMPUTATION

L	T	P	Cr
3	1	0	3.5

Course Objectives: This course introduces basic theory of computer science and formal methods of computation. The course exposes students to the computability theory, as well as to the complexity theory.

Syllabus

Regular Languages: Alphabets, Language, Regular Expression, Definitions of Finite State Machine, Transition Graphs, Deterministic & Non-deterministic Finite State Machines, Regular Grammar, Thompson's Construction to Convert Regular Expression to NDFA & Subset Algorithm to convert NDFA to DFA, Various recent development in the Conversion of Regular Expression to NFA, Minimization of DFA, Finite State Machine with outputMoore machine and Melay Machine, Conversion of Moore machine to Melay Machine & Vice-Versa.

Properties of Regular languages: Conversion of DFA to Regular Expression, Pumping Lemma, Properties and Limitations of Finite state machine, Decision properties of Regular Languages, Application of Finite Automata.

Context Free Grammar and Push Down Automata: Context Free Grammar, Derivation tree and Ambiguity, Application of Context free Grammars, Chomsky and Greibach Normal form, Properties of context free grammar, CKY Algorithm, Decidable properties of Context free Grammar, Pumping Lemma for Context free grammar, Push down Stack Machine, Design of Deterministic and Non-deterministic Push-down stack.

Turing Machine: Turing machine definition and design of Turing Machine, Variations of Turing Machines, combining Turing machine, Universal Turing Machine, Post Machine, Chomsky Hierarchy, Post correspondence problem, Halting problem, Turing decidability.

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

1. Comprehend regular languages and finite automata and develop ability to provide the equivalence between regular expressions, NFAs, and DFAs.
2. Disambiguate context-free grammars and understand the concepts of context-free languages and pushdown automata.
3. Analyse and design efficient Turing Machines.
4. Distinguish different computing languages and classify their respective types.

Text Books:

1. Hopcroft E. J., Ullman D. J. and Motwani R., Introduction to Automata Theory, Languages and Computation, Pearson Education (2007) 3rd ed.

2. Martin C. J., Introduction to Languages and the Theory of Computation, McGraw-Hill Higher Education (2011) 4th ed.
3. Lewis R. H., Papadimitriou H. C., Elements of the Theory of Computation, Prentice Hall (1998) 2nd ed.

Reference Books:

1. Cohen A. I. D., Introduction to Computer Theory, Wiley (1997) 2nd ed.
2. Sipser M., Introduction to the Theory of Computation, Cengage Learning (2013) 3rd ed.

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC701: SMART ELECTRIC GRID AND ENERGY MANAGEMENT

L	T	P	Cr
3	0	0	3.0

Course Objectives: To get acquainted with the concepts of smart grid components., energy management system, distribution management system, techniques of communication, computer networking and cyber security for smart metering systems

Syllabus

Introduction to Smart Grid: Basics of power systems, definition of smart grid, need for smart grid, functions of smart grid, opportunities & barriers of smart grid, difference between conventional & smart grid, regulatory challenges, present development & International policies in smart grid.

Architecture of Smart Grid: Functional elements of Smart grid designs, transmission automation, distribution automation, renewable integration. Distribution energy sources, microgrids, storage technologies, electric vehicles and plug-in hybrids, environmental impact and economic issues. Smart grid architecture, standards-policies, network architectures, IP-based systems, power line communications, SCADA system

Advanced Metering: Introduction to Smart meters, Advanced metering infrastructure and phasor measurement unit (PMU)

Tools and Techniques for Smart Grid: static and dynamic optimization techniques for power applications such as economic load dispatch, Conventional and evolutionary algorithms in power system

Communication Technologies in Smart Grid: Introduction to communication technology, architectures, standards, PLC, Zigbee, GSM, BPL, Local Area Network (LAN) – House Area Network (HAN) – Wide Area Network (WAN) – Broadband over Power line (BPL) – IP based Protocols – Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

Energy Management in Smart Grid: General principles, Planning and program, concept and scope of demand side management (DSM). DSM Strategy, Planning, Implementation and its application, Energy Management System (EMS) , smart substations , substation automation, feeder Automation, smart switchgear, remote terminal unit, Intelligent electronic devices , protocols, phasor measurement unit , wide area monitoring, protection and control, smart integration of energy resources.

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

1. Explain the concept and planning of smart grids.
2. Apply the various techniques of communication, computer networking and cyber security for smart metering systems.

2. Analyze smart grids and distributed energy resources (DER) with evolutionary algorithms.
3. Describe the components and functions of energy and distributed management system.
4. Analyze the application of smart grid technology in power system through case studies.

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai, Integration of Green and Renewable Energy in Electric Power Systems, Wiley, (2009)
2. Clark W. Gellings, The Smart Grid: Enabling Energy Efficiency and Demand Response, CRC Press, (2009)
3. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianz hong Wu, Akihiko Yokoyama, Smart Grid: Technology and Applications, Wiley, (2012)
4. G. Masters, Renewable and Efficient Electric Power System, Wiley–IEEE Press, 2nd Edition, (2013).
5. Stuart Borlase, Smart Grids (Power Engineering), CRC Press, (2012)

Reference Books:

1. Andres Carvallo, John Cooper, The Advanced Smart Grid: Edge Power Driving Sustainability, Artech House Publishers , (2011).
2. James Northcote, Green, Robert G. Wilson Control and Automation of Electric Power Distribution Systems (Power Engineering), CRC Press.(2017)
3. James Momoh, Smart Grid: Fundamentals of Design and Analysis, Wiley, (2012)

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC691: CAPSTONE PROJECT

L	T	P	Cr
0	0	2	8.0

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

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

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

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

ULC891: PROJECT SEMESTER

L	T	P	Cr
-	-	-	15.0

Course Objectives: The project semester is aimed to facilitate the students learn and apply their acquired skill set for the system development in the domain of Electrical and Computer Engineering. Each individual student will undertake 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. As a part of a team, the students will make a project, which emphasizes hands-on experience, and integrates analytical, design, and development skills.

Course Description: The project semester gives the student the opportunity to translate engineering theory into practice in a professional engineering environment. The technical activity in the project semester should be related to both the student's engineering studies and to the host organization's activities and it should constitute a significant body of engineering work at the appropriate level. It should involve tasks and methods that are more appropriately completed in a professional engineering environment and should, where possible, make use of human and technology resources provided by the organization. The idea is to provide an opportunity to the students to apply what they have learned throughout the course of graduate program by undertaking a specific problem. It consolidates the student's prior learning and provides a context for later research studies. The student remains a full time registered student at Thapar Institute of Engineering and Technology during the project semester and this activity is therefore wholly distinct from any industrial interactions which may occur over vacation periods.

Assessment Details: Each student is assigned a faculty supervisor who is responsible for managing and assessment of the project semester. The faculty supervisor monitors the student's progress in a semester and interacts with the industry mentor during his/her visit to the host organization twice. The evaluation scheme in the projects semester includes a Reflective Diary which is updated throughout the project semester, a Mid-Way Project Report, a Final Report with Learning Agreement/Outcomes and an End semester Presentation & Viva. Each student will present his/her work to the panel of examiners 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 forms. The faculty supervisor is responsible for managing and performing the assessment of the project semester experience.

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

1. Develop skills necessary for time management, reporting and carrying out projects within an organization/industry.
2. Acquire knowledge and experience of software and hardware practices in the area of project.
3. Carry out design calculations and implementations in the area of project.
4. Associate with the implementation of the project requiring individual and teamwork skills.
5. Communicate their work effectively through technical report writing and presentation.
6. Demonstrate the knowledge of professional responsibilities and respect for ethics

ULC892: DESIGN PROJECT

L	T	P	Cr
-	-	-	8.0

Course Objectives: The design project is introduced in Electrical and Computer Engineering undergraduate programme to include a practical training in the university itself for six months.

Course Description: Course Description: The project offers the student the opportunity to demonstrate engineering theory into practice under the supervision of a faculty supervisor in electrical engineering department. The students are also offered with two courses. The technical activity in the project semester should be related to both the student's engineering studies and the faculty supervisor's guide lines to make working model in the area of application of electrical engineering. It involves tasks and methods that are more appropriately completed in an academic practical environment and should, where possible, make use of human and technology resources provided by the university. It consolidates the student's prior learning and provides a context for later research studies. The student remains a full-time registered student at Thapar University during the project semester and this activity is, therefore, wholly distinct from any industrial interactions which may occur over vacation periods.

Assessment Details: Each student is assigned a faculty supervisor who is responsible for managing and assessment of the alternate project semester. The faculty supervisor guides the students till the end of semester and monitors the student's progress throughout the same. This includes a Reflective Diary which is updated throughout the alternate 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 faculty members from the department.

