



PROPOSED COURSE SCHEME

FOR

B.E. – ELECTRONICS AND COMMUNICATION ENGINEERING

2020

ELECTRONICS AND COMMUNICATION ENGINEERING DEPARTMENT
BE (ELECTRONICS AND COMMUNICATION ENGINEERING)

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

SEMESTER WISE CREDITS FOR

BE: ELECTRONIC AND COMMUNICATION ENGINEERING

Nature of Course	Credits to be Earned(As per Choice Based Credit System)								
	Semesters								Total
	I	II	III	IV	V	VI	VII	VIII	
Core-Foundation (CF) Courses	23.5	22	8.5	10.5	-	-	3	-	67.5
Core-Professional (CP) Courses	-	-	15	15.5	20.5	16	3	-	70
Professional & Generic Electives (PE/GE)	-	-	-	-	4	6	7		17
Project Based (PR) Courses	-	3	3	-	-	-	8	15	29
Total									183.5

SEMESTER-I

S No.	Course No.	TITLE		L	T	P	Cr	Contact Hours
1	UPH004	APPLIED PHYSICS	CF	3	1	2	4.5	6
2	UTA003	COMPUTER PROGRAMMING	CF	3	0	2	4.0	5
3	UEC001	ELECTRONIC ENGINEERING	CF	3	1	2	4.5	6
4	UTA015	ENGINEERING DRAWING	CF	2	4	0	4.0	6
5	UHU003	PROFESSIONAL COMMUNICATION	CF	2	0	2	3.0	4
6	UMA010	MATHEMATICS-I	CF	3	1	0	3.5	4
TOTAL				16	7	8	23.5	31

SEMESTER-II

S No.	Course No.	TITLE		L	T	P	Cr	Contact Hours
1	UCB008	APPLIED CHEMISTRY	CF	3	1	2	4.5	6
2	UTA018	OBJECT ORIENTED PROGRAMMING	CF	3	0	2	4.0	5
3	UEE001	ELECTRICAL ENGINEERING	CF	3	1	2	4.5	6
4	UEN002	ENERGY AND ENVIRONMENT	CF	3	0	0	3.0	3
5	UMA004	MATHEMATICS-II	CF	3	1	0	3.5	4
6	UES009	MECHANICS	CF	2	1	2*	2.5	5
7	UTA016	ENGINEERING DESIGN PROJECT – I	PR	1	0	2	3.0	3
TOTAL				18	4	8	25	32

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

SEMESTER-III

S No.	Course No.	TITLE	Code	L	T	P	Cr	Contact Hours
1	UES012	ENGINEERING MATERIALS	CF	3	1	2	4.5	6
2	UMA011	NUMERICAL ANALYSIS	CF	3	0	2	4.0	5
3	UEC403	CIRCUIT ANALYSIS AND SYNTHESIS	CP	3	1	0	3.5	4
4	UEC307	ELECTROMAGNETIC FIELD THEORY AND TRANSMISSION LINES	CP	3	1	0	3.5	4
5	UEC612	DIGITAL SYSTEM DESIGN	CP	3	1	2	4.5	6
6	UEC310	INFORMATION AND COMMUNICATION THEORY	CP	3	1	0	3.5	4
7	UTA024	ENGINEERING DESIGN PROJECT-II	PR	1	0	4	3.0	5
TOTAL				19	5	10	26.5	34

SEMESTER-IV

Sr. No.	Course No.	TITLE	CO DE	L	T	P	Cr	Contact Hours
1	UES018	MANUFACTURING TECHNIQUES	CF	2	0	2	3.0	4
2	UMA035	OPTIMIZATION TECHNIQUES	CF	3	0	2	4.0	5
3	UTA025	INNOVATIONS AND ENTERPRENEURSHIP	CF	1	0	2*	3.0	3*
4	UEC404	SIGNALS AND SYSTEMS	CP	3	1	2	4.5	6
5	UEC301	ANALOG ELECTRONIC CIRCUITS	CP	3	1	2	4.5	6
6	UEC858	MODERN CONROL THEORY	CP	2	1	0	2.5	3
7	UEC513	EMBEDDED SYSTEMS	CP	3	0	2	4.0	5
TOTAL				17	3	11	26.0	30

SEMESTER-V

Sr. No.	Course No.	TITLE	Cod e	L	T	P	Cr	Contact Hours
1	UEC401	ANALOG COMMUNICATION SYSTEMS	CP	3	1	2	4.5	6
2	UEC502	DIGITAL SIGNAL PROCESSING	CP	3	1	2	4.5	6
3	UEC509	COMPUTER ARCHITECTURE	CP	3	1	0	3.5	4
4	UEC512	LINEAR INTEGRATED CIRCUITS AND APPLICATIONS	CP	3	0	2	4.0	5
5	UCS411	ARTIFICIAL INTELLIGENCE	CP	3	0	2	4.0	5
6		ELECTIVE-I	PE	3	0	2	4.0	5
TOTAL				18	3	10	24.5	31

SEMESTER-VI

SNo.	Course No.	TITLE	Cod e	L	T	P	Cr	Contact Hours
1	UEC607	DIGITAL COMMUNICATION	CP	3	0	2	4	5
2	UEC	WIRELESS AND MOBILE COMMUNICATION	CP	2	1	2	3.5	5
3	UEC 750	MOS CIRCUIT DESIGN	CP	3	1	2	4.5	6
4	UEC747	ANTENNA AND WAVE PROPAGATION	CP	3	0	2	4.0	5
5		ELECTIVE – II	PE	3	0	2	4.0	5
6		GENERIC ELECTIVE	GE	2	0	0	2.0	2
7	UEC797	CAPSTONE PROJECT (STARTS)	PR	1*	0	2	-	0
TOTAL				16	2	12	22	28

SEMESTER-VII

Sr. No.	Course No.	TITLE	CO DE	L	T	P	Cr	Contact Hours
1	UEC	FIBER OPTIC COMMUNICATION	CP	2	0	2	3	4
2		ELECTIVE-III	PE	3	0	2	4	5
3		ELECTIVE – IV	PE	3	0	0	3	3
4	UHU005	HUMANITIES FOR ENGINEERS	CF	2	0	2	3	4
5	UEC797	CAPSTONE PROJECT	PR	0	0	2	8	2
TOTAL				10	0	8	21.0	18

SEMESTER-VIII

Sr. No.	Course No.	TITLE	CO DE	L	T	P	Cr	Contact Hours
1	UEC892	PROJECT SEMESTER	PR	0	0	0	15	-
OR								
1		ELECTIVE – V	PE	3	0	0	3	3
2		ELECTIVE – VI	PE	3	0	0	3	3
3	UEC894	PROJECT	PR	0	0	0	9	-
TOTAL				6	0	0	15	6
OR								
1	UEC	START-UP SEMESTER	PR	0	0	0	15	-

ELECTIVE BASKET

	SIGNAL PROCESSING	COMPUTING	VLSI / EMBEDDED SYSTEMS	COMMUNICATION SYSTEMS
Elective-I Credit: 4 Sem V	AUDIO AND SPEECH PROCESSING	DATA STRUCTURES AND ALGORITHMS	INTEGRATED SYSTEM DESIGN	DATA COMMUNICATION
Elective-II Credit: 4 Sem VI	VIDEO SIGNAL PROCESSING	DEEP LEARNING AND APPLICATIONS	IOT BASED SYSTEMS	NETWORK VIRTUALIZATION AND SOFTWARE DEFINED NETWORKING
Elective-III Credit: 4 Sem VII	IMAGE PROCESSING AND COMPUTER VISION	DATABASE MANAGEMENT SYSTEMS / SOFT COMPUTING	ANALOG IC DESIGN	MICROWAVE ENGINEERING
Elective-IV Credit: 3 Sem VII	DSP PROCESSORS	OPERATING SYSTEMS / CLOUD COMPUTING	SYSTEM VERILOG	WIRELESS SENSOR NETWORKS

***Maximum 60 students will be enrolled in each basket.**

ELECTIVE-I

Sr. No.	Course No.	TITLE	L	T	P	Cr	Contact Hours
1	UEC855	AUDIO AND SPEECH PROCESSING	3	0	2	4.0	5
2	UCS613	DATA STRUCTURES AND ALGORITHMS	3	0	2	4.0	5
3	UEC749	INTEGRATED SYSTEM DESIGN	3	0	2	4.0	5
4	UEC	DATA COMMUNICATION	3	0	2	4.0	5

ELECTIVE-II

Sr. No.	Course No.	TITLE	L	T	P	Cr	Contact Hours
1	UEC748	VIDEO SIGNAL PROCESSING	3	0	2	4.0	5
2	UEC630	DEEP LEARNING AND APPLICATIONS	3	0	2	4.0	5
3	UEC715	IOT BASED SYSTEMS	3	0	2	4.0	5
4	UEC707	NETWORK VIRTUALIZATION AND SOFTWARE DEFINED NETWORKING	3	0	2	4.0	5

ELECTIVE-III

Sr. No.	Course No.	TITLE	L	T	P	Cr	Contact Hours
1	UEC705	IMAGE PROCESSING AND COMPUTER VISION	3	0	2	4.0	5
2	UEC716	DATABASE MANAGEMENT SYSTEMS	3	0	2	4.0	5
3	UEC704	SOFT COMPUTING	2	0	2	3.0	3
4	UEC721	ANALOG IC DESIGN	3	0	2	4.0	5
5	UEC708	MICROWAVE ENGINEERING	3	0	2	4.0	5

ELECTIVE-IV

S No.	Course No.	TITLE	L	T	P	Cr	Contact Hours
1	UEC622	DSP PROCESSORS	3	0	0	3.0	3
2	Ucs303	OPERATING SYSTEMS	2	0	2	3.0	4
3	UEC861	CLOUD COMPUTING	2	0	2	3.0	4
4	UEC	SYSTEM VERILOG	2	0	2	3.0	4
5	UEC852	WIRELESS SENSOR NETWORKS	3	0	0	3.0	3

ELECTIVE-V

S No.	Course No.	TITLE	L	T	P	Cr	Contact Hours
1	UEC710	BIOMEDICAL SIGNAL PROCESSING	3	0	0	3	3
2	UEC854	ASIC and FPGA	3	0	0	3	3
3	UEC742	MEMS	3	0	0	3	3
4	UEC862	IC FABRICATION TECHNOLOGY	3	0	0	3	3
5							

ELECTIVE-VI

S No.	Course No.	TITLE	L	T	P	Cr	Contact Hours
1	UEC851	VLSI DIGITAL SIGNAL PROCESSING	3	0	0	3	3
2	UEC860	POWER ELECTRONICS	3	0	0	3	3
3	UEC863	VLSI INTERCONNECTS	3	0	0	3	3
4	UEC864	RADAR AND REMOTE SENSING	3	0	0	3	3

Semester	CREDITS
1	23.5
II	25.0
III	26.5
IV	26.0
V	24.5
VI	22.0
VII	21.0
VIII	15.0
TOTAL CREDITS	183.5

Tentative ELC activities for BE ECE-2020

Semester	EL Activity**
I	PCB Design
II	PCB Fabrication
III	Robotic Arm
IV	FM Receiver
V	IOT based Automation

SEMESTER-I

UPH004: APPLIED PHYSICS

L	T	P	Cr
3	1	2	4.5

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

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

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

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

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

Laboratory Work:

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

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

Course Outcomes:

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

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

Text Books

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

Reference Books

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

Scheme of evaluation

Event	Weightage
Mid-Sem Test	25
Tut/Sessional	7
Lab + Project	25
Quiz	8
End-Sem Test	35
Total	100

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 programming concepts based on user define data types and file handling using C language.

Text Books:

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

Reference Books:

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

Evaluation scheme

Sr. no.	Evaluation Elements	Weights (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quiz/Lab evaluations)	35

UEC001: Electronic Engineering

L	T	P	Cr
3	1	2	4.5

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

Semiconductor Devices: p- n junction diode: Ideal diode, V-I characteristics of diode, Diode small signal model, Diode switching characteristics, Zener diode

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

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

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

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

Familiarization with standards: *IEEE 315A-1986, IEEE 754-2008, IRE 216-1960.*

Laboratory Work:

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

Course learning outcomes (CLO): The student will be able to:

1. Demonstrate the use of semiconductor diodes in various applications.
2. Discuss and explain the working of transistors and operational Amplifiers, their configurations and applications.
3. Recognize and apply the number systems and Boolean algebra.
4. Reduce Boolean expressions and implement them with Logic Gates.
5. Analyze, design and implement combinational and sequential circuits.

Text Books:

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

Reference Books:

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

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
	MST	25
	EST	35
	Sessional (May include Assignments/Projects/Tutorials/Quiz(es)/Lab Evaluations)	40

UTA015:ENGINEERINGDRAWING

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 making the student understand and 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 tolerance dimensions and geometric tolerances symbolisms and to create and edit drawings using drafting software AutoCAD.

Engineering Drawing

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

AutoCAD

1. Management of screen menus commands
2. Introduction to drawing entities
3. Co-ordinates systems: Cartesian, polar and relative coordinates
4. Drawing limits, unit 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, objects snap modes, editing commands,
8. Dimensioning: use of annotations, dimension types, properties and placement, adding text to drawing

MicroProjects/Assignments:

1. Completing the views- Identification and drawing of missing lines in the projection of objects
2. Missing views—using two views to draw the projection of the object in the third view, primarily restricting to Elevation, Plan and Profile views
3. Projects related to orthographic and isometric projections
 - a. Using wax blocks or soap bar to develop three dimensional object from given orthographic projections
 - b. Using wax blocks or soap bar to develop three dimensional object, section it and color the section
 - c. Use of AUTOCAD as a complementary tool for drawing the projection 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 (wherever 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):

Upon completion of this module, students will 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:

Sr.No.	Evaluation Elem	Weightage (%)
1	Midsemestertest(formalwrittentest)	25
2	Endsemestertest(formalwrittentest)	40
3	Sessional: (may include the following) Continuous evaluation of drawing assignments in tutorial/regular practice of AutoCAD tutorial exercises & Individual independent	35

UHU 003: Professional Communication

L	T	P	Cr
2	-	2	3

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

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

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

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

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

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

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

Laboratory work :

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

Course learning outcome (CLO):

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

Text Books:

1. *Lesikar R.V and Flatley M.E., Basic Business Communication Skills for the Empowering the Internet Generation. Tata Mc Graw Hill. New Delhi (2006).*
2. *Raman, M & Sharma, S., Technical Communication Principles and Practice, Oxford University Press New Delhi.(2011).*
3. *Mukherjee H.S., Business Communication-Connecting at Work, Oxford University Press New Delhi, (2013).*

Reference Books:

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

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessionals (Group Discussions; professional presentations; poster presentations, public speaking; technical reports)	40

UMA010-Mathematics - I

L	T	P	Cr
3	1	0	3.5

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

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

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

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

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

Complex analysis: Introduction to complex numbers, geometrical interpretation, functions of complex variables, examples of elementary functions like exponential, trigonometric and hyperbolic functions, elementary calculus on the complex plane (limits, continuity, differentiability), Cauchy-Riemann equations, analytic functions, harmonic functions.

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

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

Text Books:

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

Reference Books:

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

Evaluation Scheme:

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

SEMESTER-II

UCB008: APPLIED CHEMISTRY

L	T	P	Cr
3	1	2	4.5

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

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

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

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

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

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

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

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

Laboratory Work

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

Acid and Bases: Determination of mixture of bases.

Spectroscopic techniques: Colorimeter, UV-Vis spectrophotometer.

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

Course Learning Outcomes: The students will be able to reflect on:

1. concepts of electrodes in electrochemical cells, migration of ions, liquid junction potential and conductometric titrations.
2. atomic and molecular spectroscopy fundamentals like Beer's law, flame photometry, atomic absorption spectrophotometry, UV-Vis and IR.
3. water and its treatment methods like lime soda and ion exchange.

4. concept of phase rule, fuel quality parameters and alternative fuels.
5. polymerization, molecular weight determination and applications as biodegradable and conducting polymers.
6. laboratory techniques like pH metry, potentiometry, colourimetry, conductometry and volumetry.

Text Books

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

Reference Books

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

Evaluation Scheme

S No	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessional (Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	35

L	T	P	Cr.
3	1	2	4.5

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

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

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

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

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

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

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

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

Course Learning Outcome (CLO):

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

1. Apply networks laws and theorems to solve electric circuits.
2. Analyze transient and steady state response of DC circuits.
3. Signify AC quantities through phasor and compute AC system behaviour during steady state.
4. Explain and analyse the behaviour of transformer.
5. Elucidate the principle and characteristics of DC motor and DC generator.

Text Books:

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

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

Reference Books:

1. Chakraborti, A., Basic Electrical Engineering, Tata McGraw–Hill (2008).
2. Del Toro, V., Electrical Engineering Fundamentals, Prentice–Hall of India Private Limited (2004)

Evaluation Scheme:

S N	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessional (Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

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-Paris scenario.

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 mobile sources.

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

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

Energy Resources: Classification of Energy Resources; Conventional energy, resources-Coal, petroleum and natural gas, nuclear energy, hydroelectric power; Non- conventional energy resources- Biomass energy, Thermo-chemical conversion 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. Comprehend the interdisciplinary context with reference to the environmental issues and 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 Harlow (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	50
3.	Sessionals/Quizzes Evaluations	20

L T P Cr

2 1 2* 2.5

(*:Two hours Lab Once In Semester)

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

Review of Newton's law of motion and vector algebra.

Equilibrium of Bodies: Free-body diagrams, conditions of equilibrium, torque due to a force, statical determinacy.

Plane Trusses: Forces in members of a truss by method of joints and method of sections.

Friction: Sliding, belt, screw and rolling.

Properties of Plane Surfaces: First moment of area, centroid, second moment of area etc.

Shear Force and Bending Moment Diagrams: Types of load on beams, classification of beams; axial, shear force and bending moment diagrams: simply supported, overhung and cantilever beams subjected to any combination of point loads, uniformly distributed and varying load and moment.

Virtual Work: Principle of virtual work, calculation of virtual displacement and virtual work.

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

Course Learning Outcomes (CLO):The students will be able to:

1. Determine resultants in plane force systems
2. Identify and quantify all forces associated with a static framework
3. Draw Shear Force Diagram and Bending Moment Diagram in various kinds of beams subjected to different kinds of loads

Text Books:

1. Shames, I. H. Engineering Mechanics: Dynamics, Pearson Education India (2006).
2. Beer, Johnston, Clausen and Staab, Vector Mechanics for Engineers, Dynamics, McGraw-Hill Higher Education (2003).

Reference Books:

1. Hibler, T.A., Engineering Mechanics: Statics and Dynamics, Prentice Hall (2012).
2. Timoshenko and Young, Engineering Mechanics, Tata McGraw Hill Education Private Limited, (2006).

Evaluation Scheme:

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

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 to apply these concepts in solving diverse range of applications.

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

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

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

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

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

Laboratory work:

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

Course learning outcomes (CLOs):

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

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

Evaluation scheme

Sr. no.	Evaluation Elements	Weights (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quiz/Lab evaluations)	35

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

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

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

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

Text Books:

- 1) Simmons, G.F., Differential Equations (With Applications and Historical Notes), Tata McGraw Hill (2009).

- 2) Krishnamurthy, V.K., Mainra, V.P. and Arora, J.L., An introduction to Linear Algebra, Affiliated East West Press (1976).

Reference Books:

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

Evaluation Scheme:

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

UTA016:ENGINEERINGDESIGNPROJECT-I

LTP Cr

102 3.0

Course Objectives: To develop design skills according to a Conceive-Design-Implement-Operate (CDIO) compliant methodology. To apply engineering science through learning-by-doing project work. To provide a framework to encourage creativity and innovation. To develop teamwork 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 includes 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 tutorial 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 the end.

Breakup of lecture details to be taken up by MED:

LecNo.	Topic	Contents
Lec1	Introduction	The Mangonel Project. History. Spreadsheet.
Lec2	PROJECTILE MOTION	no DRAG, Design spread sheet simulator for it.
Lec3	PROJECTILE MOTION	with DRAG, Design spread sheet simulator for it.
Lec4	STRUCTURES FAILURE	STATIC LOADS
Lec5	STRUCTURES FAILURE	DYNAMIC LOADS
Lec6	REDESIGNING THE MANGONEI	Design constraints and limitations of materials for redesigning the Mangonel for
Lec7	MANUFACTURING	Manufacturing and assembling the Mangonel.
Lec8	SIMULATION IN ENGINEERING DESIGN	Simulation as an Analysis Tool in Engineering Design.
Lec9	ROLE OF MODELLING & PROTOTYPING	The Role of Modelling in Engineering Design.

Breakup of lecture details to be taken up by ECED:

LecNo.	Topic	Contents
Lec1-5	Digital Electronics	Prototype,Architecture,Usingthe IntegratedDevelopment Environment(IDE)toPrepareanArduinoSketch,structuringan ArduinoProgram,Using SimplePrimitiveTypes(Variables), Simple programmingexamples. Definition ofa sensor and

TutorialAssignment/LaboratoryWork:

AssociatedLaboratory/ProjectProgram:T-MechanicalTutorial,L-ElectronicsLaboratory, W-MechanicalWorkshopof“Mangonel”assembly,redesign,operationandreflection.

Titlefortheweeklyworkin15weeks	Code
Usingaspreadsheettodevelopasimulator	T1
DynamicsofprojectilelaunchedbyaMangonel-NoDrag	T2
DynamicsofprojectilelaunchedbyaMangonel-WithDrag	T3
Designagainstfailureunderstaticactions	T4
Designagainstfailureunderdynamicactions	T5
ElectronicshardwareandArduinocontroller	L1
ElectronicshardwareandArduinocontroller	L2
ProgrammingtheArduinoController	L3
ProgrammingtheArduinoController	L4
Finalprojectofsensors,electronicshardwareandprogrammedArduino controllerbasedmeasurementofangularvelocityofthe“Mangonel”throwing arm.	L5
AssemblyoftheMangonelbygroup	W1
AssemblyoftheMangonelbygroup	W2
InnovativeredesignoftheMangonelanditstestingbygroup	W3
InnovativeredesignoftheMangonelanditstestingbygroup	W4
Finalintergroupcompetitiontoassessbestredesignandunderstandingofthe “Mangonel”.	W5

Project:TheProjectwillfacilitatethe design,constructionandanalysisofa “Mangonel”.In additionto someintroductorylectures,thecontentof thestudents’workduringthesemester willconsistof:

1. the assembly of a Mangonel from a Bill Of Materials (BOM), detailed engineering drawings of parts, assembly instructions, and few prefabricated parts;
2. the development of a software tool to allow the trajectory of a “missile” to be studied as a function of various operating parameters in condition of no-drag and drag due to air;
3. 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;
4. the development of a micro-electronic system to allow the angular velocity of the throwing arm to be determined;
5. testing the Mangonel;
6. redesigning the throwing arm of the Mangonel to optimise for distance without compromising its structural integrity;
7. an inter-group competition at the end of the semester with evaluation of the group redesign strategies.

Course Learning Outcomes (CLO):

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

1. simulate trajectories of a mass with and without aerodynamic drag using a spreadsheet based software tool to allow trajectories be optimized;

2. perform tests 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 software code to process sensor data;
4. design, construct and test an electronic hardware solution to process sensor data;
5. construct and operate a Roman catapult “Mangonel” using tools, materials and assembly instructions, in a group, for a competition;
6. operate and evaluate the innovative redesign of elements of the “Mangonel” for functional and structural performance;

Text Books:

1. Michael McRoberts, Beginning Arduino, Technology in action publications.
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	30
	Electronics Hardware and software Practical work in Laboratory	30
	Assessment of Mechanical contents in Lectures and Tutorials and Electronics contents in Lectures and Practical.	10
	Project (Assembly of the “Mangonel”, innovative	30

SEMESTER-III

UES012 – ENGINEERING MATERIALS

L	T	P	Cr
3	1	2	4.5

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

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

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

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

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

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

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

Laboratory Work and Micro-Project:

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

1. To determine Curie temperature of a ferrite sample and to study temperature dependence of permeability in the vicinity of Curie temperature.
2. To study cooling curve of a binary alloy.
3. Determination of the elastic modulus and ultimate strength of a given fiber strand.
4. To determine the dielectric constant of a PCB laminate.
5. Detection of flaws using ultrasonic flaw detector (UFD).
6. To determine fiber and void fraction of a glass fiber reinforced composite specimen.
7. To investigate creep of a given wire at room temperature.
8. To estimate the Hall coefficient, carrier concentration and mobility in a semiconductor crystal.
9. To estimate the band-gap energy of a semiconductor using four probe technique.
10. To measure grain size and study the effect of grain size on hardness of the given metallic specimens.

Course Outcomes: Student will be able to:

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

Text Books:

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

Reference Books:

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

Evaluation Scheme

Event	Weightage
Mid-Sem Test	25
Tut/Sessional	5
Lab + Project	25
Quiz	10
End-Sem Test	35
Total	100

UMA011: NUMERICAL ANALYSIS

(For all branches except ELE and EIC)

L T P Cr

3 0 2 4.0

Course Objectives: The main objective of this course is to motivate the students to understand and learn various numerical techniques to solve mathematical problems representing various engineering, physical and real-life problems.

Floating-Point Numbers: Floating-point representation, rounding, chopping, error analysis, conditioning and stability.

Non-Linear Equations: Bisection, secant, fixed-point iteration, Newton method for simple and multiple roots, their convergence analysis and order of convergence.

Linear Systems and Eigen-Values: Gauss elimination method using pivoting strategies, LU decomposition, Gauss-Seidel and successive-over-relaxation (SOR) iteration methods and their convergence, ill and well-conditioned systems, Rayleigh's power method for Eigen-values and Eigen-vectors.

Interpolation and Approximations: Finite differences, Newton's forward and backward interpolation, Lagrange and Newton's divided difference interpolation formulas with error analysis, least square approximations.

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

Differential Equations: Solution of initial value problems using Picard, Taylor series, Euler's and Runge-Kutta methods (up to fourth-order), system of first-order differential equations.

Laboratory Work: Lab experiments will be set in consonance with materials covered in the theory. Implementation of numerical techniques using **MATLAB**.

Course learning outcomes (CLOs): Upon completion of this course, the student will be able to:

1. understand the errors, source of error and its effect on any numerical computations and also analysis the efficiency of any numerical algorithms.
2. learn how to obtain numerical solution of nonlinear equations using bisection, secant, Newton, and fixed-point iteration methods.
3. solve system of linear equations numerically using direct and iterative methods.
4. understand how to approximate the functions using interpolating polynomials.
5. learn how to solve definite integrals and initial value problems numerically.

Text Books:

1. Gerald F. C. and Wheatley O. P., Applied Numerical Analysis, Pearson, (2003) 7thEdition, 2. Jain K. M., Iyengar K. R. S. and Jain K. R., Numerical Methods for

Scientific and Engineering Computation, New Age International Publishers (2012), 6thedition.

2. Steven C. Chappra, Numerical Methods for Engineers, McGraw-Hill Higher Education; 7th edition (1 March 2014)

Reference Books:

3. Mathew H. J., Numerical Methods for Mathematics, Science and Engineering, Prentice Hall, (1992) 2nd edition.
4. Burden L. R. and Faires D. J. Numerical Analysis, Brooks Cole (2011), 9thedition.
5. Atkinson K. and Han H., Elementary Numerical Analysis, John Willey & Sons (2004), 3rd edition.

Evaluation Scheme:

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

UEC403: CIRCUIT ANALYSIS AND SYNTHESIS

L	T	P	Cr
3	1	0	3.5

Introduction: Circuit components, Network graph, KCL, KVL, Circuit analysis and methods, Mutual inductance, Co-efficient of coupling (Dot analysis), Network Classification.

Network Theorems and Two Port Network Descriptions: Thevenins theorem, Nortons theorem, Maximum power transfer theorem, Superposition theorem, Tellengens theorem, Reciprocity theorem, Two port description in terms of open circuits impedance Parameters, Short circuit admittance parameters, Hybrid parameters, Image parameters, Inter-connection of two port network, Indefinites admittance matrix and its applications, Duality networks.

Network Functions: Concept of Complex frequency, Transform impedances, Network functions of one port & two port networks.

Time Domain Analysis: Unit, Step, Impulse and ramp function, Solution of networks using Laplace Transform, Steady state analysis of networks.

Attenuators: Image impedances-Image transfer coeff, Iterative impedances, Ladder network, Lattice network, Bridged T-network conversion, Insertion loss, Design of symmetrical-T & L section Attenuators.

Filters: Determination of pass and attenuation bands constant K-type, Low pass, High pass, Band pass, Band stop, M-derived filters, Lattice filter, Crystal filters.

Network Synthesis: Concept of Poles & Zero, Reliability of one port Networks, Positive real function(prf) Graphical Interpretation of positive realness, Properties of prf, Even & Odd parts of palimones Necessary & Sufficient Condition for a function to be positive real function, Hurwitz polynomials, Hurwitz polynomials test, Foster & Caner form properties of driving point impedance function of one port passive lumped reactive element network, Properties of the driving point impedance function of RL Network Properties of the driving point Impedance function of RC Network, Minimum Function Realization of Driving point Function of two-element kind by Canonic Networks, Realization of LC driving point function, Synthesis of LC, RC and RL driving point immitance function using Foster and cauer first and second forms.

Familiarization with Standards: *IEEE Std 551™-2006, IEEE Std 3002.3-2018.*

Course Learning Outcomes (CLO):

The students will be able to:

1. Do analysis of different types of circuits.
2. do analysis based on network theorems and to determine the current, voltage and power.
3. analyze two port networks and to analyze time response of the circuit.
4. check stability of a circuit and to design the circuit using foster and cauer forms

Text Books:

1. Vanvalkenberg, M.E., *Networks Analysis, Prentice Hall of India (2007) 3rded.*
2. Arshad, M., *Network Analysis and Synthesis, Laxmi Publications (2008) 2nded.*

Reference Books:

1. Kuo, F., *Network Analysis and Synthesis*, John Wiley (2003) 2nd ed.
2. Anderson, B.D.O., Vongpanitlerd, S., *Network Analysis and Synthesis*, Dover Publications (2006) 3rd ed.

Evaluation Scheme:

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

**UEC307: ELECTROMAGNETIC FIELD THEORY
AND TRANSMISSION LINES**

L	T	P	Cr
3	1	0	3.5

Course Objective: To enhance student's comprehensive capabilities in electromagnetic field theory by study the behavior of statics and time varying electric and magnetic field in a medium and transmission line.

Vector Analysis: Review of vector algebra, Review of Cartesian, Cylindrical and spherical coordinate systems,

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

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

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

Uniform Plane Waves: Introduction, Uniform plane wave propagation, Wave equations, Transverse nature of uniform plane waves, Perpendicular relation between and EM waves in charge free, Current free dielectric, Reflection by ideal conductor: Normal incidence, reflection and transmission with normal incidence at another dielectric, Plane wave in lossy dielectric, Wave impedance and propagation constant, Depth of penetration, Surface impedance and surface resistance.

Transmission Lines and Matching Networks: Introduction, Circuit representation of parallel plane transmission lines, Transmission lines with losses, Characteristic impedance, Characteristic impedance at radio frequencies, Propagation constant, Attenuation constant and phase constant, An infinite line equivalent to a finite line terminated in its characteristic impedance, Reflection, Reflection coefficient, Expression for input impedance in terms of reflection coefficient, Standing wave ratio (SWR), Relation between SWR and reflection coefficient, Location of voltage maxima and minima, Impedance matching devices, Principle of impedance matching devices, Smith Chart, lossy lines.

Wave Guides: Introduction, Simple waveguides between two infinite and parallel conducting plates, Transverse Electric (TE) Waves or H_c Introduction, Simple waveguides between two infinite and parallel conducting plates, Transverse Electric (TE) Waves or H_c impedance, Characteristic impedance at radio frequencies, Propagation constant, Attenuation constant and phase constant, An infinite equencies, dispersion relation, field patterns, power flow.

Familiarization with standards: *IEEE 148-1959, IEEE 1128-1998 and IEEE 1302-1998.*

Course Learning Outcomes (CLO s):The students will be able to:

1. Analyse the vector and scalar behaviour of Electric and magnetic along.
2. Analyse the static behaviour of electric and magnetic fields
3. Analyse the time varying fields using Maxwell's Equation
4. Investigate the characteristics of electromagnetic wave and its propagation in free space and transmission line.
5. Analyse different modes of wave propagation (TE, TM and TEM) and guided media.