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

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

ULC802: SOCIAL NETWORK ANALYSIS

L	T	P	Cr
2	0	2	3.0

Course Objectives: To enable students to put Social Network Analysis projects into action in a planned, informed and efficient manner.

Syllabus

Preliminaries: Graphs, Types of graphs, Representation, Bipartite graphs, Planar networks, The graph Laplacian, Random Walks, Maximum Flow and Minimum Cut Problem, Introduction to Approximation Algorithms, Definitions. Approximation algorithms for vertex cover and TSP.

Introduction to Social Networks: Types of Networks: General Random Networks, Small World Networks, Scale-Free Networks; Examples of Information Networks; Static Unweighted and weighted Graphs, Dynamic Unweighted and weighted Graphs, Network Centrality Measures; Strong and Weak ties.

Walks: Random walk-based proximity measures, Other graph-based proximity measures. Clustering with random-walk based measures, Algorithms for Hitting and Commute, Algorithms for Computing Personalized Pagerank and Sim- rank.

Community Detection: Basic concepts, Algorithms for Community Detection: Quality Functions, The Kernighan-Lin algorithm, Agglomerative/Divisive algorithms, Spectral Algorithms, Multi-level Graph partitioning, Markov Clustering; Community Discovery in Directed Networks , Community Discovery in Dynamic Networks, Community Discovery in Heterogeneous Networks, Evolution of Community.

Link Prediction: Feature based Link Prediction, Bayesian Probabilistic Models, Probabilistic Relational Models, Linear

Algebraic Methods: Network Evolution based Probabilistic Model, Hierarchical Probabilistic Model, Relational Bayesian Network, Relational Markov Network.

Event Detection: Classification of Text Streams, Event Detection and Tracking: Bag of Words, Temporal, location, ontology based algorithms. Evolution Analysis in Text Streams, Sentiment analysis.

Social Influence Analysis: Influence measures, Social Similarity - Measuring Influence, Influencing actions and interactions. Homophily, Influence maximization.

Laboratory Work Implementation of various concepts taught in the course using Python/R Programming

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

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

1. Formalize different types of entities and relationships as nodes and edges and represent this information as relational data.

2. Plan and execute network analytical computations.
3. Use advanced network analysis software to generate visualizations and perform empirical investigations of network data.
4. Interpret and synthesize the meaning of the results with respect to a question, goal, or task.
5. Collect network data in different ways and from different sources while adhering to legal standards and ethics standards.

Text Books:

1. Charu C. Aggarwal, Social Network Data Analytics, Springer; 2011.
2. S.Wasserman, K.Faust: Social Network Analysis: Methods and Applications, Cambridge Univ Press, 1994
3. Scott, J. (2007). Social network analysis: A handbook (2nd Ed.). Newbury Park, CA: Sage.
4. Knoke (2008). Social Network Analysis, (2nd Ed). Sage.

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC803: ETHICAL HACKING

L	T	P	Cr
3	0	2	4.0

Course Objectives: This course is designed to impart a critical and theoretical and detailed practical knowledge of a range of computer network security technologies as well as network security tools and the services related to Ethical Hacking.

Syllabus

Introduction: Understanding the importance of security, Concept of ethical hacking and essential Terminologies-Threat, Attack, Vulnerabilities, Target of Evaluation, Exploit. Phases involved in hacking.

Footprinting: Introduction to footprinting, Understanding the information gathering methodology of the hackers, Tools used for the reconnaissance phase.

Scanning: Detecting live systems-on the target network, - Discovering services running listening on target systems, Understanding port scanning techniques, Identifying TCP and LIDP services running on the target network, Understanding active and passive fingerprinting.

System-Hacking: Understanding Sniffers, Comprehending Active and Passive Sniffing, ARP Spoofing and Redirection, DNS and IP Sniffing, HTTPS Sniffing.

Session Hijacking: Understanding Session Hijacking, Phases involved in Session Hijacking, Types of Session Hijacking, and Session Hijacking Tools.

Hacking Wireless Networks: Introduction to 802.11, Role of WEP, Cracking WEP Keys, Sniffing Traffic, Wireless DOS attacks, WLAN Scanners, WLAN Sniffers, Hacking Tools, Securing Wireless Networks.

Cryptography: Symmetric and Asymmetric Cryptography, Classical Encryption techniques, Substitution techniques, Block Ciphers Principles, Fiestel Structure, DES, Double and Triple DES, AES, Public Key Cryptography, RSA, Diffie-Hellman Key Exchange, Cryptographic Hash Functions and Digital Signatures.

Laboratory Work Lab Exercises including using scanning tools like IPEYE, IPsecScan, SuperScan etc. and Hacking Tools likes Trinoo, TFN2K, Zombic, Zapper etc.

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

1. Understand the different phases involved in hacking.
2. Utilize the scanning tools used for the information gathering.
3. Recognize the phases in session hijacking and use the tools for counter-measuring the various sniffing attacks.

4. Analyse different types of attacks on the wireless networks.
5. Describe and apply different types of algorithms for securing the data.

Text Books:

1. Simpson T. M., Backman K., Corley J., Hands-On Ethical Hacking and Network Defense, Delmar Cengage Learning (2011) 2nd edition.
2. Fadia A. and Zacharia M., Network intrusion alert: an ethical hacking guide to intrusion detection, Boston, MA: Thomas Course Technology 3rd edition (2008).

Reference Books:

1. Mathew T., Ethical Hacking, OSB Publication (2003). 2nd edition
2. McClure S., Scambray J. and Kurtz G., Hacking Exposed 7: Network Security Secrets and Solutions, McGrawHill (2012) 7th Edition.

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC893: START-UP SEMESTER

L	T	P	Cr
-	-	-	15.0

Course Objectives: The start-up semester is introduced in Electrical and Computer Engineering undergraduate programme to provide training and skills to encourage start-ups among students.

Course Description: Under this six month start-up project semester , the students will learn about the following:

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

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

Course Learning Outcomes (CLOs) /Course Objectives (COs):
On completion of this course, the students will 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.

ULC641: AUTONOMOUS MOBILITY

L	T	P	Cr
3	0	0	3.0

Course Objectives: The goal of the course is to introduce students to the various technologies, the basics of automotive electronics, fundamentals of electronic control systems, and the evolution of these systems will be presented.

Syllabus

Understand Mobility And Its Evolution: Transportation Systems, Mobility and Ways of Life, Electric Mobility: Actual Changes Brought on by Electric Vehicles in Terms of Mobility Systems

Autonomous Cars: Introduction, Why Autonomous, Requirements, Software Architecture, Hardware Architecture.

Electric Mobility Technology: Introduction to electro-mobility, working of an e-car, the development of electro-mobility to the present day, Advantages of electro-mobility, Challenges facing electro-mobility, The e-car of the future.

Electric Vehicles & E Mobility: Electric Cars, Charging Infrastructure, Electric Grid, Battery Technology, Electric Vehicles Policies, Transport Modes Electrification, EV Business Models.

Drones Technology & Setup: Software & Simulated Drones, Main Components, Building Unmanned Vehicles, UAV Simulation, UAV Control.

Autonomous Robots: Introduction to the fundamentals of mobile robotics, examining the basic principles of locomotion, kinematics, sensing, perception, and cognition that are key to the development of the autonomous mobile robot.

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

1. Explain the rationale and evolution of automotive electronics.
2. Describe the concept of fully autonomous vehicles.
3. Explain the application and utility of Mobile Robots used in various sectors and fields.

Text Books:

1. Gerardus Blokdyk, Advanced Metering Infrastructure (AMI), Third edition, (2018)

Reference Books:

1. Clark W. Gellings, The Smart Grid: Enabling Energy Efficiency and Demand Response, CRC Press, (2009).

2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Smart Grid: Technology and Applications, Wiley, (2012).

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UCS531: CLOUD COMPUTING

L	T	P	Cr
2	0	2	3.0

Course Objectives: To learn the concepts of cloud infrastructure and services in addition with its implementation for assessment of understanding the course by the students

Syllabus

Introduction and Evolution of Computing Paradigms: General Benefits and Architecture, Business Drivers, Main players in the Field, Overview of Existing Hosting Platforms and its architecture, Cluster Computing, Grid Computing, XaaS Cloud Based Service Offerings, Overview of Security Issues.

Classification of Cloud Implementations: Key Amazon offerings-Amazon Web Services, The Elastic Compute Cloud (EC2), Simple Storage Service (S3), Simple Queuing Services (SQS), Bundling Amazon instances, AWS Identity Management and Security in the Cloud, Messaging in the Cloud, RESTFul Web Services.