Text Books:

1. Hayt, W.H., *Engineering Electromagnetics*, Tata McGraw-Hill, W.H., n^{th} ed.
2. Kraus, J.D., *Electromagnetics*, McGraw-Hill, J.D., E^{th} ed.
3. Sadiku, M.N.O, *Elements of Electromagnetics*, Oxford University Press (2009) 4^{th} ed

Evaluation Scheme:

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

UEC310: INFORMATION AND COMMUNICATION THEORY

L	T	P	Cr.
3	1	0	3.5

Course Objectives: To gain knowledge and understand the concepts of probability theory, random variables, stochastic processes and Information theory. To familiarize the students with the applications of probabilistic/stochastic techniques/methods in communication engineering and information theory.

Details of Contents:

Probability Theory: Review of Probability, Bernoulli Trials, Bernoulli's Theorem, Concepts of Random Variables, Distribution and Probability Density Functions, Conditional Distributions, Binomial Random variables Functions of One Random Variable, its Distribution, Mean and Variance, Moments, Characteristic Functions; Two Functions of Two Random Variables, Joint Moments, Joint Characteristic Functions, Conditional Distributions, Conditional Expected Values, Normality, Center Limit Theorem, and Bayes' Theorem

Stochastic Processes: Systems with Stochastic Inputs, Power Spectral Analysis of I/O Signals, Poisson Points, Cyclostationary Processes, Poisson Sum Formula, Ergodicity, Mean Square Estimation, Markov Chains, and Random-Walk Model

Estimation & Hypothesis Testing: Time and Ensemble Averages, Covariance Functions. Simple Binary Hypothesis Tests, Decision Criteria, Neyman Pearson Tests, Bayes' Criteria, z-Score, and p-Value Test

Information Theory: Introduction, Information measure and entropy, Information source, Markov source, Adjoint of an information source, Joint and Conditional Information measure, Joint and conditional information measure of a Markov source, Instantaneous codes, Kraft-McMillan inequality, Shannon first theorem, Coding strategies and Huffman coding, Introduction to information channels, mutual information and channel capacity, Shannon second theorem, channel capacity calculations for different channels, Differential entropy, Rate distortion theory

Statistical Modeling of Noise: Probability Density of a Jointly-Gaussian Random Vector, Wide-Sense-Stationary (WSS) Processes, Poisson Process Noise, Noise Statistics in Linear Time-Invariant Systems, Noise Power Spectral Densities, Signal-to-Noise-Ratio in Presence of AWGN and Interferences.

Familiarization with Standard: *IEEE P1933.1.*

Text Books:

1. Athanasios Papoulis, *Probability Random Variables and Stochastic Processes*, McGraw-Hill (1984)
2. John N. Daigle, *Queueing Theory with Applications to Packet Telecommunication*, Springer (2005)

3. Bernard Sklar, *Digital Communications: Fundamentals and Applications*, Prentice Hall (2001)

Reference Books:

1. P.Z. Peebles, *Probability, Random Variables, and Random Signal Principles*, McGraw-Hill (1980)

2. Dimitri P. Bertsekas, Robert G. Gallager, *Data Networks*, Prentice-Hall (1987)

3. A. Larson and B.O. Schubert, *Stochastic Processes, vol. I and II*, Holden-Day (1979)

4. W. Gardener, *Stochastic Processes*, McGraw Hill (1986)

5. *IEEE Transactions on Information Theory*

6. David J. C. Mackay, *“Information Theory, Inference and Learning Algorithms”*, Cambridge University Press, 2003

Course Learning Outcomes:

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

1. apply the probabilistic concepts as well as properties of the random variables
2. perform the spectral analysis of stationary stochastic processes, for the modeling of real-time desired signals and spurious-signals/noise
3. incorporate the estimation and hypothesis testing principles to find remedial solutions
4. utilize the features/characteristics of queueing theory in communication systems
5. employ information theory and coding concepts, to improve information symbol transmission rate, and also use it for data compression.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
4.	MST	30
5.	EST	45
6.	Sessional (<i>Including assignments, quiz & micro-project etc.</i>)	25

Course Objectives: To familiarize the student with the analysis, design and evaluation of digital systems of medium complexity based on SSI, MSI and Programmable logic devices. To familiarize the students with the issues in the design of iterative networks, timing analysis of synchronous and asynchronous systems. To introduce Hardware description language (VHDL) and familiarize students to design combinational and sequential circuits using VHDL and simulators.

Binary Codes: Review of special binary codes, Error detection and correction codes.

Combinational Circuits: Q. M. Method, Variable Map Method, Ripple carry adder, BCD adder, High speed adder, Subtractor, Code conversion, Magnitude comparators, Applications of Encoders, Decoders, MUX, DEMUX, Implementations using ROM, PLA, PAL. Standard ICs and their applications. Using combinational modules to design digital systems, Iterative networks.

Sequential Circuits: Various types of latches and flip-flops and their conversions, Universal Shift Registers, Counters – Ring, Johnson, Design of Counters, Timing issues, Setup and hold times, operating frequency limitations, Static Timing Analysis, Standard ICs for their applications, Finite State Machines – Moore and Mealy, Design of Synchronous and Asynchronous sequential circuits, Races and hazards, hazard free design.

Logic Circuits: TTL, MOS, CMOS logic families their comparison, Detailed study of TTL & CMOS logic families and their characteristics i.e. Fan-in, Fan-out, Unit load, Propagation delay, Power dissipation, Current & voltage parameters, Tristate Logic, Interfacing of TTL & CMOS logic families, reading and analyzing Datasheets, Performance estimation of digital systems.

VHDL: Introduction, Structure of HDL Module, Operators, Data types, Types of Descriptions, Simulation and synthesis, Brief comparison of VHDL and Verilog. Data-Flow Descriptions: Highlights of Data flow descriptions, Structure of data-flow description, Data type-vectors.

Familiarization with standards: *IEEE 91a-1991 and IEEE 91-1984.*

Laboratory Work: To study standard ICs and their usage, latches and Flip-flops, Design of registers and asynchronous/synchronous up/down counters, Variable modulus counters, Design of Finite State Machines, Study of timing waveforms, Usage of IC tester. Programming of combinational and sequential systems using VHDL.

Course Learning Outcomes (CLO): The student will be able to:

1. Design the basic logic functions, simplification of expressions, Karnaugh maps,
2. Design flip flops, sequential systems,
3. Design Moore and Mealy Finite State Machine.
4. Design digital Systems using VHDL.
5. Compare the performance of a given digital circuits/systems with respect to their speed, power consumption, number of ICs, and cost.

Text Books:

1. Fletcher, W.I., Engineering Approach to Digital Design, Prentice Hall of India (2007) 4thed.
2. Mano, M.M. and Ciletti M. D., Digital Design, Prentice Hall (2001) 3rd ed.

Reference Books:

1. Givone D. D., Digital Principles and Design, Tata McGraw Hill (2007) 2nded.
2. Tocci, R.J., Digital Systems: Principles and Applications, Prentice-Hall (2006) 10thed.
3. Wakerly, J.F., Digital Design Principles and Practices, Prentice Hall of India (2013) 5thed.

Evaluation Scheme:

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

UTA-024 Engineering Design Project-II (Buggy Lab)
(including 2 self effort hours)

L	T	P	Cr
1	0	4	3.0

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

Hardware overview of Arduino:

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

Sensors and selection criterion:

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

Active and passive components:

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

Programming of Arduino:

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

Basics of C#:

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

Familiarization with Standards: *IEEE 1451.2-1997 and IEEE 1212-2001.*

Laboratory Work:

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

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

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

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

Course learning outcome (CLO): The student will be able to:

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

Text Books:

1. *Michael McRoberts, Beginning Arduino, Technology in action publications, 2nd Edition.*
2. *Alan G. Smith, Introduction to Arduino: A piece of cake, CreateSpace Independent Publishing Platform (2011).*

Reference Books:

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

SEMESTER-IV

UEC404: SIGNALS AND SYSTEMS

L	T	P	Cr
3	1	2	4.5

Course Objective: The aim of this subject is to develop analytical capability of students, by which they would be able to handle real-time signal processing related problems and projects. The knowledge of various transforms will help students to work in multi-disciplinary fields of engineering in group activities.

Representation of Signals and Systems: Signals, Basic Continuous and discrete Time signals and systems, Energy and power signals, System modeling concepts, Linear time invariant systems, Representation of signals in terms of impulses, Discrete time LTI systems continuous time LTI systems, Properties of LTI systems, Systems described by differential and difference equations, Sampling theorem, Quantization.

Fourier Analysis: Continuous and discrete time Fourier series, Trigonometric and exponential Fourier series, Properties of Fourier series, Parseval's theorem, Line spectrum, Continuous and discrete time Fourier transforms and its properties, Analysis of discrete time signals and systems, Correlation, Autocorrelation, Relation to Laplace transform.

Z-Transform: Definition of Z-transform and Properties of Z-transform, Inverse Z-transform - Power series, partial fraction expansion, residue method and their comparison, Relation between Z.T. and F.T, Transfer function, Discrete time convolution, Stability considerations, Time domain and frequency domain analysis, Solution of difference equation, Applications of Z-transforms.

Introduction to Fast Fourier Transforms: Discrete Fourier transform, Properties of DFT, Fast Fourier transforms, Divide and Conquer Approach, Decimation in time and decimation in frequency, Radix-2 FFT, Radix-4 FFT algorithms, Linear Convolution, Circular Convolution, Power spectrum and correlation with FFT.

Other transforms: Discrete Sine Transform, Discrete Cosine Transform and its types.

Familiarization with Standard: *IEEE 1641-2004, IEEE 1139-1999.*

Laboratory work:

Signal generation, Solving difference equation, Calculating Z-transform, Linear and Circular convolution, Correlation, DFT / IDFT, FFT algorithms using Matlab.

Course learning outcome (CLO): The student will be able to:

1. analyze the properties of continuous and discrete time signals and systems.
2. represent signals and systems in the frequency domain using Fourier tools.
3. apply Z-transform to analyze discrete time signals and system.
4. obtain the Fast Fourier transform of a sequence and measure its computational efficiency.

Text Books:

1. Oppenheim, A.V. and Willsky, A.S., *Signal & Systems*, Prentice Hall of India (1997).
2. Kani, A.N. *Signals and Systems*, McGraw Hill Higher Education,(2011)
3. Proakis, J.G. and Manolakis, D.G., *Digital Signal Processing Principles Algorithm & Applications*, Prentice Hall, (2007).

Reference Books:

1. Lathi, B.P., *Modern Digital and Analog Communication Systems*, Oxford Univ. Press, 1998
2. Papoulis, A., *Probability Random Variables and Stochastic Processes*, McGraw Hill, 2008

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessionals (May include Assignments / Projects / Tutorials / Quizes / Lab Evaluations)	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 startup venture finance.

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

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

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

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

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

Course learning outcomes (CLO):

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

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

Text Books:

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

Reference Books:

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

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

Evaluation scheme:

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

UEC301: Analog Electronic Circuits

L	T	P	Cr
3	1	2	4.5

Course Objective: The aim of this course is to familiarize the student with the analysis and design of basic transistor amplifier circuits, oscillators and wave shaping circuits.

Transistor Biasing and Thermal Stabilization: The Operating Point, Biasing Stability, Self-Biasing or Emitter Bias, Stabilization against Variations in I_{CO} , V_{BE} , and β , General Remarks on Collector-Current Stability, Bias Compensation, Thermal Runaway, Thermal Stability, The FET Small-Signal Model, The metal-oxide-semiconductor FET (MOSFET), The low-frequency common-source and common-drain amplifiers, Biasing FET

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

Multistage Amplifiers: Classification of amplifiers, Distortion in amplifiers, Frequency response of an amplifier, Step Response of an amplifier, Bandpass of cascaded stages, The RC-coupled amplifier, Low-frequency response of an RC-coupled stage, Effect of an emitter Bypass capacitor on low-frequency response.

Power Amplifiers: Class A, B, AB, Push pull & Class C amplifiers, Comparison of their Efficiencies, Types of distortion.

Feedback Amplifiers: Classification of Amplifiers, The feedback concept, The transfer gain with feedback, General characteristics of negative-feedback amplifiers, Input resistance, Output resistance, Method of Analysis of a Feedback Amplifier, Voltage-series feedback, Current-series feedback, Current-shunt feedback, Voltage-shunt feedback

Stability and Oscillators: Sinusoidal Oscillator, The phase-shift oscillator, Resonant-circuit oscillators, A General form of oscillator circuit, The Wien Bridge oscillator, Crystal oscillator, Frequency Stability

Wave shaping circuits: Multi-vibrators (Astable, Mono-stable, Bi-Stable), High pass and low pass filters using R-C Circuits & their response to step input, Pulse input, Square input and Ramp Input, Schmitt Trigger.

Laboratory Work: Frequency response analysis of RC coupled amplifier, Tuned amplifiers, Push-pull amplifier, Feedback amplifier. Hartley and Colpitts Oscillator. RC Phase shift oscillator. Study of Multi-vibrators (Astable, Mono-stable, Bi-stable Multi-vibrator). Clipper and Clamper circuit, Schmitt Trigger.

Familiarization with standards: *IEEE 218-1956, IEEE/AIEE 425-1957, IEEE Std 181-2011.*

Course learning outcome (CLO): The student will be able to:

1. Determine operating point and various stability factors of transistor.
2. Analyse low and high frequency transistor model.
3. Analyse the performance of multistage, feedback and power amplifiers.
4. Design oscillator circuits and analyse its performance.
5. Analyse various filters and multi-vibrators circuits.

Text Books:

1. Milliman, J. and Halkias, C.C., Intergrated Electronics, Tata McGraw Hill (2007).
2. Milliman, J. & Taub, H., Pulse, Digital and switching waveforms, Tata McGraw Hill (2007).

Reference Books

1. Malvino, L., Electronic principles, Tata McGraw Hill (1998).
2. Cathey, J. J., 2000 Solved Examples in Electronics, McGraw Hill (1991).

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UES018: Manufacturing Techniques

L	T	P	Cr
2	0	2	3.0

Course Objectives: The course introduces the basic concepts of manufacturing via machining, joining and assembly, enabling the students to develop a basic knowledge of the mechanics, operation and limitations of basic machining tool. The course also introduces the concept of metrology and measurement of parts. The course also provides students with skill, knowledge and hands on experience to work on different vacuum-based deposition techniques, understanding of nucleation and growth of thin films and their different characterization for various electronic application.

***Part A (Common to all)**

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

Joining Processes: Electric arc, Resistance welding, Soldering, Brazing.

***Part B (Program Specific)**

Thin Films Deposition Techniques: Introduction to vacuum systems, different vacuum pumps and pressure gauges, vacuum leak detection and its solution, Physical Vapour Deposition (PVD), Chemical Vapor Deposition (CVD), Radio Frequency (RF) Sputtering, Direct Current (DC) Sputtering, Thermal Evaporation, Metallization, film thickness measurements, Oxidation techniques and systems, Oxidation of polysilicon.

Device Manufacturing: Metal Semiconductor Junctions: Ohmic and Schottky, Metal Oxide Semiconductor (MOS) Device, Application of thin films in different areas such as electronics, medical, defence, sports, auto mobiles etc. Characterization of thin films, MOS device-based characterization, Conductivity measurements, two probe vs four probe resistivity method, CV characterization.

***Part A will be covered before MST and Part B will be covered after MST.**

Course learning outcome (CLOs):

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

1. Develop simple CNC code, and use it to produce components while working in groups.
2. Analyse various machining processes and calculate relevant quantities such as velocities, forces.
3. Recognise cutting tool wear and identify possible causes and solutions.
4. Appropriately select the deposition techniques for various electronic application.
5. Analyse and understand the requirements to achieve sound welded joint while welding different similar and dissimilar engineering materials.
6. Perform the device manufacturing and its characterization.

Text Books / Reference Books

1. Chandra, S., Jayadeva, Mehra, A., *Numerical Optimization and Applications*, Narosa Publishing House, (2013).
2. Taha H.A., *Operations Research-An Introduction*, PHI (2007).
3. Pant J. C., *Introduction to optimization: Operations Research*, Jain Brothers (2004)
4. Bazaarra Mokhtar S., Jarvis John J. and ShiraliHanif D., *Linear Programming and Network flows*, John Wiley and Sons (1990)
5. Swarup, K., Gupta, P. K., Mammohan, *Operations Research*, Sultan Chand & Sons, (2010).
6. M. Ohring, *Materials science of thin films*, Academic press (2001).
7. Seshan K., *Handbook of Thin Film Deposition*, Elsevier(2012).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	20 (Part A)
2.	EST	40 (Part A:10 + Part B:30)
3.	Sessional (Assignments/Practical/Tutorials/Quizzes)	40 (Part A:20 + Part B:20)

UMA035: OPTIMIZATION TECHNIQUES

L	T	P	Cr
3	0	2	4.0

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

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

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

Integer Programming: Branch and bound technique, Gomory's Cutting plane method.