Virtualization: Virtualization, Advantages and disadvantages of Virtualization, Types of Virtualization: Resource Virtualization i.e. Server, Storage and Network virtualization, Migration of processes, Classic Data Center, Virtualized Data Center (Compute, Storage, Networking and Application), Business Continuity in VDC. VMware vCloud – IaaS, Network virtualization through Software Defined Networks.

Cloud based Data Storage: Introduction to Hadoop, Hadoop Ecosystem (Pig, Hive, Cassandra and Spark), Introduction No-SQL databases, Map- Reduce framework for Simplified data processing on Large clusters using Hadoop, Data Replication, Shared access to data stores.

Related Technologies: Introduction to Fog Computing and Edge Computing, Usage of Cloud for IoT and Big data analytics, Overview of Google AppEngine - PaaS, Windows Azure

Self-learning Content: Cloud Issues and Challenges: Cloud models, Cloud computing issues and challenges like Security, Elasticity, Resource management and Scheduling, QoS (Quality of Service) and Resource Allocation, Cost Management and Cloud bursting.

Laboratory Work To implement Cloud, Apache and basics of Hadoop framework, an open source implementation of MapReduce, and its Java API, Hadoop Distributed File System (HDFS). Implementation of RESTFul Web Services. To understand various concepts about virtualization and data storage. To implement few algorithms with the help of MapReduce and some high-level language.

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

1. Comprehend the basic concepts and architecture of Cloud computing.
2. Implement Cloud Services through AWS offerings and Restful web services.

3. Apply the knowledge of virtualization through different virtualization technologies.
4. Perform operations on data sets using Map Reduce framework, SQL and NO SQL databases.

Text Books:

1. Buyya K, R., Broberg J. and Goscinski M. A., Cloud Computing: Principles and paradigms, MIT Press (2011) 4th ed.
2. Kai Hwang, Geoffrey Fox and Jack Dongarra, Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Morgan Kaufmann (2012) 2nd ed.
3. Miller M., Cloud Computing, Que Publishing (2008) 1st ed.
4. Puttini R. and Mahmood Z., Cloud Computing: Concepts, Technology & Architecture, Service Tech press (2013) 1st ed.

Reference Books:

1. Velte A., Velte T., and Elsenpeter R., Cloud Computing: A practical Approach, Tata McGrawHill (2009) 1st ed.
2. Hurwitz J., Bllor R., Kaufman M. and Halper F., Cloud Computing for dummies (2009) 1st ed.

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UCS653: DATA MINING AND VISUALIZATION

L	T	P	Cr
2	0	2	3.0

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

Syllabus

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.

Laboratory Work Related to various topics in the syllabus with latest softwares.

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

1. Apply basic concepts and techniques of Data Mining.
2. Develop skills of using data mining libraries for solving practical problems.
3. Gain experience of doing independent study.
4. 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).
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Probability & Statistics for Engineers & Scientists, (9th Ed.), 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, G., Witten, D., Hastie T., and Tibshirani, R., 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, ata Visualisation with R, Springer, (2019)

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC643: FORECASTING METHODS AND APPLICATIONS

L	T	P	Cr
2	0	2	3.0

Course Objectives: This course aims to impart the depth-in-knowledge about the concepts of forecasting regression and economic methods, fundamentals of ARIMA time-series model and will learn the concept of advanced forecasting models.

Syllabus

Introduction: An overview of forecasting techniques, Explanatory versus time series forecasting, Qualitative forecasting, Basic steps in a forecasting task, Basic forecasting tools: Time series and cross-sectional data, Graphical summaries, Numerical summaries, Measuring forecast accuracies, Prediction intervals, Transformations, and adjustments

Smoothing and Decomposition Time Series Methods: Smoothing Methods: Averaging methods, Exponential smoothing methods, Other smoothing methods, Comparison of methods, General aspects of smoothing methods, Development of the mathematical basis of smoothing methods, Decomposition methods: Principles of decomposition, Moving average and its types, Classical decomposition method.

Regression and Economic Methods: Types of regression Methods, Least-squares estimation, Correlation coefficient, Cautions in using correlation, Simple regression, and the correlation coefficient, Residuals, outliers, and influential observations, Correlation and causation, Multiple regression: Introduction to multiple linear regression, selecting independent variables and model specification, Multiple regression and the coefficient of determination, Assumptions behind multiple linear regression models

Box Jenkins (ARIMA) Time-Series Model: Fundamentals of Time-series Analysis, The Box Jenkins Methods: identification, Estimation of parameters, Diagnostic checking, Load forecasting with ARIMA Model

Advanced Forecasting Models: Dynamic regression models: Basic forms of the dynamic regression model, Forecasting, Koyck Model Applications of Forecasting Techniques for load forecasting, solar energy forecasting

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

1. Explain the basics of forecasting techniques.
2. Comparison of smoothing and decomposition time-series methods.
3. Describe and comprehend various types of regression and economic methods.
4. Apply ARIMA time-series model in Load forecasting
5. Analyze, model, and implement advanced models in load forecasting.

Text Books:

1. 1. Markakis, S.G., Steven C. Wheelwright, Rob J Hyndman, Forecasting: Methods and Applications, Wiley Press, (1997).

2. Boylan John E., Syntetos Aris A., Intermittent Demand Forecasting: Context, Methods, and Applications, Wiley Press, (2022).

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC664: CYBER AND NETWORK SECURITY

L	T	P	Cr
2	0	2	3.0

Course Objectives: This course will enable students to know about security concerns in Email and Internet Protocol, understand cyber security concepts, list the problems that can arise in cyber security and discussion about the various cyber security frame work.

Syllabus

Transport Level Security: Web Security Considerations, Secure Sockets Layer, Transport Layer Security, HTTPS, Secure Shell (SSH).

E-mail Security: Pretty Good Privacy, S/MIME, Domain keys identified mail.

IP Security: IP Security Overview, IP Security Policy, Encapsulation Security Payload (ESP), Combining security Associations Internet Key Exchange. Cryptographic Suites.

Cyber network security concepts: Security Architecture, Anti-pattern: signature-based malware detection versus polymorphic threads, document driven certification and accreditation, policy driven security certifications. Refactored solution: reputational, behavioural and entropy-based malware detection. The problems: cyber anti-patterns concept, forces in cyber anti-patterns, cyber anti pattern templates, cyber security Anti-pattern CatLog.

Cyber network security frameworks: Enterprise security using Zachman framework Zachman framework for enterprise architecture, primitive models versus composite models, architectural problem-solving patterns, enterprise workshop, matrix mining, mini patterns for problem solving meetings.

Case study: Cyber security hands on managing administrations and root accounts, installing hardware, reimaging OS, installing system protection/ antimalware, configuring firewalls

Laboratory Work Demonstrate use of Environment variables and privileged programs, Demonstrate Buffer Overflow and showcase EIP and other register status, insert malicious shell code into a program file and check its malicious or benign status, perform ARP poisoning, implement state ful firewall using IPTables.

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

1. Discuss the IP Security, Cyber network security concepts and cyber security problems.
2. Explain Enterprise Security using Zachman Framework.
3. Apply concept of cyber security framework to computer system administration.

Text Books:

1. William Stallings, “Cryptography and Network Security Principles and Practice”, Pearson Education Inc., 6th Edition, 2014, ISBN: 978-93-325- 1877-3.

2. Thomas J. Mowbray, “Cyber Security – Managing Systems, Conducting Testing, and Investigating Intrusions”, Wiley.

Reference Books:

1. 1. Cryptography and Network Security, Behrouz A. Forouzan, TMH, 2007.
2. Cryptography and Network Security, Atul Kahate, TMH, 2003

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC665: DEEP LEARNING

L	T	P	Cr
2	0	2	3.0

Course Objectives: The objective of this course is to provide exposure to the students on the advances in learning theories and their applications to real life problems.

Syllabus

Deep Learning Networks: Deep networks for unsupervised and supervised learning, Hybrid deep networks, Deep auto-encoders including variational auto-encoders and its relationship with PCA, Pre-trained CNNs for classification and object detection.

Sequence Modelling: Recurrent Neural Networks (RNNs), BPTT, Truncated BPTT, Gated Recurrent Units, Long Short Term Memory.

Deep Generative Models: Basics of generative adversial networks (GANs), GAN training, Synthesizing and manipulating images with GANs.

Self Learning Content: Machine Learning Basics: Learning, Under fitting, Over fitting, Estimators, Bias, Variance, Maximum likelihood estimation, Bayesian Statistics, Supervised learning, Unsupervised learning, Reinforcement learning, Stochastic gradient decent and its variants for Backpropagation, Regularization techniques.

Laboratory Work To implement the models included in this syllabus using open source libraries. The students will be encouraged to work on a project related with NLP/Speech Processing/Computer Vision etc.

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

1. Analyze the advanced machine learning techniques.
2. Compare and explain various deep learning architectures and algorithms for autoencoders and CNNs.
3. Experiment the working of sequence and generative models.
4. Apply deep learning specific open source libraries for solving real life problems.

Text Books:

1. Ian Goodfellow and YoshuaBengio and Aaron Courville, "Deep Learning", MIT Press, 2016.
2. Michael Nielsen, "Neural Network and Deep Learning", Online Book 2016.

Reference Books:

1. Le Deng and Dong Yu, "Deep Learning: Methods and Applications", Foundations and Trends in Signal Processing, 2013.

2. Charu C. Aggarwal, “Neural Networks and Deep Learning”, Springer; 1st ed. 2018.

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UCS532: COMPUTER VISION

L	T	P	Cr
2	0	2	3.0

Course Objectives: To understand the basic concepts of Computer Vision. The student must be able to apply the various concepts of Computer Vision in other application areas. Digital Image Formation and low-level processing.

Syllabus

Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

Image Representation & Description: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, LBP and its variants, Gabor Filters and DWT.

Image Segmentation: Region Growing, Edge Based approaches to segmentation, GraphCut, Mean-Shift, MRFs, Texture Segmentation; Object detection.

Pattern Analysis: Clustering: K-Means, Fuzzy C-means; Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Dimensionality Reduction: PCA, LDA, ICA.

Motion Analysis: Background Subtraction and Modeling, Optical Flow, KLT, SpatioTemporal Analysis, Dynamic Stereo; Motion parameter estimation.

Self-Learning Content: Miscellaneous: Applications: CBIR, CBVR, Activity Recognition, computational photography, Biometrics, stitching and document processing; Modern trends - superresolution; GPU, Augmented Reality; cognitive models, fusion and SR&CS.

Laboratory Work To implement various techniques and algorithms studied during course.

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

1. Understand the fundamental problems of computer vision.
2. Implement various techniques and algorithms used in computer vision.
3. Analyse and evaluate critically the building and integration of computer vision algorithms and systems.
4. Demonstrate awareness of the current key research issues in computer vision.

Text Books:

1. Szeliski, R., Computer Vision: Algorithms and Applications, Springer-Verlag London Limited (2011), 1st Edition.
2. Forsyth, A., D. and Ponce, J., Computer Vision: A Modern Approach, Pearson Education (2012) 2nd Edition.

Reference Books:

1. Hartley, R. and Zisserman, A., Multiple View Geometry in Computer Vision Cambridge University Press, 2nd Edition (2003).
2. Fukunaga, K., Introduction to Statistical Pattern Recognition, Academic Press, Morgan Kaufmann, 2nd Edition (1990).
3. Gonzalez, C., R. and Woods, E., R. Digital Image Processing, Addison- Wesley, 4th Edition (2018)

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UCS635: GPU COMPUTING

L	T	P	Cr
2	0	2	3.0

Course Objectives: To study architecture and capabilities of modern GPUs and learn programming techniques for the GPU such as CUDA programming model.

Syllabus

Introduction: Heterogeneous Parallel Computing, Architecture of a Modern GPU, Speeding Up Real Applications, Parallel Programming Languages and Models.

History of GPU Computing: Evolution of Graphics Pipelines, The Era of Fixed-Function Graphics Pipelines, Evolution of Programmable Real-Time Graphics, Unified Graphics and Computing Processors, GPGPU, Scalable GPUs, Recent Developments, Future Trends.

Introduction to Data Parallelism and CUDA C: Data Parallelism, CUDA Program Structure, A Vector Addition Kernel, Device Global Memory and Data Transfer, Kernel Functions and Threading.

Data-Parallel Execution Model: CUDA Thread Organization, Mapping Threads to Multidimensional Data, Matrix-Matrix Multiplication—A More Complex Kernel, Synchronization and Transparent Scalability, Assigning Resources to Blocks, Thread Scheduling and Latency Tolerance.

CUDA Memories: Importance of Memory Access Efficiency, CUDA Device Memory Types, A Tiled Matrix – À Matrix Multiplication Kernel, Memory as a Limiting Factor to Parallelism.

An Introduction to OpenCL: Data Parallelism Model, Device Architecture, Kernel Functions, Device Management and Kernel Launch, Electrostatic Potential Map in OpenCL.

Parallel Programming with OpenACC: OpenACC Versus CUDA C, Execution Model, Memory Model, Basic OpenACC Programs, Parallel Construct, Loop Construct, Kernels Construct, Data Management, Asynchronous Computation and Data Transfer. **Self-Learning Content:** Basics of Parallel and distributed Computing, CUDA programming model

Laboratory Work Practice programs using CUDA, OpenCL and OpenACC.

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

1. Comprehend commonly used terms in parallel computing.
2. Understand common GPU architectures and Programming Models.
3. Implement algorithms efficiently for common application kernels.
4. Develop efficient parallel algorithms to solve given problems

Text Books:

1. Sanders, J. and Kandrot, E., CUDA by Example: An Introduction to General-Purpose GPU Programming, Addison-Wesley Professional (2012) 4th Edition.

2. Kirk, D. and Hwu, M., W., Programming Massively Parallel Processors: A Hands-on Approach. Morgan Kaufmann (2016) 3rd Edition.

3. Grama, A., Gupta, Karypis, G., Kumar, V., Introduction to Parallel Computing, Addison Wesley, (2003) 2nd Edition.

Reference Books:

1. Hwu, M., W., A GPU Computing Gems Emerald Edition (Applications of GPU Computing Series), Morgan Kaufmann (2011) 1st Edition.

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UMC622: MATRIX COMPUTATION

L	T	P	Cr
2	0	2	3.0

Course Objectives: This course aims to provide a platform for the students to use linear algebra in real life. Most of the real life problems are based on computation of eigenvalues and singular values. In this course we stress on the computational methods to compute the same. The Matlab implementation of the methods will be insightful for better understanding. The students are expected to have taken basic and a continuation course in numerical analysis or acquired equivalent knowledge in a different way.

Syllabus Matrix Analysis:

Review of matrices and vector spaces: rank of a matrix, linear dependence and independence, bases and dimensions, linear transformations, range and null space of a matrix, rank-nullity theorem.

Inner product space: Gram Schmidt orthogonalization, dual space and invariant space.
Matrix transformations: similarity transformation, diagonalization of matrices, Householder transformation, QR factorization.
Conditioning of matrices: vector and matrix norms, convergent matrices, condition number of a matrix.
Techniques for finding eigen values: Eigen value problems, spectral stability of matrices, reduction to Hessenberg or tridiagonal form, iterative techniques using Krylov subspace concepts for eigen value problems.

Spectral theory of matrices: spectral decompositions, Gersgorin bounds on eigenvalues, spectrum of perturbed matrices, Schur decomposition theorem.

Singular value decomposition: SVD and their applications.

Real life applications of eigen values and singular values: Discussion of real life problems based on eigen values and SVDs and their application in image processing and big data analysis.

Laboratory Work Matlab experiments will be designed to implement algorithms from the syllabus.

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

1. Explain and apply fundamental linear algebra concepts,
2. Evaluate norms of vectors and matrices,
3. Solve eigen value problems using theoretical and computational methods,
4. Apply singular value decomposition,
5. Implement linear algebra algorithms using Matlab.

Text Books / Reference Books:

1. Kenneth Hoffman and Ray Kunze, Linear Algebra, Pearson India, second edition, 2015.
2. Derek J. S. Robinson, A course in linear algebra with application, World Scientific Press, second edition, 2006.
3. Gene H. Golub and Charles F. Van Loan, Matrix Computations, Johns Hopkins University Press, fourth edition, 2012.
4. Roger A. Horn and Charles R. Johnson, Matrix Analysis, second Edition, Cambridge University Press, 2012.
5. L. N. Trefethen and David Bau, Computational Linear Algebra, SIAM, 1997.
6. Gilbert Strang, Linear algebra and its Applications, fourth edition, CENGAGE, 2014.

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC662: CHARGING INFRASTRUCTURE

L	T	P	Cr
3	0	0	3.0

Course Objectives: To familiarize the student with the essential components of the electric vehicle charging system, with an emphasis on power converters, communication system and connectors.

Syllabus

Energy Storage: Introduction to energy storage requirements in hybrid and electric vehicles, battery based energy storage and its analysis, fuel cell based energy storage and its analysis, super capacitor based energy storage and its analysis.

Robust mechanical design and battery packaging: exposure to high impact forces, thermal runaway, structural safety and high cooling performance, robust and lightweight module frame, minimizing the deformation of batteries in case of swelling or explosion.