Network Models: Construction of networks, Network computations, Free Floats, Critical path method (CPM), optimal scheduling (crashing). Initial basic feasible solutions of balanced and unbalanced transportation problems, optimal solutions, assignment problem.

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

Nonlinear Programming:

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

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

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

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

Text Books:

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

Recommended Books:

- 1) Pant J. C., Introduction to optimization: Operations Research, Jain Brothers (2004)
- 2) BazaarraMokhtar S., Jarvis John J. and ShiraliHanif D., Linear Programming and Network flows, John Wiley and Sons (1990)

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

Evaluation Scheme:

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

UEC858: MODERN CONTROL THEORY

L	T	P	Cr
2	1	0	2.5

Course Objective: This course provides the insight of the fundamentals of modern control theory by analysing time and frequency response of open and CLO ssed loop systems. Furthermore, the concept is extended to advanced concepts of modern control theory - centred on the system stability and state space methods. Emphasis is placed on concepts of controllability and observability in addition to fundamentals of digital control systems.

Mathematical Models, Block Diagrams and Signal Flow Graphs of Systems: Introduction of mathematical models and transfer function, Construction and reduction of block diagram and signal flow graphs, Application of Mason's gain formula.

Time-Domain Analysis of Control Systems: Transient and steady state response, time response of first and second-order systems, sensitivity to parameter variations, steady-state errors, Types of Systems and Error Constants.

System Stability: Conditions for stability of linear systems, Algebraic Stability criteria - Hurwitz criterion, Routh criterion, Root locus techniques, Frequency domain analysis, Correlation between frequency response and transient response, Polar plots, Nyquist plots, Bode plots.

Classical Controller Design Methods: General aspects of the CLO ssed-loop control design problem, Controller circuits design concepts for P, PD, PI and PID Controllers

State Variable Analysis: Introduction, state variable representation, conversion of transfer function model to state variable model, conversion of state variable model to transfer function model, Eigen values and Eigen vectors, solution of state equations. Concepts of controllability and observability,

Digital Control System: Basic structure of digital control systems, description and analysis of Linear Time-Invariant Discrete-time systems.

Familiarization with Standard: *IEEE 55-1960.*

Course learning outcome (CLOs): The student will be able to:

1. Understand CLO sse and open loop control system representations in terms of block diagrams, signal flow graphs and transfer function,
2. Analyze the time and frequency response of the control systems and to establish the correlation between them,
3. Analyze the stability of the control systems and learn various methods to judge the stability criterion.
4. Understand the fundamentals of designing of P-I-D controllers,
5. Achieve knowledge about the concepts of the state space analysys and the concept of controllability and observability for classical and digital control system.

Text Books:

1. *Nagrath, I. J., and Gopal, M., Control Systems Engineering, New Age International Publishers, 2006, 4th ed.*
2. *Benjamin C. Kuo, Automatic Control Systems, Pearson education, 2003*

3. *G F Franklin, J D Powell and M Workman 'Digital Control of Dynamic Systems', 1997, 3rded.*
4. *M. Gopal, Digital Control and State Variable Methods, McGraw-Hill, 2008.*

Reference Books:

1. *Ogata, Katsuhiko, Modern Control Engineering, Prentice-Hall, (2010) 5th ed.*
2. *Warwick, Kevin, An Introduction to Control Systems, World Scientific Publishing Co. Ptv. Ltd, (1996) 2nd ed.*
3. *Levine, W. S., Control System Fundamentals, CRC Press, (2000) 3rd ed.*
4. *Mutambara, Arthur G. O., Design and Analysis of Control Systems, CRC Press, (1999) 2nd ed.*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	50
3.	Sessional (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	20

UEC608: EMBEDDED SYSTEMS

L	T	P	Cr
3	0	2	4.0

Course objective: Embedded systems are pervasive in all areas of society, and as such, knowledge of how to design them is a vital skill for all electronic engineers. The objective of this course is to equip students with the necessary fundamental knowledge and skills that enable them to design basic embedded systems, where a microprocessor or microcontroller is the central element.

Introduction to Processor Design

General purpose processor architecture and organization, Von-Neuman and Harvard architectures, Processor design trade-offs, CISC and RISC architectures, Advantages of RISC architecture, Processor cores: soft and hard.

ARM Introduction and Pipeline structures

ARM processor architecture, Endianness, Processor core VS CPU core, ARM7TDMI Interface signals, Memory Interface, Bus Cycle types, Register set, Operational Modes. Instruction Format, ARM Core Data Flow Model, ARM 3 stage Pipeline, ARM family attribute comparison. ARM 5 stage Pipeline, Pipeline Hazards, Data forwarding

ARM7TDMI assembly instructions and modes

ARM ISA and Processor Variants, Different Types of Instructions, ARM Instruction set, condition codes, Load-Store instructions, Data processing instructions, Shift Operations, Arithmetic, Logical instructions, Addressing modes. Swap Instructions, Swap Register related Instructions, Control Flow Instructions, Interrupts and Exceptions, software Interrupt Instruction, Assembly Language Programming, Thumb state, Thumb Programmers model, Thumb Applications, ARM coprocessor interface and Instructions, Coprocessor Instructions,

ARM tools and Peripherals

ARM Development Environment, Arm Procedure Call Standard (APCS), Example C/C++ programs, Embedded software Development, Image structure, linker inputs and outputs, Protocols (I2C, SPI), GPIO, ARM systems with MPU, memory Protection Unit (MPU). Physical Vs Virtual Memory, Paging, Segmentation. AMBA Overview, Typical AMBA Based Microcontroller, AHB bus features, AHB Bus transfers, APB bus transfers, APB bridge. DMA, Peripherals, Programming Peripherals in ARM.

Familiarization with Standards: *IEEE 1275.1-1994 and IEEE 1754.*

Laboratory Work: Practical/experiments based on the assembly language programming, C/C++ programming and integration of ARM core with embedded peripherals.

Course learning outcome (CLO):

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

1. analyze ARM processor assembly instructions, their formats and usage.
2. write ARM processor-based assembly language programs.
3. understand how thumb mode operations are designed and various coprocessors are interfaced in an embedded system.

4. interface AMBA bus architecture, various HW peripherals in embedded systems and how memory mapping can be done.
5. understand issues to be handled in any processor software tool chain for embedded system development especially using C/C++.

Text Books:

1. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian, "COMPUTER ORGANIZATION AND EMBEDDED SYSTEMS, Sixth Edition, McGraw Hill, 2012.
2. Steve Furber, "ARM System-on-Chip Architecture, Second Edition, PEARSON, 2013.

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.

Evaluation Scheme:

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

SEMESTER - V

UEC401: ANALOG COMMUNICATION SYSTEMS

L	T	P	Cr
3	1	2	4.5

Course Objective: The aim of this course is to build fundamental understanding of a communication system and its performance metrics. The course will describe the theory of modulation and its different counterparts with the help of mathematical analysis of their various characteristics. The generation of AM, FM and PM waves will be described. The course will also focus on the design of AM and FM receivers and will deal with various types of noises in the communication channel.

Introduction to Communication systems: Introduction to Communication system, analog and digital messages, signal to noise ratio, Noise, Resistor noise, Multiple resistor noise sources, Noise Temperature, Noise bandwidth, Effective input noise temperature, channel bandwidth, rate of communication, modulation, necessity for modulation, signal distortion over a communication channel, signal energy and signal energy density, signal power, power spectral density,

Amplitude Modulation: Baseband and carrier communication, Theory of amplitude modulation, DSB-AM, SSB-AM, Vestigial sideband transmission, carrier acquisition, , power calculations, Square law modulation, Amplitude modulation in amplifier circuits, Suppressed carrier AM generation (Balanced Modulator) ring Modulator, Product Modulator/balanced Modulator.

AM Reception: Tuned Ratio Frequency (TRF) Receiver, Super heterodyne Receiver, RF Amplifier, Image Frequency Rejection, AM diode detector, AM receiver using a phase locked loop (PLL), AM receiver characteristics.

Angle Modulation: Concept of instantaneous frequency, bandwidth of angle modulated waves, Theory of frequency modulation, Mathematical analysis of FM, Spectra of FM signals, Narrow band FM, Wide band FM, Phase modulation, Phase modulation obtained from frequency modulation, FM allocation standards, Generation of FM by direct method, Indirect generation of FM, The Armstrong method RC phase shift method,, Noise triangle. Comparison of AM, FM and PM

FM/PM Reception: Direct methods of Frequency demodulation, Travis detector/frequency discrimination (Balanced stop detector), Foster seely of phase discriminator, Ratio detector, Indirect method of FM demodulation, FM detector using PLL, Zero crossing detector as a Frequency Demodulator, Pre-emphasis / de-emphasis, Limiters, The FM receiver

Analog Pulse Modulation: Introduction, Pulse amplitude modulation (PAM), Pulse Time Modulation (PTM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM), Spectra of pulse modulated signals, SNR calculations for pulse modulation systems.

Statistical Modeling of Noise: Probability Density of a Jointly-Gaussian Random Vector, Wide-Sense-Stationary (WSS) Processes, Poisson Process Noise, Noise Statistics in Linear Time-Invariant Systems, Noise Power Spectral Densities, Signal-to-Noise-Ratio in Presence of AWGN and Interferences.

Familiarization with Standard: *IEEE/IHF 185-1975.*

Laboratory work: Study of AM modulators / demodulators: (Balanced modulator, Ring modulator) / (Balanced modulator Super heterodyne Receiver), Study of FM/PM modulators/demodulators: (direct method, Varactor diode Modulator, Indirect generation of FM) / (Balanced stop detector, Foster seely of phase discriminator, Ratio detector), FM stereo receiver.

Course learning outcome (CLOs): The students will be able to

1. describe different types of noise and predict its effect on various analog communication systems.
2. analyze energy and power spectral density of the signal.
3. express the basic concepts of analog modulation schemes
4. evaluate analog modulated waveform in time /frequency domain and also find modulation index.
5. develop understanding about performance of analog communication systems
6. calculate bandwidth and power requirements for analog systems.
7. analyze different characteristics of receiver

Text Books:

1. Kennedy, G., *Electronic Communication Systems, McGraw-Hill (2008) 4th ed.*
2. Lathi.B.P., *Modern Digital and Analog Communications Systems 3rd ed.*

Reference Books:

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

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

3 1 2 4.5

Course Objective: The subject of discrete-time signal processing constitutes an important part of communication and computer engineering. The signals are processed to generate a sequence of numbers that represent samples of a continuous variable in a domain such as time, space, or frequency. Major objective is to apply various mathematical and computational algorithms to continuous-time and discrete-time signals to produce a modified signal that's of higher quality than the original signal, which in turn improves the efficiency of underlying systems. Its utility to analyze the vital characteristics of signals and systems in time- and frequency-domain makes it an inevitable module of engineering practice.

Course Content Details:

Brief Review of Transforms: Introduction to sampling theorem, Concept of frequency in continuous-time and discrete-time signals, Brief details about Laplace-transform, z-transform, CTFT, DTFT and DFT, decimation-in-time and decimation-in-frequency FFT algorithms.

Discrete-time Signals' and Systems' Frequency Response Analysis: Power density spectrum of periodic signals, Energy density spectrum of aperiodic signals, Cepstrum, Concept of bandwidth, LTI systems as frequency-selective filters (LPF, HPF, BPF, digital resonators, notch filters, comb filters and all pass filters), inverse systems and deconvolution.

Implementation of Discrete-time Systems: LTI systems characterized by constant-coefficient difference equations and their impulse response attributes. Structures for FIR systems, Structures for IIR systems, Recursive and nonrecursive realizations, Linear filtering methods based on DFT, and Goertzel algorithm.

Design of FIR Filters: Causality and its implications, Characteristics of practical frequencyselective filters, Symmetric and antisymmetric FIR filters, Design of linear-phase FIR filters using window method (Hamming, Hanning, Kaiser etc.), Design of FIR filters using frequencysampling method.

Design of IIR Filters: Characteristics of commonly used analog filters, Design of IIR filters from analog filters by approximation of derivatives, Design by impulse invariance, Design by bilinear transformation.

Multirate Signal Processing: Decimation by a factor D , Interpolation by a factor I , Sampling rate conversion by a rational factor I/D , Polyphase filter structures for decimation and interpolation, sampling rate conversion with cascaded integrator comb filters, Introduction to digital filter banks.

Optimum Filtering and Equalization: Wiener filtering, Linear prediction and Concept of equalization.

Familiarization with Standards: *IEEE 265-1966, IEEE 1057-2007, ISO/IEC 11172-3.*

Laboratory Work: MATLAB software based lab practicals related to DSP and its applications.

Micro-Project/Assignment: To be assigned by concerned instructor/course-coordinator.

Course Learning Outcomes (CLOs): The students will be able to

- 1 analyze discrete-time signals and systems in frequency-domain.
- 2 employ linear time-invariant systems for discrete-time signal processing.
- 3 design and implement FIR frequency-selective filters.
- 4 design and implement IIR frequency-selective filters
- 5 tackle engineering system problems using multirate signal processing and optimum filtering approaches

Text Books:

1. D.G. Manolakis and J.G. Proakis, Digital Signal Processing: Principles, Algorithms, and Applications. 4th ed., India: Pearson Education (Paperback), 2007.
2. A.V. Oppenheim, R.W. Schaffer, and J.R. Buck, Discrete-time Signal Processing. 2nd ed., India: Pearson Education (Paperback), 2007.

Reference Books:

1. V.K. Ingle and J.G. Proakis, Digital Signal Processing using MATLAB. 2nd ed., India: Thomson Learning, 2007.
2. S. Salivahanan and A. Vallavaraj, Digital Signal Processing. 2nd ed., New York, U.S.A.: Tata McGraw-Hill, 2011.

Evaluation Scheme:

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

UEC512: LINEAR INTEGRATED CIRCUITS AND APPLICATIONS

L	T	P	Cr
3	0	2	4.0

Course Objectives: To enhance comprehension capabilities of students through understanding of operational amplifiers, frequency response, various applications of operational amplifiers, active filters, oscillators, analog to digital and digital to analog converters and few special function integrated circuits.

Introduction to Differential Amplifiers: Differential Amplifier, configurations of differential amplifier, Analysis of single input balanced output, single input unbalanced output, dual input balanced output and dual input unbalanced output differential amplifiers

Operational amplifier: various characteristics of op-amp, CMRR, PSRR, Internal structure of Op-amp, Ideal Op-amp. Inverting and Non-Inverting Configuration, Ideal Open-Loop and Closed-Loop Operation of Op-Amp, Feedback Configurations: Voltage-Series Feedback Amplifier, Voltage-Shunt Feedback Amplifier, Differential Amplifiers with One & Two Op-Amps

Frequency Response of an Op-Amp: Introduction to Frequency Response, Compensating Networks, Frequency Response of Internally Compensated Op-Amp, Frequency response of Non-compensated Op-Amp, Closed-Loop Frequency Response.

General Applications: DC & AC Amplifiers, Peaking Amplifier, Summing, Scaling and Averaging amplifier, Instrumentation Amplifier, The Integrator, The Differentiator, Log and Antilog Amplifier, Comparator, Zero Crossing Detector, Schmitt Trigger, Sample and Hold Circuit, Clippers and Clampers etc.

Active Filters and Oscillators: Butterworth Filters, Band-Pass Filters, Band Reject Filters, All Pass Filters, Phase Shift Oscillator, Wien Bridge Oscillator, Voltage-Controlled Oscillator (VCO), Square Wave Generator.

Specialized IC Applications: Introduction, The 555 Timer, Monostable and Astable Multivibrator using IC 555, Phase-Locked Loop (PLL), Voltage Regulators.

Familiarization with Standards: *IEEE 165-1977.*

Laboratory Work: Inverting and Non Inverting Characteristics of an Op-Amp, Measurement of Op-amp parameters, Op-amp as integrator & differentiator, comparator, Schmitt trigger, Converter (ADC, DAC), square wave generator, Sawtooth waveform generator, precision half wave and full wave rectifiers, log-antilog amplifier, 555 as an astable, monostable and bi-stable multivibrators, active filters.