EV Battery Charging Fundamentals: voltage levels and charging types, charging connectors, charging process, protection issues. Classification of EV chargers, AC charging and DC charging, Inboard and off board charger specification, Type of Mode of charger Mode -2, Mode-3 and Mode-4, differences between slow charger and fast charger, electric vehicle supply equipment (EVSE) and associated charge times calculation. Introduction to V2G and V2V modes, connected mobility, integration of EVs in smart grids, interdependence between EVs and photovoltaic systems.

Power Electronics in EV Battery Charging: Introduction of AC and DC Charging Station, Power Topologies in AC/DC conversion stage: single-phase active bridge power factor correction topology, three-phase active bridge power factor correction topology. Power Topologies in DC/DC conversion stage: boost converter, buck-boost converter (including bidirectional mode of operation), Dual Active Bridge (DAB) converter.

Selection and sizing of fast and slow charger (AC and DC): AC charging pile, DC charging pile, EVSE power module selection and technical specifications, selection of EVSE communication protocol (PLC / Ethernet / Modbus/ CAN Module), communication gateway, specification of open charge point protocol (OCCP 1.6/2.0), Bharat DC001 and AC001 charging specifications, communication interface between charger and CMS (central management system).

Selection and sizing of common types of connectors and applications: Selection of AC charger type-1, type -2 and type -3, communication between AC charger and EV, selection of DC charger connector GB/T, CHAdeMO , CCS-1 and CSS-2, communication methodology of DC fast chargers, IS/ IEC/ARAI/ standard of charging topology, communication and connectors (IEC 61851-1, IEC 61851-24,62196-2), sizing of connector cable.

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

1. Clearly explain the charging process and fundamentals requirements expected from EVSE.
2. Demonstrate the role of power electronics equipment in EV charging.
3. Demonstrate the role of communication processes in EV charging.
4. Explain the selection procedure and sizing of charging connectors.

Text Books:

1. 1. Emadi, A. (Ed.), Miller, J., Ehsani, M., "Vehicular Electric Power Systems" Boca Raton, CRC Press, (2003)
2. Larminie, James, and John Lowry, "Electric Vehicle Technology Explained" John Wiley and Sons, (2012)

Reference Books:

1. 1. T R Crompton, "Battery Reference Book-3 rd Edition", Newnes- Reed Educational and Professional Publishing Ltd., 2000.
2. Amir Khajepour, Saber Fallah and Avesta Goodarzi, "Electric and Hybrid Vehicles Technologies, Modelling and Control: A Mechatronic Approach", John Wiley & Sons Ltd, 2014.
3. Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Springer, 2013

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC663: CYBER PHYSICAL SYSTEMS

L	T	P	Cr
3	0	0	3.0

Course Objectives: This course introduces students to the design and analysis of cyber-physical systems (CPS) - the tight integration of computing, control, and communication.

Syllabus

Introduction: Definition of CPS, Applications (autonomous systems, frequency and voltage generation in electric grids), CPS as a multi-dimensional system, C PS challenges, embedded systems and cyber physical systems

Model based design of CPS: An introduction to model-based design, Modelling of Continuous Dynamics, Actor Model of Systems, Discrete Dynamics, hybrid modelling.

Hybrid modelling: Hybrid modelling, Mealy finite state machine, Composition of Sate Machines, Concurrent Composition, Hierarchical State machines, Discrete event systems

CPS Hardware: Embedded system Hardware, Different sensors and actuators, Design issues with sensors and actuators (calibration, nonlinearity, sampling, noise)

CPS Design: Multitasking, OS, Micro-kernals, Thread Scheduling-basics, task models, Introduction to Edge AI, Study of electric grid as CPS, key smart grid challenges

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

1. Explain the core principles behind CPSs.
2. Develop hybrid models and controls.
3. Identify safety specifications and critical properties of CPSs.
4. Describe abstraction and system architectures.
5. Relate the design by invariant.

Text Books:

1. Platzer, A. Foundations of Cyber-Physical Systems. Lecture Notes, Computer Science Department, Carnegie Mellon University. (2016).
2. Lee E.A., Sanjit Arun kumar Seshia, Introduction to Embedded Systems: A Cyber-Physical Systems Approach, Lulu.com; 1st edition (2011)

Reference Books:

1. Alur, Rajeev. Principles of Cyber-Physical Systems. MIT Press, (2015)
2. Peter Marwedel, Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems, Springer; 2nd Edition. edition (2010).

3. Wolf, Marilyn. High-Performance Embedded Computing: Applications in Cyber-Physical Systems and Mobile Computing. Elsevier, (2014)
4. Wolf, Marilyn. Computers as components: principles of embedded computing system design. Elsevier, (2017).

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UEE525: DATA ANALYTICAL METHODS

L	T	P	Cr
2	0	2	3.0

Course Objectives:
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.

Syllabus

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.

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

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

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 (CLOs) /Course Objectives (COs):
On completion of this course, the students will be able to:

1. Analyze data by utilizing clustering and classification algorithms
2. Analyze big data and create statistical models
3. Explore advanced level of understanding of the usage of big data in real world

4. 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

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC742: DIGITAL CONTROL SYSTEMS

L	T	P	Cr
3	0	0	3.0

Course Objectives: To present the basic concepts on analysis and design of sampled data control system and to apply these concepts to typical physical processes.

Syllabus

Introduction to discrete time control system : Principle features of discrete time control system, Mathematical analysis and sampling process, quantizing and coding, Data acquisition, conversion and distribution system, Reconstruction of original signal from sampled signal

The Z-Transform: Fundamentals of Z-transform, Important properties and theorems of the Z-transform, Z-transform from the convolution integral, Inverse Z-transform, Direct Division, Partial Fraction, Inversion Integral, Z-transform method for solving difference equation

Analysis of discrete time control system : S-plane to Z-plane mapping and Vice-versa, Stability analysis of closed loop systems in the Z-plane, Discrete time equivalents of continuous time systems, Discrete time equivalents of analog controllers, Transient and steady state response analysis

Design and compensation of discrete time control system : Digital filters: structure, implementation, frequency response, applications, Control system controllers: structure, hardware/software features, responses to control signals, use of root locus and frequency domain concepts, Phase lead and phase lag compensator design for discrete time system, PID controller design and selection of parameters for discrete time system

Discrete time state equations : State space representation of discrete time systems, Discretization of the continuous time state space equation, Pulse transfer function matrix, Stability assessment from the discretized state space equations

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

1. Analyze signals in both time domain and Z domain.
2. Analyze transient and steady state behaviors of linear discrete time control systems
3. Analyze the stability of digital control systems
4. Design digital controllers/compensators and assess their design through the constraint specifications, and decide whether their initial design is acceptable or can be improved.
5. Determine input and output sequence of state space represented discrete time systems.

Text Books:

1. Ogata K., Discrete Time Control Systems, 2nd Ed., Prentice Hall, Englewood Cliffs, New Jersey, (1995).
2. Charles L. Phillips, Digital Control System: Analysis and Design, Prentice Hall, Englewood Cliffs, New Jersey (1985)
3. Kuo, B.C., Digital Control Systems, The Oxford Series, 2nd Ed., (1995).

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UCS636: 3D MODELLING AND ANIMATION

L	T	P	Cr
2	0	2	3.0

Course Objectives: To develop the skill & knowledge in 3D Modeling & Animation. Students will understand the know-how and can function either as an entrepreneur or can take up jobs in the multimedia and animation industry, video studios, edit set-up and other special effects sectors.

Syllabus

3D Object Modelling: Basic modelling concepts, vertices, edges, and faces, basic transformations, pivot points, duplication and merging, extrusion, insetting, modifiers, loop cuts and face loops, subdivision methods, coordinate system and exporting, model rendering.

Low Poly Models: Triangular meshes, objects and mesh data, cursor and origins hidden geometry, Boolean modifiers, geometry from curve, curve resolution, non-planner geometry.

3D Character Modelling: Introduction, character modelling, unwrapping UVs & mapping texture, texture painting, armatures, character rigging, constrained movements, forward and inverse kinematics, time-line, keyframes, character animation, animation rendering.

Physically Based Modelling and Animation: Introduction, Simulation Foundation, Particle based Models, Collision detection and response, Particle System, Particle Simulation, Particle Rendering, Numerical Integration in Particle System, Deformable Meshes, Rigid Bodies and Constrained Dynamics, Fluid Simulation.

Self-Learning Content: Real Time Animation: Splines and curves, Key-frame techniques, Quaternions for rotations / orientations, Blending and interpolation, Kinematics, Motion capture systems, Motion graphs and character control, Animation data representations, Behavioural Animation, Facial Animation, Perception in animation.

Laboratory Work This course covers beginner to intermediate 3D Modeling and Animation. In this Lab the students will be able to model the 3D character and objects, its UV Mapping, Texture Painting, Rigging, and Animation. Evaluation will be mainly via projects and assignments taking a creative approach to expressive 3D modelling and Animation.

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

1. Apply modelling concepts in order to implement 3D objects. (Blender / Max).
2. Understand the basic geometry and triangulation techniques behind low poly models.
3. Implement 3D humanoid characters and to apply the concept of rigging for animating the character using key frames.
4. Illustrate the theoretical and practical aspects of 3D Modelling, Key Frame Animation, Simulation & effects.

5. Demonstrate different types of animation and its effects in the real world.
6. Analyse the different processes, post processes involved in computer animation field

Text Books:

1. House, H., D. and Keyser, C., J., Foundations of Physically Based Modeling and Animation, CRC Press (2017) 1st Edition.
2. Chopine, A., 3D Art Essentials: The Fundamentals of 3D Modeling, Texturing, and Animation, Focal Press (2011) 1st Edition.
3. Zeman, B., N., Essential Skills for 3D Modeling, Rendering, and Animation, A K Peters / CRC Press (2017) 1st Edition.

Reference Books:

1. Villar, O., Learning Blender: A Hands-On Guide to Creating 3D Animated Characters, Addison Wesley (2017) 2nd Edition.
2. Kerlow, I., The Art of 3D Computer Animation and Effects, Wiley, (2009) 4th Edition.
3. Flavell, L., Beginning Blender: Open Source 3D Modelling, Animation, and Game Design, Apress, (2010) 1st Edition.
4. Boardman, T., 3dsmax 7 Fundamentals, New Riders, (2005) 1st Edition.

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC702: INDUSTRIAL COMMUNICATION PROTOCOLS AND SCADA

L	T	P	Cr
3	0	0	3.0

Course Objectives: The objective of this course is to impart strong knowledge about industrial automation, communication technologies and SCADA in students, This course includes ndustrial communication protocols, Data Communication basics, network architecture and network protocols, typical SCADA system Architecture, Human machine interface, Properties of SCADA system, features. The course also includes SCADA protocols such as DNP3 protocol control net and applications of SCADA systems.

Syllabus

Industrial Communication Protocols: Introduction to Communication Protocols Data Communication basics, OSI reference model, Network Classification, Device Networks, Control Networks, Enterprise Networks. Introduction to Networks in process automation, Industry Networks, Network selection, Proprietary and open networks.

Network Architecture and Wireless Protocols: Network Architectures, Building blocks, Industry open protocols: RS-232, RS-422, RS-485, Ethernet, Modbus, Profibus, Fieldbus; Hardware: Fieldbus Design, Advantages and Limitations. Introduction to wireless Protocols Wi-Fi, Bluetooth, Overview of IEC 61850 Standard: Data Models, Communication Services.

Supervisory Control and Data Acquisition Systems: Introduction and block diagram of SCADA system, typical SCADA Architectures (First generation-Monolithic, Second generation-Distributed, Third generation–Networked Architecture), Properties of SCADA system , Advantages and limitations of SCADA system, DCS Vs SCADA, Human Machine Interface, SCADA security, Practical modern SCADA protocols: DNP3,60870.5 and related systems, API Std 1164 SCADA Security, Verification of security intelligence for a resilient SCADA system, SCADA system specification.

SCADA Protocols: Open systems interconnection (OSI) models, TCP/IP protocol, DNP3 protocol, IEC61850 layered architecture, Control and Information Protocol (CIP), Device Net, Control Net, Ether Net/IP, Flexible Function Block process (FFB), Process Field bus (Profibus). IEEE recommended practice for Master/Remote SCADA Communications.

Applications of SCADA system: Communication Protocols for Power System Communication requirements and its automation, SCADA systems in operation and control of interconnected power system.

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

1. Understand the various industrial communication protocols.
2. Describe the network architecture.

3. Identify the various architecture of SCADA system.

4. Illustrate the different SCADA protocols.

5. Analyze the challenges and issues in SCADA systems

6. Analyze about power distribution system and study of automation- SCADA

Text Books:

1. Eric Knapp, Joel Thomas Langill, "Industrial Network Security: Securing Critical Infrastructure Networks for Smart Grid, SCADA, and Other Industrial Control Systems", Elsevier, Second Ed., (2015)

2. Mini. S. Thomas and John D. McDonald, "Power System SCADA and Smart Grids", CRC Press, First Ed., (2015).

3. Ronald L. Krutz, "Securing SCADA System", Wiley Publications, (2005)

4. Stuart A Boyer, "SCADA supervisory control and data acquisition", ISA, 4th Revised edition, (2009)

Reference Books:

1. David J Teumim„ "Industrial Network Security", 2nd Edition-International Society of Automation ISA, (2010).

2. R. Radvanovsky, J. Brodsky , Handbook of SCADA/Control Systems Security, (2016).

3. B.G. Liptak, Process Software and Digital Network, CRC Press ISA- The Instrumentation, Systems, and Automation Society, 4th Ed., (2011)

4. User Manuals of Foundation Fieldbus, Profibus, Modbus, Ethernet, Devicenet, Controlnet, IEC 61850.

5. Peterson Davie, "Computer Networks—A System Approach", Maugann Kauffmann Publisher 6th Ed., (2021)

6. Fundamentals of Supervisory systems, IEEE tutorial, IEEE Press, (1991)

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC741: ADVANCED METERING INFRASTRUCTURE

L	T	P	Cr
3	0	0	3.0

Course Objectives: To get acquainted with the concepts of smart grid components. To understand the concept of AMI with fundamental component. To apply the various techniques of communication, computer networking and cyber security for smart metering systems.

Syllabus

Fundamentals of Smart Grids: Existing power grid and its evolution with modernization, Concept of Smart Grid, Need of Smart Grid, Applications of Smart Grid to power systems, Different components of Smart Grid, Role of Intelligent Energy Network, Advanced Metering Infrastructure (AMI).

Advanced Metering Infrastructure (AMI): Detailed concept of Smart Grid and benefits, Basic concept and components of AMI, Challenges faced by AMI, Technologies and topologies of Automatic Meter Reading (AMR) and explain that smart meter is an impending entry point, Security Issues faced by AMI.

Fundamental component of AMI: Role of Smart Meter installed at subscribers' premises, focus on in-home security vulnerabilities of Smart Meter, and Energy Theft susceptibilities, and Smart Metering Programs based on enhanced cryptographies.

AMI protocols: Standards and initiatives, Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

Elements of communication, networking and interfacing: Architectures, standards, PLC, Zigbee, GSM, BPL, Local Area Network (LAN) - House Area Network (HAN) - Wide Area Network (WAN) - Broadband over Power line (BPL) - IP based Protocols - Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

Fundamentals of Cyber Security: Types of Security Attacks and Threats, Model of Cyber Security and Security Protocols for Smart Grid. Highlight Information Assurance Fundamentals (such as Authentication, Authorization, Integrity, Confidentiality, and Non Repudiation, etc

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

1. Explain the concept of smart grid electricity network.
2. Explain the concept and fundamental elements of AMI.
3. Comprehend the communication technologies involved and security aspects.

Text Books:

1. Gerardus Blokdyk, Advanced Metering Infrastructure (AMI), 3rd Ed., (2018).

Reference Books:

1. Gellings, C.W., The Smart Grid: Enabling Energy Efficiency and Demand Response, CRC Press, (2009).

2. Ekanayake J., Jenkins, N., Liyanage K., Smart Grid: Technology and Applications, Wiley, (2012).

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC743: ELECTRIC GRID SECURITY

L	T	P	Cr
2	0	2	3.0

Course Objectives: This course will introduce the students about the investigate key concepts behind electric grid security that includes cyberattack, vulnerability assessment and the Intrusion Detection System (IDS) development.

Syllabus

Introduction to grid security: Study of electric grids as a cyber-physical systems, key smart grid security challenges (physical and cyber), different cyber-attack events and their analysis (Ukrainian attack, STUXNET), current security initiatives

Types of attack: Cyber-attacks definition, their types, Strategic attack, template attack, location attack, modelling of attack (Time delay attack, denial of service attack)

Vulnerability assessment: Vulnerability assessment of different types of cyber-attack, case study in PMU, automatic generation control, economic load dispatch problems

Attack detection and prevention: State estimation methods, Observer-based different faulty data detection methods and AI-based schemes

Metrics for electricity sectors: Study of different metrics and protocols to evaluate and benchmark resilience, framework recommendations and technology evaluations.

Laboratory Work Computer simulations related to modelling of the cyberattacks, analysis and detection methods of electric systems (automatic generation control/PMU systems economic load dispatch problem).