Course Learning Outcomes (CLOs): The student will be able to:

1. know the importance and significance of Op-Amp.
2. apply the concepts in real time applications.
3. design Integrators, Differentiators, and Comparators using Op-Amp.
4. use Op-Amp to generate Sine and Square wave forms.
5. design active filters and oscillators using Op-Amp.
6. use IC 555 as an astable, monostable and bi-stable multivibrators.

Text Books:

1. Ramakant A. Gayakwad, 'OP-AMP and Linear IC's', Prentice Hal, 1999.
2. Sergio Franco, 'Design with operational amplifiers and analog integrated circuits', McGraw-Hill, 2002.

Reference Books:

1. D. Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 2000.
2. J. Michael Jacob, 'Applications and Design with Analog Integrated Circuits', Prentice Hall of India, 2002.

Evaluation Scheme:

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

UEC509: COMPUTER ARCHITECTURE

L	T	P	Cr
3	1	0	3.5

Course Objectives: To introduce the concept of 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 interfacing of I/O structures using interrupts and to enhance the student's ability to evaluate performance of these machines by using evaluation methods like CPU time Equation, MIPS rating and Amdahl's law.

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

Instruction Set Principles: Classification of Instruction set architectures, Memory Addressing, Operations in the instruction set, Type and Size of operands, Encoding an Instruction set, Program Execution, Role of registers, Evaluation stacks and data buffers, The role of compilers, The DLX Architecture, Addressing modes of DLX architecture, Instruction format, DLX operations, Effectiveness of DLX.

Pipelining and Parallelism: Idea of pipelining, The basic pipeline for DLX, Pipeline Hazards, Data hazards, Control Hazards, Design issues of Pipeline Implementation, Multicycle operations, The MIPS pipeline, 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.

Memory Hierarchy Design: Introduction, Cache memory, Cache Organization, Write Policies, Reducing Cache Misses, Cache Associatively 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.

Multiprocessors: Characteristics of Multiprocessor Architectures, Centralized Shared Memory Architectures, Distributed Shared Memory Architectures, Synchronization, Models of Memory Consistency.

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.

Familiarization with standards: *IEEE P802.11, ANSI/IEEE standard 754.*

Course Learning Outcomes (CLO S): The students will be able to:

1. Understand and analyze a RISC based processor.
2. Understand the concept of parallelism and pipelining.
3. Evaluate the performance of a RISC based machine with an enhancement applied and make a decision about applicability of that respective enhancement as a design engineer.
4. Understand the memory hierarchy design and optimise the same for best results. Understand how input/output devices can be interfaced to a processor in serial or parallel with their priority of access defined.

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*, McGraw-Hill (2002) 2nd ed.

Reference Books:

1. Murdocca, M. J. and Heuring, V.P., *Principles of Computer Architecture*, Prentice Hall (1999) 3rd ed.
2. Stephen, A.S., Halstead, R. H., *Computation Structure*, MIT Press (1999) 2nd ed.

Evaluation Scheme:

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

UCS411: ARTIFICIAL INTELLIGENCE

L	T	P	Cr
3	0	2	4.0

Course Objectives: To be familiar with the applicability, strengths, and weaknesses of the basic knowledge representation, problem solving, machine learning, knowledge acquisition and learning methods in solving particular engineering problems.

Overview: foundations, scope, problems, and approaches of AI.

Intelligent agents: reactive, deliberative, goal-driven, utility-driven, and learning agents.

Problem-solving through Search: forward and backward, state-space, blind, heuristic, problem-reduction, A, A*, AO*, minimax, constraint propagation, neural, stochastic, and evolutionary search algorithms, sample applications.

Knowledge Representation and Reasoning: ontologies, foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, sample applications.

Planning: Planning as search, partial order planning, construction and use of planning graphs, existing expert systems like MYCIN, RI, Expert system shells.

Representing and Reasoning with Uncertain Knowledge: probability, connection to logic, independence, Bayes rule, Bayesian networks, probabilistic inference, sample applications. Decision-Making: basics of utility theory, decision theory, sequential decision problems, elementary game theory, sample applications.

Machine Learning and Knowledge Acquisition: learning from memorization, examples, explanation, and exploration. Learning nearest neighbor, naive Bayes, and decision tree classifiers, Q-learning for learning action policies, applications.

Languages for AI problem solving: Introduction to PROLOG syntax and data structures, representing objects and relationships, built-in predicates. Introduction to LISP- Basic and intermediate LISP programming.

Expert Systems: Architecture of an expert system.

Laboratory work: Programming in C/C++/Java/LISP/PROLOG: 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, Designing expert system using logic in PROLOG, Implementing an intelligent agent.

Course Learning Outcomes (CLOs) / Course Objectives (COs): After the completion of the course, the student will be able to:

1. Learn the basics and applications of artificial intelligence and categorize various problem domains, basic knowledge representation and reasoning methods.

2. Analyze basic and advanced search techniques including game playing, evolutionary search algorithms, and constraint satisfaction.
3. Learn and design intelligent agents for concrete computational problems.
4. Understand and implement the basic concepts of programming languages like Prolog and LISP.
5. Acquire knowledge about the architecture of an expert system and design new expert systems for real life applications.

Text Books:

1. Rich E., Knight K. and Nair B. S., Artificial Intelligence, Tata McGraw Hills (2009) 3rd ed.
2. Luger F. G., Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson Education Asia (2009) 6th ed.

Reference Books:

1. Patterson W. D., Introduction to Artificial Intelligence and Expert Systems, Pearson (2015) 1st ed.
2. Russel S., Norvig P., Artificial Intelligence: A Modern Approach, Prentice Hall (2014) 3rd ed.

Evaluation Scheme:

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

ELECTIVE - I

UEC859: INTEGRATED SYSTEM DESIGN

L T P Cr

3 0 2 4.0

Course Objective: To enhance comprehension capabilities of students through understanding on the use of VHDL and Verilog for the design, synthesis, modeling, and testing of VLSI devices. These are IEEE standards that are used by engineers to efficiently design and analyze complex digital designs.

Basic Digital Circuits: Lexical Elements and data types, program skeleton, structural, dataflow and behavioural descriptions, testbench.

RTL Combinational circuit: Operators, Block statement, Concurrent assignment statements, Modelling with a process, Routing circuit with if and case statements, Constants and Generics

Regular Sequential Circuit: HDL code of Flip flops and Registers, simple design examples, testbench for sequential circuits, case study

FSM: Mealy and Moore FSMs, Design Examples

Synthesis: Register Transfer level description, Timing and Clock Constraints, technology libraries, Translation, Boolean optimization, Factoring, Mapping to gates

Xilinx FPGA Implementation Memory: Method to incorporate memory modules, HDL templates for memory interface

Familiarization with standards: *IEEE 1164-1993, IEEE 1076-2019.*

Laboratory Work: Modeling and simulation of all VHDL and Verilog constructs using ModelSim, their testing by modeling and simulating test benches, Logic Synthesis using FPGA Advantage, Mapping on FPGA Boards.

Micro Project: Design & Simulate a digital system in VHDL or Verilog and its implementation on FPGA board.

Course Learning Outcomes (CLOs): The student will be able to:

1. Build a synchronous system in hdl and verify its performance.
2. Build and test complex FSMs
3. Automate testbenches for automatic pass/fail
4. Make design decisions for fixed point implementations given constraints
5. Analyse memory usage/requirements for FPGA
6. Target sequential designs to FPGA

Text Books:

1. Bhaskar, J., *A VHDL Primer, Pearson Education/ Prentice Hall (2006) 3rd Ed.*
2. Palnitkar, Samir, *Verilog HDL, Prentice Hall, 2nd Edition,*

Reference Books:

1. Ashenden, P., *The Designer's Guide To VHDL*, Elsevier (2008) 3rd Ed.
2. Donald E. Thomas, Philip R. Moorby, Donald B. Thomas, *The Verilog HDL*, Kluwer Academic Publication, 5th Edition, 2002,
3. Chu Pong P., *FPGA Prototyping by VHDL / Verilog Examples*, Wiley (2008)

Evaluation Scheme:

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

UEC: DATA COMMUNICATION

L	T	P	Cr
3	0	2	4.0

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

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

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

Data link layer: Types of errors, Detection, Error correction, Flow and error control, Stop and wait ARQ, go back n ARQ, Selective repeat ARQ, HDLC, point to point protocol, PPP stack, Random access, Controlled access, Channelization, IEEE Standards: 802.3 to 802.6, 802.11 and 802.15.4; FDDI, Bluetooth; Telephone networks, DSL technology, Cable modem, SONET/SDH. Connecting devices, Backbone network, Virtual LAN, Cellular telephony, Satellite networks.

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

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

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

Switching: Introduction to Virtual circuit switching including frame relay, X.25, ATM and Softswitch Architecture, Packet switching, Message Switching.

Familiarization with standards: *IEEE 802.3 to 802.6 and 802.11, IEEE/ISO/IEC 8802-15-6-2017, IEEE 802.1CS-2020.*

Laboratory Work

Simulation experiments for protocol performance, configuring, testing and measuring network devices and parameters/policies; network management experiments; Exercises in network programming.

Course Learning Outcomes (CLO): Upon completion of this course, the student will be able to:

1. Understand the layered architecture of Internet's reference models: OSI & TCP/IP and basis of physical layer and media.
2. Acquire knowledge about design issues, framing, error detection and correction, channel allocation techniques and link layer protocols.
3. Identify various routing algorithms, elements of transport protocols, congestion control, QOS, internetworking, IP and IP addressing mechanism.
4. Design a network topology with the available networking elements and can implement a routing protocol along with a secure mechanism ensuring the error free transmission of data.
5. Outline various communication applications like email, web browser, familiarization with cryptography and network security.

Text Books:

1. *Ferouzan, Behrouz A., Data Communications and Networking, TATA McGraw Hill (2017) 5th Edition.*
2. *Tanenbaum, Andrew S., Computer Networks, PHI (2013) 5th Edition.*
3. *D. Gross and C. Harris, Fundamentals of Queueing Theory, 3rd Edition, Wiley, 1998. (WSE Edition, 2004).*

Reference Books:

1. *Stallings William, Data and Computer Communication, Pearson Education (2017) 10th Edition.*
2. *James F. Kurose, Computer networking: A top-down approach, Pearson Education (2017), 6th Edition.*
3. *Athanasios Papoulis, Probability Random Variables and Stochastic Processes, McGraw-Hill (2002), 4th Edition.*

Evaluation Scheme:

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

UCS613: DATA STRUCTURES AND ALGORITHMS

L	T	P	Cr
3	0	2	4.0

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

Linear data structures: arrays, records, strings and string processing, references and aliasing, linked lists, strategies for choosing the appropriate data structure, abstract data types and their implementation: stacks, queues, priority queues, sets, maps.

Basic Analysis: Differences among best, expected, and worst case behaviors of an algorithm, Asymptotic analysis of upper and expected complexity bounds, Big O notation: formal definition and use, Little o, big omega and big theta notation, Complexity classes, such as constant, logarithmic, linear, quadratic, and exponential, Time and space trade-offs in algorithms, Recurrence relations, Analysis of iterative and recursive algorithms.

Searching and Sorting: Linear Search, Binary Search, Bubble Sort, Selection Sort, Insertion Sort, Shell Sort, Quick Sort, Heap Sort, Merge Sort, Counting Sort, Radix Sort.

Algorithmic Strategies with examples and problem solving: Brute-force algorithms with examples, Greedy algorithms with examples, Divide-and-conquer algorithms with examples, Recursive backtracking, Dynamic Programming with examples, Branch-and-bound with examples, Heuristics, Reduction: transform-and-conquer with examples.

Non-Linear Data Structures And Sorting Algorithms: Hash tables, including strategies for avoiding and resolving collisions, Binary search trees, Common operations on binary search trees such as select min, max, insert, delete, iterate over tree, Graphs and graph algorithms, Representations of graphs, Depth- and breadth-first traversals, Heaps, Graphs and graph algorithms, Shortest-path algorithms (Dijkstra and Floyd), Minimum spanning tree (Prim and Kruskal).

Problem Clauses: P, NP, NP- Hard and NP-complete, deterministic and non-deterministic polynomial time algorithm approximation and algorithm for some NP complete problems. Introduction to parallel algorithms, Genetic algorithms, intelligent algorithms.

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

Project: It will contain a Project which should include designing a new data structure/algorithm/ language/tool to solve new problems & implementation. It can also involve creating visualizations for the existing data structures and algorithms. Quantum of project should reflect at least 60 hours of Work excluding any learning for the new techniques and technologies. It should be given to group of 2-4 students. Project should have continuous evaluation and should be spread over different components. There should be a formal project

report. Evaluation components may include a poster, video presentation as well as concept of peer evaluation and reflection component.

Course learning outcome (CLOs): The students will be able to

1. Implement the basic data structures and solve problems using fundamental algorithms.
2. Implement various search and sorting techniques.
3. Analyze the complexity of algorithms, to provide justification for that selection, and to implement the algorithm in a particular context.
4. Analyse, evaluate and choose appropriate data structure and algorithmic technique to solve real-world problems.

Text Books:

1. *Corman, Leiserson & Rivest, Introduction to Algorithms, MIT Press (2009), 3rd Ed.*
2. *Narasimha Karumanchi, Data Structures and Algorithms Made Easy” (2014), 2nd Ed.*

Reference Books:

1. *Sahni, Sartaj, Data Structures, Algorithms and Applications in C++, Universities Press (2005), 2nd ed.*

Evaluation Scheme:

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

UEC855 - AUDIO & SPEECH PROCESSING

L T P Cr
3 0 2 4.0

Course Objective: To provide students with the knowledge of basic characteristics of speech signal in relation to production and hearing of speech by humans. To describe basic algorithms of speech analysis common to many applications. To give an overview of applications (recognition, synthesis, coding) and to inform about practical aspects of speech algorithms implementation.

Introduction: Review of digital signal and systems, transform representation of signal and systems, Sampling Theorem, Digital filters and filter banks.

Digital Models for Speech signals: Speech production and acoustic tube modeling, acoustic phonetics, anatomy and physiology of the vocal tract and ear, hearing and perception.

Digital Representation: Linear quantization, companding, optimum quantization, pulse code modulation (PCM), effects of channel errors, vector quantization (VQ), adaptive quantization, differential PCM, APCM vs. ADPCM, delta modulation, adaptive delta modulation, and CVSD.

Digital Vocoders: Linear predictive coding (LPC), hybrid coders: voice excited vocoders, voice excited linear predictor, and residual excited linear predictor (RELPE).

Speech Recognition: Isolated word recognition, continuous speech recognition, speaker (in) dependent, measures and distances (articulation index, log spectral distortion, Itakura-Saito, cepstral distance), dynamic time warping (DTW), HMM, HMM networks, Viterbi algorithm, discrete and continuous observation density HMMs.

Speaker recognition: speaker verification/authentication vs. speaker identification, closed vs. open set, feature vectors (e.g., line spectrum pair and cepstrum), pattern matching (e.g., DTW, VQ, HMM), hypothesis testing, and errors.

Advanced Topics: Emerging speech coding standards (e.g., 2400 bps MELP), Internet phone, voice and multimedia applications.

Familiarization with standards: *IEEE 1857.5-2015, MELP.*

Course Learning Outcomes (CLOs):

The student will be able to:

1. Model speech signals and represent them digitally.
2. Analyse and design digital vocoders
3. analyse speech and speaker recognition systems
4. Understand latest and advanced topics in audio and speech processing

Text Books:

1. *Deller, J., Proakis, J. and Hansen, J., Discrete-Time Processing of Speech Signals, IEEE(1993).*
2. *Rabiner, L. and Schafer, R., Digital Processing of Speech Signals. Signal Processing, Prentice-Hall (1978).*

Reference Books:

1. *Borden, G. and Harris, K., Speech Science Primer, 2nd Edition, Williams and Wilkins,(2006).*
2. *Furui, S., Digital Speech Processing, Synthesis and Recognition, CRC (2001).*
3. *Owens, F. J, Signal Processing of Speech, McGraw-Hill (1993).*

4. *Parsons, T., Voice and Speech Processing: Communications and Signal Processing,*
5. *McGraw-Hill (1986).*

Evaluation Scheme:

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

SEMESTER – VI

UEC607: DIGITAL COMMUNICATION

L	T	P	Cr
3	0	2	4.0

Course Objectives: The aim of this course is to build the foundation for communication system design focusing on the challenges of digital communication. The intended objective is to impart knowledge to the engineering students about the transmission/reception of data over physical layer through any channel. They will be able to identify the physical interpretation of mathematical expressions/modelling, while dealing with communication systems in the presence of noise, interference and fading.