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

1. Understand the meaning of cyber-attack in electric grids
2. Comprehend and model cyber attacks
3. Analyze the effects of cyber attack
4. Identify the types of attack
5. Learn how to make grid resiliency according to standards

Text Books:

1. Borlase Stuart. Smart Grid: Infrastructure, Technology and Solutions, CRC Press, (2012).

Reference Books:

1. Resilience Framework, Methods, and Metrics for the Electricity Sector (TR83), IEEE PES report.

2. Thomas, Mini S., McDonald. John D, Power System SCADA and Smart Grids, CRC Press, (2015)

3. Abur A. and Exposito A. G.. Power System State Estimation: Theory and Implementation, Marcel and Dekker Ink, (2004).

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC744: FACTS AND CUSTOM POWER

L	T	P	Cr
3	0	0	3.0

Course Objectives: This course aims to learn the concept of power flow control through various power electronic controllers including state of art FACTS controllers their operational aspects and their capabilities and their integration in power flow analysis so as to understand the basic concepts of power quality.

Syllabus

Basics of Transmission System And Facts Controllers: Reactive power flow control in Power Systems Control of dynamic power un-balances in Power System. Power flow control Constraints of maximum transmission line loading, Benefits of FACTS Transmission line compensation. Uncompensated line, Shunt compensation Series compensation , Phase angle control. Reactive compensation at transmission and distribution level.

Shunt Compensation: Passive shunt compensation: TCR-SC, TCR, TSR, TSC, TCR-SC, Description of Static versus passive VAR compensators, SVC and STATCOM - Operation and control of STATCOM, Comparison between shunt compensators.
Series Compensation: Basic characteristics, working principles, Impedance type series compensation, working of TCSC, TSSC, SSSC, Active Series Compensators: operating principles, SSSC, DVR operations.

Unified Power Flow Controller: SSR and its damping Unified Power Flow Controller: Circuit Arrangement, Operation and control of UPFC. Basic Principle of P and Q control, Applications

Interline Power Flow Controller: Principle of operation, Control and characteristics, Model of IPFC for power flow and optimum power flow studies.

Power Quality Issues And Application of FACTS: Voltage swells, sags, flicker, unbalance and mitigation of these problems by power line conditioners- IEEE standards on power quality, Application of FACTS devices for power-flow control and stability improvement. Example of power swing damping in a single-machine infinite bus system using a TCSC. Example of voltage regulation of transmission mid-point voltage using a STATCOM.

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

1. Distinguish the performance of Transmission line with and without FACTS Devices
2. Compare the SVC and STATCOM.
3. Understand the operation and control of various Static Series Compensators.
4. Understand the operation and control of Unified Power Flow Controller.

5. Distinguish various power quality issues and how are they mitigated by various FACTS devices.

Text Books:

1. Hingorani, N. G. and Gyugyi, L., Understanding FACTS: Concepts and Technology of FACTS Systems, Wiley-IEEE Press, (1999).
2. Padiyar K. R., FACTS Controllers in Power Transmission and Distribution", New Age International (P) Ltd. , (2007).

Reference Books:

1. Song, Y.H. and Johns, A.T., Flexible AC Transmission Systems, IEEE Press (1999).
2. T. J. E. Miller, Reactive Power Control in Electric Systems, John Wiley and Sons, New York, 1983.
3. Zhang, X. P., Rehtanz, C. and Pal, B., Flexible AC Transmission Systems: Modelling and Control, Springer (2006).
4. G. T. Heydt, Electric Power Quality, Stars in a Circle Publications, 1991.
5. Thomas, Mini S., McDonald. John D, Power System SCADA and Smart Grids, CRC Press, (2015)
6. Abur A. and Exposito A. G.. Power System State Estimation: Theory and Implementation, Marcel and Dekker Ink, (2004).

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

ULC745: MODERN PROPULSION SYSTEM AND ROBOTICS

L	T	P	Cr
2	0	2	3.0

Course Objectives: This course aims to provide an in-depth knowledge about propulsion systems of electric vehicles and on robots for their control and design.

Syllabus

Vehicle Propulsion model: Dynamic model of a vehicle, tractive force. Fundamental of propulsion, power transmission and brake system of an electric /hybrid vehicle: Sizing of the traction system in electric and hybrid vehicles, Power transmission in Electric and Hybrid Vehicles, Braking and Energy recovery in Electric and Hybrid Vehicle. Standard conduction cycles.

Introduction to Robotics: Types and components of a robot, Classification of robots, closed-loop and openloop control systems, Kinematics systems; Definition of mechanisms and manipulators.

Robot Kinematics and Dynamics: Direct kinematics problem, The inverse kinematics solution, DH parameters, Lagrange-Euler formation, Generalized D'Alembert equations of motion, Denavit Hartenberg convention and its applications.

Sensors and Vision System: Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc. Cameras and their calibration, Geometry of Image formation, Euclidean/Similarity/Affine/Projective transformations, Vision applications in robotics.

Robot Actuation Systems: Motor control for mobile robots, Servo control for robotic arms, Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators

Laboratory Work Study components of a real robot and its DH parameters. Forward kinematics and validate using a software (Robo Analyser). Inverse kinematics of the real robot and validation using any software, Use of open source computer vision programming tool openCV. Positioning and orientation of robot arm, Integration of assorted sensors (IR, Potentiometer, strain gages etc.), micro-controllers and ROS (Robot Operating System)

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

1. Perform kinematic and dynamic analyses with simulation.
2. Design control laws for a robot.
3. Integrate mechanical and electrical hardware for a real prototype of robotic device.
4. Select a robotic system for given application.

Text Books:

1. J. M. Miller, Propulsion Systems for Hybrid Vehicles, 2nd Edition, (2010)
2. Saha, S.K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, (2014).
3. Ghosal, A., "Robotics", Oxford, New Delhi, (2006).
4. Niku Saeed B., "Introduction to Robotics: Analysis, Systems, Applications", PHI, New Delhi.
5. Mittal R.K. and Nagrath I.J., "Robotics and Control", Tata McGraw Hill.
6. Craig, J.J., Introduction to Robotics: Mechanics and Control, Pearson, New Delhi, (2009)

Reference Books:

1. I. Husain, Electric and Hybrid Vehicles: Design Fundamentals, 2nd Edition, (2010)
2. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, Robot Modelling and Control, John Wiley and Sons Inc, (2005)
3. Steve Heath, Embedded System Design, 2nd Edition, Newnes, Burlington, (2003)
4. Merzouki R., Samantaray A.K., Phathak P.M. and Bouamama B. Ould,, Intelligent Mechatronic System: Modeling, Control and Diagnisis, Springer 2013.

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UMA038: OPTIMIZATION AND HEURISTICS

L	T	P	Cr
2	0	2	3.0

Course Objectives: The main objective of the course is to formulate mathematical models and to understand solution methods for real life optimal decision problems. The emphasis will be on basic study of classical optimization techniques, non-linear programming, heuristic techniques and multi-objective optimization.

Syllabus

Introduction to Optimization Technique: Introduction, Engineering application of optimization, Statements of optimization problem, Classification of optimization problems.

Classical Optimization Techniques: Introduction, Solution approaches for single and multi-variable optimization problem with equality and inequality constraints, Linear programming (LP), Solution of LP by simplex method, Duality theory, and Dual simplex method.

Non-Linear Programming: Introduction, Interpolation methods: quadratic interpolation method, Direct root methods (Newton method, Quasi-Newton method), Direct search methods, Indirect search methods.

Heuristic Techniques: Introduction, Comparison with conventional techniques, evolutionary techniques, Genetic algorithm, Particle swarm optimization, Ant colony optimization.

Constraint Handling Techniques: Constraint handling approaches, Challenges, issues and perspective, Constraint handling with metaheuristics

Multi-objective Optimization: Introduction, Principles of Multi-objective Optimization, Dominance and Pareto-Optimality, constrained multiobjective optimisation evolutionary algorithms

Applications of Engineering Optimisation in areas like power system operation planning, optimal power flow, pricing, automatic generation and control etc.

Laboratory Work Implementation of classical and heuristic optimization techniques to solve single objective and multi-objective constrained optimization problems in the area of power system operation like economic load dispatch, optimal power flow, electricity pricing etc.

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

1. solve optimization problems using classical optimization techniques.
2. solve optimization problems using non-linear programming techniques.

3. apply heuristic techniques to solve complex optimization problems.
4. understand principles of multi-objective optimization.