Introduction to Pulse Modulation Systems: Basic model of digital communication system, Bandpass and lowpass signal and system representations, lowpass equivalent of bandpass signals, Sampling theorem for baseband and bandpass signals, quantization, companding, signal reconstruction filter, Shannon-Hartley channel capacity theorem, Bandwidth – SNR tradeoff and bounds, Difference between analog pulse modulation and digital pulse modulation techniques, Details about PCM, Differential-PCM, DM, Adaptive-DM, time-division-multiplexed system (T- & E-type), and output SNR calculations.

Digital Formats and Baseband Shaping for Data Transmission: NRZ, RZ, Manchester formats, Power spectra of discrete-PAM signals, ISI, Nyquist's criterion for distortionless baseband transmission with ideal and practical solutions, generalized correlative coding and its types, and eye pattern.

Fundamentals of Detection and Estimation: Gram-Schmidt orthogonalization procedure, MAP criterion, maximum likelihood (ML) decision rule, Correlator and Matched filter receiver structures, ML estimation procedure, probability of bit-error & symbol-error calculations for digital modulation techniques under AWGN channel.

Digital Modulation Schemes With & Without Memory: Details about Binary-ASK, BFSK, BPSK, QPSK, M-ary ASK, M-ary FSK, M-ary PSK, M-ary QAM; MSK, generalized continuous-phase-FSK; Differential-PSK, phase-locked-loop, and carrier recovery procedures

Coding Aspects: Block-code generation, its types and decoding procedures, convolutional code generation, its types and Viterbi decoding procedure, error detection and correction concepts in decoding.

Multiple Access Techniques: Brief introduction about TDMA, FDMA, WDMA, CDMA, and OFDM systems.

Familiarization with standard: *IEEE P802.11.*

Laboratory Work: Practical/experiments based on the hardware using communication kits, and simulation with the help of available simulation packages.

Course Learning Outcomes:

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

1. Evaluate different modulation techniques in the presence of AWGN working under the various capacity constraints.
2. Incorporate digital formats and M-ary baseband modulations to improve bandwidth efficiency.
3. Perform statistical analysis of the transmitted and received modulated waveforms from estimation and detection point of view.
4. Improve the overall performance of digital communication systems by interference suppression/ excision and by implementing the signal-to-noise-ratio enhancement techniques.
5. Analyze the concepts of correlative coding and channel coding to mitigate the effects of interference and noise in the channel.

Text Books:

1. John G. Proakis, Masoud Salehi, Communication System Engineering, PHI, 2nd Edition, 2002
2. John G Proakis, Digital Communications, McGraw-Hill, Third Edition (1994)
3. Simon Haykin, Digital Communications, Wiley, Student Edition (1988)
4. Bernard Sklar, Digital Communications: Fundamentals and Applications, Prentice Hall (2001)

Reference Books:

1. *Taub & Schilling, Principles of Communication Systems, McGraw-Hill Publications, Second Edition (1998)*
2. *Simon Haykin, Communication Systems, Wiley, Fourth Edition (2006)*
3. *B.P. Lathi, Modern Analog and Digital Communication Systems, Oxford University Press, Third Edition (1998)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	45
3.	Sessional (<i>Including lab, assignments, quiz & micro-project etc.</i>)	30

UEC747: ANTENNA AND WAVE PROPAGATION

L	T	P	Cr
3	0	2	4.0

Course Objective: Students will be able to understand vector theory, antenna basic parameters, linear wire antennas, antenna arrays and their patterns, folded dipole, Yagi Uda, loop and Microstrip antenna, wave propagation over ground, through troposphere and ionosphere.

Review of vector theory: Vector algebra, Cartesian coordinate system, dot product, cross product, and other coordinate systems.

Introduction to Basic Antenna parameters: Radiation pattern, Radiation intensity, Beam width, Gain, Directivity, Polarization, Bandwidth, Efficiency, Side lobes, Side lobe level, Antenna Vector Effective Length and Equivalent Areas, Maximum Directivity and Maximum Effective Area, Friss Transmission Equation and Radar Range Equation, Plane wave and Properties of uniform plane waves.

Radiation Integrals and Auxiliary Potential Functions: Retarded vector and scalar potential, Vector Potential A for an Electric Current Source J, Vector Potential F for a Magnetic Current Source M, Electric and Magnetic Fields for Electric (J) and Magnetic (M) Current Sources.

Linear Wire Antennas: Radiation from an infinitesimal small current element, Radiation from an elementary dipole (Hertzian dipole), Small Dipole, Finite length dipole, half wave dipole, Linear Elements Near or on Infinite Perfect Conductors, Monopole antenna, folded dipole and Yagi Uda antenna.

Antenna Arrays: Two-Element Array, Broadside arrays, End fire arrays. N-Element Linear Array: Uniform Amplitude and Spacing, N-Element Linear Array: Directivity, N-Element Linear Array: Uniform Spacing, Non uniform Amplitude, Binomial Array, Chebyshev Arrays, Principle of pattern multiplication. Array pattern Synthesis.

Microstrip Antennas: Microstrip Antennas & their advantages, Media: Dielectric effect, Dielectric Loss Tangent- $\tan \delta$, Substrates,

Propagation of Radio Waves: Different modes of propagation: Ground waves, Space waves, Space wave propagation over flat and curved earth, Surface waves and Troposphere waves, Wave propagation in the Ionosphere, Critical frequency, Maximum usable frequency (MUF), Skip distance, Virtual height

Familiarization with Standards: *IEEE 145-2013, IEEE 1502-2007 and IEEE 211-1997.*

Laboratory Work: Drive antenna by voltage, Radiation pattern of half wave dipole, Radiation pattern of monopole, Effective height of antenna, Radiation pattern of capacitance and inductive loaded antenna, Directional radiation from two composite antennas, Radiation from conducting sheet with slot, Matching stub in antenna, Measure the SWR, Radiation polar diagram of directional antenna.

Course Learning Outcomes (CLOs): The student will be able to:

1. identify basic antenna parameters
2. design and analyze wire antennas
3. design and analyze antenna arrays
4. to identify characteristics of radio wave propagation
5. perform various antenna measurements

Text Books:

1. *Antenna Theory, Ballanis, John Wiley & Sons, 2003.*
2. *Antennas and Radio Propagation, Collins, R. E, McGraw-Hill, 1987.*

Reference Books:

1. *Antennas, Kraus and Ronalatory Marhefka, John D., Tata McGraw-Hill, 2002.*
2. *Microwave & RF Design, Michael Steer, Sci.Tech Publishing, 2009.*

Evaluation Scheme:

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

UEC750: MOS CIRCUIT DESIGN

L	T	P	Cr
3	1	2	4.5

Course objective: The course aims to present the principles and techniques of both MOS based digital and analog circuit design, connecting digital circuits, logic design, and analog components with the fundamental device physics, processing techniques and transistor level characteristics of Silicon integrated circuits, both in theoretical and practical aspects.

MOS Transistor Theory: MOS Structure and its operation, I-V Characteristics, Threshold Voltage Equation, Body Effect, Second Order Effects, Scaling Theory and Limitations of Scaling, Short-Channel Effects, MOS Device Models, Small Signal operation and Equivalent Circuit of MOS Transistor, MOS Capacitors, MOS switch, Noise in MOS transistors.

NMOS & CMOS Process technology: Evolution of ICs. Masking sequence of NMOS and CMOS Structures, Latch up in CMOS, Electrical Design Rules, Stick Diagram, Layout Design.

Circuit Characterization: Resistive Load & Active Load MOS Inverters, NMOS Inverters, CMOS Inverters : Static Characteristics, Switching Characteristics, Interconnect Parasitics, Propagation Delay, Static and Dynamic Power Dissipation, Noise Margin, Logic Threshold Voltage, Logical effort, Driving large loads.

Combinational Circuits: MOS Logic Circuits with Depletion NMOS loads, CMOS Logic Circuits, CMOS logic Styles, Realization of simple gates, Complex logic circuits, Pass Gate, Transmission Gate.

Operation of MOS Circuits: Behaviour of MOS Circuits at DC, MOS as an Amplifier, Calculation of the DC Bias Point, Voltage Gain, Transconductance, T Equivalent Circuit Model, Modeling the Body Effect, Biasing of Discrete MOS Amplifiers and Integrated Circuit MOS Amplifiers.

Familiarization with standard: *IEEE 1181-1991.*

Laboratory Work:

Familiarization with Circuit design/simulation tools (Cadence/Mentor/Tanner Tools) for schematic and layout entry, Circuit simulation using SPICE. DC transfer Characteristics of Inverters, Transient response, Calculating propagation delays, rise and fall times, Circuit design of inverters, Complex gates with given constraints.

Course Learning Outcomes (CLO):

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

1. Use MOS structures in basic digital and analog circuits.
2. Describe the general processing steps required to fabricate an integrated circuit.
3. Analyse the fundamental static and dynamic performance of CMOS inverter.
4. Analyse the fundamental static and dynamic performance of logic gates with given constraints.
5. Implement various CMOS logic circuits.
6. Design simple circuits to meet stated operating specifications.

Text Books:

1. Kang ,Sung-Mo (Steve) &Leblebici, Yusuf., *CMOS Digital Integrated Circuits Analysis & Design*, McGraw Hill, (1999) 2nd ed.
2. A. S. Sedra and K. C. Smith, *Microelectronic Circuits*. 4th ed. New York, NY: Oxford University Press, 1998.

Reference Books:

1. Gregorian, R. and Temes, G.C., *Analog MOS Integrated Circuits for Signal Processing*, John Wiley (2004).
2. Jan Rabaey, A. Chandrakasan&Nikolic, B., *Digital Integrated Circuits – A Design Perspective*, Pearson, (2003) 2nd ed.
3. *CMOS VLSI Design: A Circuits and Systems Perspective*, 4th ed., Neil Weste and David Harris, Pearson Addison Wesley, 2011.
4. Pucknell D. A., &Eshraghian, K., *Basic VLSI Design*, Prentice Hall of India, (2007) 3rd ed.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessional (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UEC804: WIRELESS AND MOBILE COMMUNICATION

L	T	P	Cr
2	1	2	3.5

Course Objective: To impart knowledge about wireless communication systems and related design parameters to undergraduate students. To inculcate ability in students to design wireless communication systems, which can provide high data rate to a large number of users. The main goal is to utilize the concepts of analog/digital modulation techniques and signal processing in transmission and reception of wireless signals under static and dynamic channels, in the presence of noise.

Introduction to Wireless Communication Systems:History of Wireless Communication and Future Trends, Narrowband, Wideband, Ultra-Wideband Communication Systems, Description of 2G, 3G, 4G and Hybrid Communication Systems, Brief Introduction of Digital Modulation Techniques Like M-ary QAM and GMSK.

Cellular Concepts and System Design Fundamentals:Introduction to Cellular Concepts and Cellular System Design Fundamentals, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference and System Capacity, Trunking and Grade of Service, Cell Splitting, Sectoring, Repeaters and Microcell Zone Concepts.

Mobile Radio Propagation and Fading: Introduction to Radio Wave Propagation, Free Space Propagation Model, Large-Scale Path Loss due to Reflection, Diffraction and Scattering, Practical Link Budget Design using Path Loss Models, Outdoor Propagation Models, Indoor Propagation Models, Signal Penetration into Buildings, Ray-Tracing and Site Specific Modelling; Small-Scale Fading and Multipath Propagation, Impulse Response Model of Multipath Channels, Parameters and Statistics, Doubly-Selective Wireless Fading Channels and Theory of Multipath Shape Factors, Nakagami-m Fading Channel Model.

Multiple Access Techniques for Wireless Communications: Time-Division Multiple Access, Frequency-Division Multiple Access, Code-Division Multiple Access (DS-SS, WCDMA, Frequency-Hopped Spread Spectrum), Orthogonal-Frequency-Division Multiple Access, Space-Division Multiple Access and Multi-Carrier Communication Systems. Capacity and Probability of Symbol Error Calculations.

Equalization, Diversity and Channel Coding:Linear and Nonlinear Equalizers (Zero-Forcing and MMSE), Fractionally Spaced Equalizers, Wireless Diversity Techniques, RAKE Receiver, Brief Introduction of Channel Coding- Trellis Coding and Turbo-Coding, Interleaving and Viterbi Decoder.

Advanced Wireless Communication Systems: Brief Introduction of GSM Architecture, MIMO, STBC, STTC, BLAST Architectures, Cognitive Radio, Software Defined Radio and Reconfigurable-Hardware Applications in Wireless Communication Systems.

Familiarization with standards: *IEEE 802.11-2007, IEEE 802.16-2001 and IEEE 802.16e-2005.*

Laboratory Work: Minor Project, Experiments based on Contemporary Hardware and Software Tools (MATLAB).

Course Learning Outcomes (CLOs):

The student will be able to:

1. Model Time-Invariant and Time-Variant Multipath Fading Channels
2. Use Different Multiple Access Communication Strategies to Enhance System Capacity
3. Use Equalization and Coding Schemes to Control Bit Error Rate
4. Use Various Wireless Diversity and Reception Techniques to Improve Signal to Noise Ratio
5. Design High Data-Rate Indoor and Outdoor Wireless Communication Systems

Text Books:

1. Rappaport, T.S., *Wireless Communication-Principles and Practice*, Pearson, (2000) 2nd Edition.
2. Haykin S & Moher M., *Modern Wireless Communication*, Pearson, (2005) 3rd Edition.

Reference Books:

1. Lee, William C. Y., *Mobile Communication Design and Fundamentals*, (1999) 4th Edition.
2. Pandya, R., *Mobile and Personal Communication System*, PHI (2002) 5th Edition.
3. *IEEE Journal on Selected Areas in Communications*
4. *IEEE Communications Magazine*

Evaluation Scheme:

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

ELECTIVE - II

UEC748: VIDEO SIGNAL PROCESSING

L T P Cr
3 0 2 4.0

Course Objective: To make students acquainted with state-of-the-art video processing techniques, their technical details and challenges. To develop algorithms for video compression.

Introduction: Video formats, Capturing of video signals, Color space, Quality.

Video Compression: Introduction to H.264 & HEVC, H.264 encoding and decoding process, H.264 Profiles and Levels .

Prediction and Transform Model: Macroblock prediction, Intra and Inter prediction, Loop filter, Transform and Quantization, Block scan orders.

H.264 Standardization Process: Conforming, Transport support, Licensing.

Advanced Topics: Scalable video coding, Multiview video coding, reconfigurable video coding.

Familiarization with standards: *IEEE 1857-2013, IEEE H.264/AVC video coding standard.*

Laboratory work and Project: Students have to write MATLAB® programs for dividing raw video into frames, divide them into macroblocks. Compression of macroblock and reframing the video. Various operations on video frames. Introduction to Video Processor.

Course Learning Outcomes (CLOs):

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

1. Understand video formats and color spaces.
2. Understand video prediction model and compression.
3. Understand standardization process.
4. Get acquaintance state-of-the-art video topics.

Text Books:

1. *Iain E. Richardson, THE H.264 ADVANCED VIDEO COMPRESSION STANDARD, John Wiley and Sons, Ltd., 2003.*

Reference Books:

1. *Alan C. Bovik, The Essential Guide to Video Processing, Academic Press; 2009*
2. *J. W. Woods, Multidimensional Signal, Image, and Video Processing and Coding, Academic Press, 2011.*

Evaluation Scheme:

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

	Quizes/Lab Evaluations)	
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Course Objective: To have a deep understanding of two important, emerging network technologies: Software Defined Networking (SDN) and Network Functions Virtualization (NFV). Use SDN emulator (Mininet) to set up and test network topologies.

Software Defined Network: History of programmable networks and Evolution of Software Defined Networking (SDN), IETF Forces, Active Networking. Separation of Control and Data Plane - Concepts, Advantages and Disadvantages, OpenFlow, protocol, 4D network architecture. Traditional Networking versus SDN.

Control & Data Plane: Overview, distributed and centralized control plane & data plane. Control plane: Existing SDN Controllers including Floodlight and Open Daylight projects. Customization of Control Plane: Switching and Firewall. Data Plane: Software-based and Hardware-based; Programmable Network Hardware.