Text Books:

1. Rao S.S., Engineering Optimization, Theory and Practice, John Wiley & Sons Inc. Fourth Edition, (2009).
2. Deb. K., Multi-Objective Optimization using Evolutionary Algorithms, Wiley, (2001)

Reference Books:

1. Nash S.G., Sofer A., Griv I., Linear And Nonlinear Optimization, Second Edition, SIAM, (2017).
2. Kothari D.P., Dhillon J.S., Power system Optimisation, PHI Learning, 2nd ed., (2011)
3. Bazaarra Mokhtar S., Jarvis John J. and Shirali Hanif D., Linear Programming and Network flows, John Wiley and Sons, (1990).
4. Swarup, K., Gupta, P. K., Mammohan, Operations Research, Sultan Chand & Sons, (2010).

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UCS751: SIMULATION & MODELLING

L	T	P	Cr
2	0	2	3.0

Course Objectives: To become familiar with fundamentals of creating mathematical model of physical systems and their simulation for analysis.

Syllabus

Introduction to Modeling and Simulation: Basic concept of Simulation, Advantages, Disadvantages, Applications of simulation, limitation of simulation, Model and types of models, modeling and simulation, Continuous and discrete simulation, analog and digital simulation, System environment, components of a system, steps in a simulation study, Simulation of Queuing and Inventory System.

Random Numbers generation: Pseudo-random generators, Testing of Pseudo-random number generators, Generation of non-uniformly distributed random numbers. Parallel process modeling: Using Petri nets and finite automata in simulation, Cellular automata and simulation.

Simulation Experiments: Run length of Static and Dynamic Stochastic Simulation Experiments, Minimizing variability in simulators without increasing Number of simulation Runs.

Design of Simulators: Design of Application Simulators for Multi-server Queuing System, PERT, Optimizing Inventory Policy and Cost in Business environment.

Input Modeling: Data collection, Identification and distribution with data, parameter estimation, Goodness of fit tests, Selection of input models without data, Multivariate and time series analysis. Verification and Validation of Model: Model Building, Verification, Calibration and Validation of Models.

Output Analysis: Types of Simulations with Respect to Output Analysis, Stochastic Nature of output data, Measures of Performance and their estimation, Output analysis of terminating simulation, Output analysis of steady state simulations.

Self-Learning Content: Different Simulation Softwares and their applications for different analysis, Trends in Simulation Software.

Laboratory Work To carry out work on any simulation tools, Implementation of various techniques to generate random numbers. Apply any simulation model in real life applications.

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

1. Describe the role of various elements of discrete event simulation and modeling paradigm.
2. Conceptualize real world situations related to systems development decisions, originating from source requirements and goals.

3. Generate and test random number variates and apply them to develop simulation models.
4. Interpret the model and apply the results to resolve critical issues in a real-world environment.
5. Classify various simulation models and their usage in real-life applications.

Text Books:

1. Payne A. J., Introduction to Simulation: Programming Techniques and Methods of Analysis, McGraw Hill (1982).
2. Gorden G., System Simulation, Prentice Hall publication (1978), 2nd ed.

Reference Books:

1. Narsingh D., Systems Simulation with Digital Computer, PHI Publication (EEE) (2004), 3rd ed.
2. Banks J., Carson J. S., Nelson L. B., Nicol M. D, Discrete Event system Simulation, Pearson Education, Asia (2010), 5th ed.

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UCS646: GAME DESIGN & DEVELOPMENT

L	T	P	Cr
2	0	2	3.0

Course Objectives: To become familiar with various fundamental and advanced gaming concepts including basic maths and physics used behind the game engine.

Syllabus

Introduction: Types of games, History, Impact of Games on Society , Game life cycle, Game loop, Components of game, Model and scene rendering, State Management, Scene management, Texture compression, Level of details, Frustum culling, Occlusion culling, Game as a software, Steps for Game Design, Data Structure for Game, CPU vs.GPU, Game Engine, Components of game engine, Linear Transformation. Composite transformation.

Fundamental Gaming concepts: Static and Dynamic Game objects, Vectors, Concept of Time, Lighting, Particle System, Collider, Collision handles, Materials, Texture mapping, Input Process, Object replication, Instantiation, Special Effects, Terrain, Audio design and production, Ray Casting.

Maths behind Game Engines: Introduction to Vectors- Addition & Subtraction, Vector length, Scaling, Unit length vectors, Dot & Cross product, Linear Interpolation, Euler Angles, Intersection, Matrices, Coordinate systems, Projections, Triangle Meshes, Optimizations, Quaternion.

Advanced Games: Augmented Reality, Virtual Reality, Mixed Reality, AR & VR based Games, Artificial Intelligence based Game, Networking based game, Android based games, Debugging mode, Understanding of Screen and World Coordinate system, Raycasting, Touch & Swipe Input: Touch in Orthographic view, Touch in Perspective view, Accelerometer input, Scaling of Game screen, AR/VR/Android/iOS/Windows Game Deployment methods.

Self-Learning Content: Game Physics: Mathematical concepts, Basic transformations, Collision Detection and response, Newton's law of motion, Modeling gravity, Air resistance, Unstable rotation, Inertia tensor, Moment of Inertia, Applying torque to rigid body, The Magnus effect, Overview of friction, Critical angle, Dynamic Friction.

Laboratory Work 2D and 3D game development for windows and android platform using Unity 3D Game Engine and C# language.

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

1. Illustrate the basic concepts, requirements and processes of game design and development
2. Implement the fundamental gaming concepts to create a game.
3. Understand the physics and mathematics behind the game engine.
4. Demonstrate the advanced gaming concepts such as AR, VR, Android etc.
5. Develop a 2D/3D game using C# and Unity 3D Game engine

Text Books:

1. Eberly H. D., Game Physics, Morgan Kaufmann Publisher (2010), 2nd ed.
2. Bond G. J., Introduction to Game Design, Prototyping, and Development: From Concept to Playable Game with Unity and C#, Addison-Wesley (2015), 2nd ed.

Reference Books:

1. House H. D., Keyser C. J, Foundations of Physically Based Modeling and Animation, CRC Press (2017), 1st ed.
2. Okita. A., Learning C# Programming with Unity 3D, CRC Press (2014), 1st ed.

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**

UCS754: BLOCKCHAIN TECHNOLOGY AND APPLICATIONS

L	T	P	Cr
2	0	2	3.0

Course Objectives: The objective of this course is to provide exposure on blockchain technology and its real-time applications.

Syllabus

Basic Cryptography: Introduction to cryptography and cryptanalysis, Cryptographic issues, cryptographic components, cryptographic techniques, cryptographic categories: symmetric key and asymmetric key cryptography, traditional ciphers, modern ciphers, message integrity, message authentication, key management, digital signatures, entity authentication, ECDSA, ECC, Ring, One time signature, Hashing: SHA-356, SHA-512, TLS and SSL, Timestamp, Public and Private keys, Merkle root hash.

Bitcoin Cryptocurrencies: What is Bitcoin, Brief history of Bitcoin, Bitcoin mining and supply, Bitcoin cryptocurrency (BTC), Traditional centralized vs. decentralized, Bitcoin's blockchain: evolution of blockchain, block header, genesis block, hash generation, Bitcoin address: formats, hash generation, address structure, transactions: multi-signatures, generating transactions, storing data, block verification and validation, block mining.

Smart Contracts: Introduction to smart contracts, smart contracts used in a centralized and decentralized systems, Blockchain platforms using smart contracts: Ethereum, architecture of Ethereum virtual machine, token- ETH, Mining process, ERC- standards, transactions in Ethereum, Hyperledger fabric, Sidechains, NXT, Stellar, R3Conda, Litecoin, Quorum, IBM, Openchain, Eris:db.

Consensus Mechanisms: Double spending problem, BFT, PBFT, PoW, PoS, DPoS, PoA, PoB, PoR, PoET, PoI, PoO, PoSp, PoC, Ripple, Tendermint.

Applications of Blockchain: Financial system, smart grid, healthcare, smart transportation system, e-Governance, education, exchange and trading, online market place, commercial supply chain, food production, drug manufacturing, safety and security.

Laboratory Work Experiments on creating of blockchain, implementation of smart contract on Python, Conda and Ethereum, Solidity.

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

1. Create their own blockchain using Block creation and verification
2. Create the smart contracts for transaction execution
3. Evaluate the performance of blockchain in presence of various attacks
4. Develop and validate various security models for real-life applications.

Text Books:

1. Melanie Swan, “Blockchain: Blueprint for a new economy”, Oreilly publications.

Reference Books:

1. Bellaj Badr, Rcihcard Horrocks and Xun Brian Wu, “Blokchain by example”, Packt Publications.

2. Fatima Castiglione Maldonado, “Introduction to Blockchain and Ethereum”, Packt Publications.

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**35**
End Semester Examination (ESE)	**35**
Sessional (may include Quiz, Assignment, Lab Evaluation, Project as applicable)	**30**