Network Virtualization: Concepts, Applications, Existing Network Virtualization Framework (VMWare and others), Network Functions Virtualization (NFV) and Software Defined Networks: Concepts, Implementation and Applications.

Network Programmability: Introduction, Northbound Application Programming Interface, Current Languages and Tools.

Data Center Networks: Packet, Optical and Wireless Architectures Network Topologies

Use Cases of SDNs: Data Centers, Internet Exchange Points, Backbone Networks, Home Networks, Traffic Engineering.

Familiarization with standard: *IEEE P1916.1, P1915.1, P1917.1.*

Laboratory Work:

1. Set up and get familiar with SDN emulator – Mininet and set up a virtual network
2. Basic mininet operations
3. Manually control the switch
4. Move the rules to SDN controller
5. Set different forwarding rules for each switch in the controller

Course Learning Outcomes (CLO): The student will be able to:

1. Understand the SDN architecture and analyse the advantages of programmable networks over traditional networks
2. Analyse the SDN layers and plane oriented view, decoupled control plane and data plane
3. Understand network virtualization , Network Functions Virtualization components and how they work together
4. Apply the SDN and NVF concepts to analyse use case like data center network and others
5. Design and implement networking problems using SDN-friendly network emulator.

Text Books:

1. SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies, By Thomas D. Nadeau, Ken Gray Publisher: O'Reilly Media, August 2013, ISBN: 978- 1-4493-4230-2, ISBN 10:1-4493-4230-2.
2. Software Defined Networks: A Comprehensive Approach, by Paul Goransson and Chuck Black, Morgan Kaufmann, June 2014, Print Book ISBN: 9780124166752, eBook ISBN : 9780124166844

Reference Books:

1. Network Innovation through OpenFlow and SDN: Principles and Design, Edited by Fei Hu, CRC Press, ISBN-10: 1466572094, 2014.
2. Doherty, Jim. SDN and NFV simplified: a visual guide to understanding software defined networks and network function virtualization. Addison-Wesley Professional, 2016.

Evaluation Scheme:

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

UEC715: IOT based Systems

L T P Cr

3 0 2 4.0

Course Objective: The objective of this course is to impart necessary and practical knowledge of components of Internet of Things and develop skills required to build real-life IoT based projects.

Introduction to IoT: Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service(XaaS), Role of Cloud in IoT, Security aspects in IoT.

Elements of IoT: Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components- Programming API's (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.

IoT Application: Development Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.

IoT Case Studies: IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation

Familiarization with standards: *IEEE P2413-2019, IEEE 1451-99, IEEE P2510*

Laboratory Work:

1. Familiarization with Arduino/Raspberry Pi and perform necessary software installation.
2. To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
3. To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
4. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
5. To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.
6. To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
7. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
8. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.
9. Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to thingspeak cloud.
10. Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from thingspeak cloud.
11. To install MySQL database on Raspberry Pi and perform basic SQL queries.
12. Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.

13. Write a program on Arduino/Raspberry Pi to subscribe to MQTT broker for temperature data and print it.
14. Write a program to create TCP server on Arduino/Raspberry Pi and respond with humidity data to TCP client when requested.
15. Write a program to create UDP server on Arduino/Raspberry Pi and respond with humidity data to UDP client when requested.

Course Learning Outcomes (CLO):

The student will be able to:

1. Understand internet of Things and its hardware and software components
2. Understand the design aspects of hardware and software components of IoT
3. Design Interface for I/O devices, sensors & communication modules
4. Analyze and process of data from sensors
5. Apply IoT knowledge to Implement basic IoT applications on embedded platform

Text Books:

1. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
2. Vijay Madiseti, Arshdeep Bahga, "Internet of Things, "A Hands on Approach", University Press

Reference Books:

1. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
2. Adrian McEwen, "Designing the Internet of Things", Wiley
3. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill
4. Cuno Pfister, "Getting Started with the Internet of Things", O Reilly Media

Evaluation Scheme:

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

SEMESTER - VII

UEC*** : FIBER OPTIC COMMUNICATION

L	T	P	Cr
2	0	2	3.0

Course Objectives: To understand fiber optic communication system, transmitter section, medium- the optical fiber, receiver section, analyze system based on important parameters for characterizing optical fiber, optical source, detector and amplifier, fundamentals and advances in lasers, LEDs, photodiodes.

Optical Fibers and Their Characteristics: Introduction to high frequency communication, nature of light, advantages of optical communication, fiber structures, wave guiding, basic optical laws and definitions, optical fiber modes and configuration, mode theory for circular waveguides, single mode fibers, graded index fiber, fiber materials, fabrication and mechanical properties, fiber optic cables; joints, splices, connectors, attenuation, signal distortion, nonlinear properties, dispersion and polarization mode dispersion in optical fibers, mode coupling, specialty optical fibers, design optimization of single mode fibers.

Optical Sources and Amplifiers: Light emitting diodes, semiconductor laser, various configurations of semiconductor laser, performance parameters of LEDs and semiconductor lasers, light source linearity, modal partition and reflection noise, reliability consideration; power launching and coupling, optical amplifiers: erbium doped fiber amplifier, semiconductor optical amplifier, Raman amplifier.

Photodetectors: Operating principle and physical properties of photodiodes, pin and avalanche photodiodes, photodetector noise, response time, avalanche multiplication noise, temperature effect on avalanche gain, photodiode material.

Optical Communication Systems: Optical receiver operation- fundamental receiver operation, digital receiver performance calculation, preamplifier types, analog receivers. digital transmission systems- point to point links, line coding, eye pattern, noise effects on system performance. analog system: overview of analog links, carrier to noise ratio, multichannel transmission techniques, WDM: basics and components, LAN, coherent optical fiber communication- classification of coherent system, requirements on semiconductor lasers, modulation techniques, polarization control requirements.

Familiarization with standards: *IEEE 404-1977, IEEE 812-1984, ITU G.651-G.657, ANSI Z136.2.*

LABORATORY WORK : Basic optical communication link experiments (analog & digital), measurement of numerical aperture, splicing, multiplexing experiments, bending losses, measurement with OTDR, design and performance analysis using simulation tools.

Course Learning Outcomes (CLOs):

The students will be able to:

1. Identify and formulate the types, basic properties and transmission characteristics of optical fibers.
2. Analyse different types of optical sources and amplifiers for efficient optical fiber communication.
3. Analyse and formulate pin and avalanche photodetectors in optical fiber communication systems.
4. Realize the analog and digital fiber optic communication systems and networks with

different modulation techniques.

Test Books:

1. *Keiser, Gred, Optical Fiber Communications, Tata McGraw-Hill, (2013) 5th ed.*
2. *Senior, John M., and Yousif Jamro, M., Optical fiber communications: principles and practice, Prentice Hall, (2009) 3rd ed.*

Reference Books:

1. *Ajoy Kumar Ghatak and K. Thyagarajan, Optical Electronics, Cambridge University Press (2012) 2nded.*
2. *Bahaa E. A. Saleh, Malvin C. Teich, Fundamentals of Photonics, John Wiley & Sons, (2019) 3rd ed.*

Evaluation Scheme:

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

UHU005: HUMANITIES FOR ENGINEERS

L	T	P	Cr
2	0	2	3.0

Course Objectives: The objective of the course is to understand the interplay between, psychological, ethical and economic principles in governing human behaviour. The course is designed to help the students to understand the basic principles underlying economic behaviour, to acquaint students with the major perspectives in psychology to understand human mind and behavior and to provide an understanding about the how ethical principles and values serve as a guide to behavior on a personal level and within professions.

UNIT I: PSYCHOLOGICAL PERSPECTIVE

Introduction to Psychology: Historical Background, Psychology as a science. Different perspectives in Psychology.

Perception and Learning: Determinants of perception, Learning theories, Behavior Modification.

Motivational and Affective basis of Behaviour: Basic Motives and their applications at work. Components of emotions, Cognition and Emotion. Emotional Intelligence.

Group Dynamics and Interpersonal relationships.

Development of self and personality.

Transactional Analysis.

Culture and Mind.

Laboratory work:

1. Experiments on learning and behaviour modification.
2. Application of Motivation Theories: Need based assessment.
3. Experiments on understanding Emotions and their expressions.
4. Personality Assessment.
5. Exercises on Transactional analysis.
6. Role plays, case studies, simulation tests on human behaviour.

UNIT II: HUMAN VALUES AND ETHICAL PERSPECTIVE

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

Value Spectrum for a Good Life: Role of Different Types of Values such as Individual, Societal, Material, Spiritual, Moral, and Psychological in living a good life.

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

Analyzing Individual human values such as Creativity, Freedom, Wisdom, Love and Trust.

Professional Ethics and Professional Ethos, Codes of Conduct, Whistle-blowing, Corporate Social Responsibility.

Laboratory Work:

Practical application of these concepts by means of Discussions, Role-plays and Presentations, Analysis of Case studies on ethics in business and CSR.

UNIT III: ECONOMIC PERSPECTIVE

Basics of Demand and Supply

Production and cost analysis

Market Structure: Perfect and Imperfect Markets.

Investment Decisions: capital Budgeting, Methods of Project Appraisal.

Macroeconomic Issues: Gross domestic product (GDP), Inflation and Financial Markets.

Globalisation: Meaning, General Agreement on Trade and tariffs (GATT), World Trade Organisation (WTO). Global Liberalisation and its impact on Indian Economy.

Laboratory Work:

The practicals will cover numerical on demand, supply, market structures and capital budgeting, Trading games on financial markets, Group discussions and presentations on macroeconomic issues. The practicals will also cover case study analysis on openness and globalisation and the impact of these changes on world and Indian economy.

Micro Project: Global Shifts and the impact of these changes on world and Indian economy.

Course Learning Outcomes (CLO):

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

1. Improve the understanding of human behavior with the help of interplay of professional, psychological and economic activities.
2. Able to apply the knowledge of basic principles of psychology, economics and ethics for the solution of engineering problems.
3. Explain the impact of contemporary issues in psychology, economics and ethical principles on engineering.

Text Books:

1. Morgan, C.T., King, R.A., Weisz, J.R., & Schopler, J. *Introduction to Psychology*, McGraw Hill Book Co(International Student (1986).
2. A. N. Tripathi, *Human Values*, New Age International (P) Ltd (2009).
2. Krugman, Paul and Wells Robin, *Economics*, W.H. Freeman & Co Ltd. Fourth Edition (2015).
3. Rubinfeld Pindyck. *Microeconomic Theory and application*, Pearson Education New Delhi (2012).
4. Samuelson, Paul, A. and Nordhaus, William, D. *Economics*, McGraw Hill, (2009).
5. Mankiw, Gregory N. *Principles of Macroeconomics*, South-Western College Pub., (2014).
6. Gregory, Paul R. and Stuart, Robert C. *The Global Economy and Its Economic Systems*, 2013South-Western College Pub (2013).

Reference Books:

1. Atkinson, R.L., Atkinson, R.C., Smith, E.E., Bem, D.J. and Nolen-Hoeksema, S. (2000). *Hilgard's Introduction to Psychology*, New York: Harcourt College Publishers.
2. Berne, Eric (1964). *Games People Play – The Basic Hand Book of Transactional Analysis*. New York: Ballantine Books.
3. Ferrell, O. C and Ferrell, John Fraedrich *Business Ethics: Ethical Decision Making & Cases*, Cengage Learning (2014).
4. Duane P. Schultz and Sydney Ellen Schultz, *Theories of Personality*, Cengage Learning, (2008).
5. Saleem Shaikh. *Business Environment*, Pearson (2007).
6. Chernilam, Francis *International Buisness-Text and Cases*, Prentice Hall (2013).
7. Salvatore, Dominick, Srivastav, Rakesh., *Managerial Economics: Principles with Worldwide Applications*, Oxford, 2012.
8. Peterson H. Craig. and. Lewis, W. Cris. *Managerial Economics*, Macmillan Pub Co; (1990).

Evaluation Scheme:

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

ELECTIVE - III

UEC708: MICROWAVE ENGINEERING

L	T	P	Cr
3	0	2	4.0

Course Objective: To enhance student's comprehensive capabilities in Microwave engineering through understanding of electromagnetic wave generation, transmission and measurement theory and technology by study of microwave transmission medium, media and microwave devices and components.

Electromagnetic Plane Waves: Microwave Frequencies, IEEE microwave frequency bands, Microwave systems and measurements, Electromagnetic plane wave, Electric and magnetic wave equations, Poynting theorem, Uniform plane wave: reflection, Transmission and absorption, Plane wave in a good conductor, Poor conductor and lossy dielectric, Microwave radiation attenuation.

Wave Guides and Resonators: TE, TM Modes in rectangular & Circular wave guides, Wave guide excitation, characteristics impedance of waveguides, Rectangular, Circular and aperture coupling, Excitation of wave guides

Microwave Components: Waveguide Microwave Junctions, Scattering matrix and their properties, Microwave T junctions – H Plane Tee, E Plane Tee Rat Race Junction, Directional coupler – Two hole directional coupler, Single hole coupler and scattering matrix of a directional coupler, Waveguide joints, Bends, Corners, Transition & twists, Coupling probes & loops, Waveguide terminations, Reentrant cavities, Ferrite devices – faraday rotation in devices, Circulator & isolator, Microwave filter – YIG filter resonators, Phase shifters and microwave attenuators.

Microwave Tubes and Circuits: High frequency limitations of conventional tubes, Klystrons - two cavity klystron amplifier & oscillator, Multicity klystron, Reflex klystron, Travelling wave & MW characteristics, Microwave cross-field tube magnetron – operation and MW characteristics, Helix TWT construction, Operation and applications.

Microwave Measurements: General measurement setup, Microwave bench, Power measurement – low, Medium & high, Attenuation measurement, Measurement of VSWR, Measurement of dielectric constant, Measurement of Impedance: using Smith Chart, Measurement with spectrum analyzer, Scalar & vector network analyzer operation, S-parameter and Q measurement.

Microwave Solid State Devices & Their Applications: P-I-N devices, GUNN Diode, IMPATT, SB diodes parametric amplifier.

Laboratory Work: To study the performance of mode characteristics of reflex klystrons circulator, Characteristics of Gunn diode, Directional coupler, Attenuator, Sliding screw tuner, Verify the relation of wavelength, finding unknown impedance, VSWR measurement, E-plane, H-plane, Magic Tee, Computer based simulation experiments.

Familiarization with standards: *IEEE 521-2002, IEEE 147-1979, IEEE 470-1972 and IEEE 544-1975, IRE 2.S1-1955*

Course Learning Outcomes (CLOs): The student will be able to:

1. Develop understanding about plane wave characteristic and its propagation in different medium.
2. Understand about different modes of wave propagation (TE, TM and TEM) and waveguide structure.
3. Have knowledge about different microwave components
4. Have understanding about devices used in microwave generation
5. Get aware with microwave measurement theory and technology
6. Have understanding about microwave solid state devices.

Text Books:

1. Liao, S.Y., *Microwave Devices & Circuits*, Tata McGraw Hill (2006) 2nd edition.
2. David M. Pozar, *Microwave Engineering*, Wiley-India(2011) 3rd edition
3. Collins, Robert, *Foundation of Microwave Engineering*, McGraw Hill (2005) 3rd edition.

Reference Books:

1. Wolf E.A., and kaul, R., *Microwave Engineering & Systems Applications*, Wiley Interscience (2002) 4th edition.
2. Sze, S. M., *Physics of Semiconductor Devices*, Wiley Eastern (2003) 2nd edition.
3. Sarvate, V.V., *Electromagnetic Fields & Waves*, John Wiley & Sons (2004) 3rd edition.

Evaluation Scheme:

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

UEC705: IMAGE PROCESSING AND COMPUTER VISION

L	T	P	Cr
3	0	2	4.0

Course objective: To make students understand image fundamentals and how digital images can be processed, Image enhancement techniques and its application, Image compression and its applicability, fundamentals of computer vision, geometrical features of images, object recognition and application of real time image processing.

Introduction: Digital image representation, fundamental steps in image processing, elements of digital image processing systems digitization.

Digital Image fundamentals: A Simple Image Model, Sampling and Quantization, Relationship between Pixel, Image Formats, Image Transforms.

Image Enhancement: Histogram processing, image subtraction, image averaging, smoothing filters, sharpening filters, enhancement in frequency and spatial domain, low pass filtering, high pass filtering.

Image Compression: Fundamentals, Image Compression Models, Elements of Information Theory, Error-Free Compression, Lossy Compression, Recent Image Compression Standards.

Computer Vision: Imaging Geometry; Coordinate transformation and geometric warping for image registration, Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal Component Analysis, Shape priors for recognition.

Familiarization with standards: *IEEE 610.4-1990.*

Laboratory Work:

1. Introduction to image processing on MATLAB.
2. Image effects based on image quantization.
3. Image enhancement algorithms for histogram processing, filtering.
4. Fourier transform of images and filtering in frequency domain.
5. Realization of any one image compression algorithm.
6. Introduction to computer vision tools.

Minor Project: Image Compression and Facial Feature Detection with FPGA/ASIC/ARM/ DSP Processors.

Course learning outcome (CLOs):

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

1. Fundamentals of image processing.
2. Basic skills to enhancing images.
3. Fundamental and state of the art image compression standards.
4. Real time image processing with computer vision.

Text Books:

1. Gonzalez, R.C., and Woods, R.E., *Digital Image Processing, Dorling Kingsley (2009) 3rd ed.*
2. Jain A.K., *Fundamentals of Digital Image Processing, Prentice Hall (2007).*
3. Sonka M., *Image Processing and Machine Vision, Prentice Hall (2007) 3rd ed.*
4. D. Forsyth and J. Ponce, *Computer Vision - A modern approach, Prentice Hall.*
5. B. K. P. Horn, *Robot Vision, McGraw-Hill.*
6. E. Trucco and A. Verri, *Introductory Techniques for 3D Computer Vision, Prentice Hall.*
7. Richard Szeliski, *Computer Vision: Algos and Applications, Springer.*

Reference Books:

1. Tekalp A.M., *Digital Video Processing, Prentice Hall (1995).*
2. Ghanbari M., *Standard Codecs: Image Compression to Advanced Video Coding, IET Press (2003).*

Evaluation Scheme:

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

UEC721: ANALOG IC DESIGN

L	T	P	Cr
3	0	2	4.0

Course Objectives:

The goal is to achieve a basic understanding and knowledge of the driving and limiting factors in circuit performance, of circuit design techniques, and of technology issues important to integrated amplifier circuits. To familiarize the design and analysis of basic analog integrated circuits i.e. single ended amplifiers, differential amplifiers, current sources and mirrors, reference circuits, etc. in a standard flow with consideration of performance and power. The course will also familiarize with the issues like noise analysis, OP-Amp design, stability and compensation.

Basic MOS Device Physics: MOS IV Characteristics, Second order effects, Short-Channel Effects, MOS Device Models, Review of Small Signal MOS Transistor Models, MOSFET Noise.

Single Stage Amplifiers: Common Source Stage, Source Follower, Common Gate Stage, Cascode, FoldedCascode.

Differential Amplifier: Single ended and Differential Operation, Qualitative and Quantitative Analysis of Differential pair, Common Mode response, Gilbert Cell.

Current Sources and Mirrors: Current Sources, Basic Current Mirrors, Cascode Current Mirrors, Wilson Current Mirror, Large Signal and Small-Signal analysis.

Frequency Response of Amplifiers: Miller Effect, Association of Poles with nodes, Frequency Response of all single stage amplifiers.

Voltage References: Different Configurations of Voltage References, Major Issues, Supply Independent Biasing, Temperature-Independent References.

Feedback: General Considerations, Topologies, Effect of Loading.

Operational Amplifier: General Considerations, Theory and Design, Performance Parameters, Single-Stage Op Amps, Two-Stage Op Amps, Design of 2-stage MOS Operational Amplifier, Gain Boosting, Comparison of various topologies, slew rate, Offset effects, PSRR.

Stability and Frequency Compensation: General Considerations, Multi-pole systems, Phase Margin, Frequency Compensation, Compensation Techniques.

Noise: Noise Spectrum, Sources, Types, Thermal and Flicker noise, Representation in circuits, Noise Bandwidth, Noise Figure.

Switched-Capacitor Circuits: Sampling Switches, Speed Considerations, Precision Considerations, Charge Injection Cancellation, Switched-Capacitor Amplifiers, Switched-Capacitor Integrator, Switched-Capacitor Common-Mode Feedback.

Familiarization with standard: *IEEE 802.15.4.*

Laboratory Work: Review of Mentor Tools; Analysis of Various Analog Building Blocks such as, Current Sources, Current Mirrors, Differential Amplifier, Output Stages; Design and Analysis of Op-Amp (Closed loop and open loop) and its Characterization, Switched-Capacitor Integrator.

Text Book(s)

1. Razavi, B., *Design of Analog CMOS Integrated Circuits*, Tata McGraw Hill (2008).
2. Gregorian, R. and Temes, G.C., *Analog MOS Integrated Circuits for Signal Processing*, John Wiley (2004).

Reference Book(s)

1. Allen, P.E. and Holberg, D.R., *CMOS Analog Circuit Design*, Oxford University Press (2002) 2nd ed.
2. Johns, D.A. and Martin, K., *Analog Integrated Circuit Design*, John Wiley (2008).
3. Gray, P.R., Hurst, P.J., Lewis, S.H., and Meyer, R.G., *Analysis and Design of Analog Integrated Circuits*, John Wiley (2001) 5th ed.

Course Learning Outcomes (CLOs):

The student will be able to demonstrate the ability to

1. Fluently use the MOS structure in basic circuits.
2. Analyze low-frequency characteristics of single-stage amplifiers and differential amplifiers.
3. Analyze and design current sources/sinks/mirrors.
4. Analyze high-frequency response of amplifiers.
5. Understand the stability and frequency compensation for amplifiers.

Evaluation Scheme:

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

UCS310: DATABASE MANAGEMENT SYSTEM

L T P Cr

3 0 24.0

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

Introduction: 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 Denormalization 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):

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) 6thed.
2. Elmasri R. and Navathe B. S., Fundamentals of Database Systems, Pearson (2016) 7thed.

Reference Books:

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

Evaluation Scheme:

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

UEC704: SOFT COMPUTING

L	T	P	Cr
3	0	2	4.0

Course objective: To familiarize with soft computing concepts. Introduce the ideas of Neural networks, fuzzy logic and use of heuristics based on human experience. Familiarize the concepts of Genetic algorithm. Apply the soft computing concepts to solve practical problems.

Introduction: Introduction to soft computing, Problem complexity, Problem complexity classification, Types of soft computing techniques, Soft computing versus hard computing, Advantages of soft computing.

Artificial Neural Networks: Biological neuron, Artificial Neural Network, Mathematical Models, McCulloch Neural Model, Perceptron, Adaline and Madaline, Learning & Training in ANN, Hopfield Neural Network, Self-Organizing Networks, Recurrent Networks, Associative memories

Fuzzy Logic System: Crisp Vs Fuzzy set theory, Membership functions, Fuzzy set operations, Fuzzy rules, Mamdani and Sugeno fuzzy inference systems, Defuzzification methods.

Genetic Algorithms: Introduction and biological background of GA, String Encoding of chromosomes, Selection methods, Single & multi-point crossover operation, Mutation, Adjustment of strategy parameters such as Population size, Mutation & Crossover probabilities

Tools & Applications: MATLAB Toolboxes: Fuzzy Logic Toolbox, Neural Network Toolbox, FLS for Antilock Breaking System (ABS), GA in route planning for Travelling Sales Person, Time-Series forecasting using ANN.

Familiarization with standards: *IEEE P3333.1.3*

Laboratory Work: Familiarization of MATLAB toolboxes for neural network and fuzzy logic. Implementing neural networks and fuzzy logic in MATLAB for different applications. Familiarization of GA toolbox MATLAB and implementing it to find optimal solution of optimization problems.

Micro Project: The student shall work on any micro project based on various learning schemes of their choice. Every student will verify results of his/her micro project using MATLAB and submit report to the course coordinator for its evaluation.

Course Learning Outcomes:

Upon completion of this course, the student should be able to:

1. Understand the characteristics of Soft Computing Techniques
2. Explain neural networks and their applications.
3. Demonstrate proficient performance in the application of neural nets.
4. Apply fuzzy logic and fuzzy reasoning for decision making
5. Explain genetic algorithms and their applications.
6. Demonstrate proficient performance in the application of genetic algorithms.

Text Books

1. Jang, J.S.R., Sun, C.T., and Mizutani, E., *Neuro-Fuzzy and Soft Computing*, Pearson Education (2004) 2nd ed.
2. Eberhart, R., Simpson, P., and Dobbins, R., *Computational Intelligence - PC Tools*, AP Professional (1996) 3rd ed.

Reference Books:

1. Jacek M. Zurada – *Introduction to Artificial Neural Systems*
2. S N Sivanandam, S N Deepa – *Principles of Soft Computing*, Wiley Publications
3. John Yen, Reza Langari – *Fuzzy Logic Intelligence, Control, and Information*
4. Goldberg, Davis E., *Genetic Algorithms: Search, Optimization and Machine Learning*, Wesley Addison (1989) 3rd ed

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessional (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	35

ELECTIVE - IV

Course Objectives: The objective of this course is to provide methods and techniques to verify the functionality of digital electronic systems using System Verilog.

Data types: Built-in data types, fixed-size arrays, dynamic arrays, queues, associative arrays, linked lists, array methods, choosing a storage type, creating new types with typedef, creating user-defined structures, type conversion, enumerated types, constants, strings and expression width.

Procedural statements and routines: procedural statements, tasks, functions, and void functions, routine arguments, local data storage and time values.

Connecting the test bench and design: separating the testbench and design, the interface construct, stimulus timing, interface driving and sampling, top-level scope, program – module interactions, system Verilog assertions and Four-Port ATM router.

Basic OOP: Introduction, OOP terminology, creating objects, object deallocation, static variables vs. global variables, class methods, defining methods outside of the class, scoping rules, using one class inside another, understanding dynamic objects, copying objects, public vs. local, straying off course and building a test bench.

Randomization: Randomization in System Verilog, Constraint, solution probabilities, controlling multiple constraint blocks, pre_randomize and post_randomize functions, random number functions, constraints tips and techniques, common randomization problems, iterative and array constraints, atomic stimulus generation vs. scenario generation, random control, random number generators and random device configuration.

Threads and interprocess communication: Threads, disabling threads, interprocess communication, events, semaphores, mailboxes and building a testbench with threads & IPC.

Familiarization with standards: *IEEE 1364-2005, IEEE 1800-2017.*

Laboratory Work: Modelling and simulation of digital blocks, their verification by using SystemVerilog.

Course learning outcome (CLO): The student will be able to:

1. Acquire the knowledge of different data types used in System Verilog.
2. Verify the functionality of design by developing a test bench code.
3. Apply the concepts of object oriented programming in System Verilog.
4. Apply randomization methods in System Verilog.

Text Books:

1. Chris Spear, SystemVerilog for Verification A Guide to Learning the Testbench Language Features, Springer, (2008) 2nd Ed.

Evaluation Scheme:

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

UCS303: OPERATING SYSTEMS

L	T	P	Cr
2	0	2	3.0

Course objective: Role and purpose of the operating system, Functionality of a typical operating system, managing atomic access to OS objects.

Operating System Principles: Structuring methods (monolithic, layered, modular, microkernel models), processes, and resources, Concepts of APIs, Device organization, interrupts: methods and implementations, Concept of user/system state and protection, transition to kernel mode.

Concurrency: Implementing synchronization primitives, Multiprocessor issues (spin locks, reentrancy).

Scheduling and Dispatch: Dispatching and context switching, Preemptive and non-preemptive scheduling, Schedulers and policies, Processes and threads.

Memory Management: Review of physical memory and memory management hardware, Working sets and thrashing, Caching, Paging and virtual memory, Virtual file systems.

File Systems: Files: data, metadata, operations, organization, buffering, sequential, nonsequential, Directories: contents and structure, Naming, searching, access, backups, Journaling and log-structured file systems.

Deadlock: Introduction, Analysis of conditions, Prevention & avoidance, Detection & recovery.

Security and Protection: Overview of system security, Security methods and devices, Protection, access control, and authentication.

Virtual Machines: Types of virtualization (including Hardware/Software, OS, Server, Service, Network).

Device Management: Characteristics of serial and parallel devices, Buffering strategies, Direct memory access, Disk structure, Disk scheduling algorithms.

Laboratory work: To explore different operating systems like Linux, Windows etc. To implement main algorithms related to key concepts in the operating systems.

1. Detailed architecture of linux commands and flow of command execution.
2. Detailed commands related to basics of linux, file handling, process management.
3. Shell program having sequential, decision and loop control constructs.
4. CPU Scheduling Algorithms
5. Threaded programming in Linux (eg. POSIX threads in LINUX)

Course learning outcome (CLO):

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

1. Explain basic operating system concepts such as overall architecture, interrupts, APIs, user mode and kernel mode.
2. Distinguish concepts related to concurrency including, synchronization primitives, race conditions, critical sections and multi-threading.
3. Analyze and apply CPU scheduling algorithms, deadlock detection and prevention algorithms.
4. Examine and categorise various memory management techniques like caching, paging, segmentation, virtual memory, and thrashing.
5. Appraise high-level operating systems concepts such as file systems, security, protection, virtualization and device-management, disk-scheduling algorithms and various file systems.

Text Books:

1. *Silberschatz, A., Galvin, P.B. and Gagne, G., Operating System Concepts, John Wiley (2013), 9th ed.*
2. *Stallings, Willam, Operating Systems Internals and Design Principles, Prentice Hall (2014), 7th ed.*

Reference Books:

1. *Daniel P. Bovet, Marco Cesati, "Understanding the Linux Kernel", 3rd Ed., O'Reilly Media, November 2005*
2. *Michael Kifer, Scott Smolka, "Introduction to Operating System Design and Implementation: The OSP 2 Approach, Springer; 2007*

Evaluation Scheme:

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

UEC861: CLOUD COMPUTING

L	T	P	Cr
2	0	2	3.0

Course Objective: To appreciate the benefits of Cloud computing and apply Cloud paradigms for evolving businesses. To familiarize with Cloud architectural models and resource allocation strategies. The student should comprehensively be exposed to Cloud based services.

Introduction: Basics of the emerging Cloud computing paradigm, Cloud computing history and evolution, Cloud enabling technologies, practical applications of Cloud computing for various industries, the economics and benefits of Cloud computing.

Cloud Computing Architecture: Cloud Architecture model, Types of Clouds: Public private & Hybrid Clouds, Resource management and scheduling, QoS (Quality of Service) and Resource Allocation, Clustering.

Cloud Computing delivery Models: Cloud based services: IaaS, PaaS and SaaS Infrastructure as a Service (IaaS): Introduction to IaaS, Resource Virtualization i.e. Server, Storage and Network virtualization Platform as a Service (PaaS): Introduction to PaaS, Cloud platform & Management of Computation and Storage, Azure, Hadoop, and Google App. Software as a Service (SaaS): Introduction to SaaS, Cloud Services, Web services, Web 2.0, Web OS Case studies related to IaaS, PaaS and SaaS.

Data Processing in Cloud: Introduction to Map Reduce for Simplified data processing on large clusters, Design of data applications based on Map Reduce in Apache Hadoop

Advanced Technologies: Advanced web technologies (AJAX and Mashup), distributed computing models and technologies (Hadoop and MapReduce), Introduction to Open Source Clouds like Virtual Computing Lab (Apache VCL), Eucalyptus

Cloud Issues and Challenges: Cloud computing issues and challenges like Cloud provider Lock-in, Security etc.

Introduction to Python Runtime Environment: The Datastore, Development Workflow

Familiarization with standards: *IEEE 2301-2020, 2302, 2303*

Course learning outcome (CLOs):

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

1. Familiarization with Cloud architectures.
2. Knowledge of data processing in Cloud.
3. Ability to apply clustering algorithms to process big data real time.
4. Ability to address security issues in Cloud environment.
5. Understand the nuances of Cloud based services.

Text Books:

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

Reference Books:

1. *Anthony Velte, Toby Velte and Robert Elsenpeter , Cloud Computing: A practical Approach Tata McGrawHill, 2010, Second Edition*
2. *Judith Hurwitz, Robin Bllor, Marcia Kaufmann, Fern Halper, Cloud cOmputing for Dummies, 2009, Third Edition*

Evaluation Scheme:

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

UEC622: DSP PROCESSORS

L	T	P	Cr
2	0	2	3.0

Course Objective: To enhance comprehension capabilities of students through fundamentals of DSP processors with its architecture, memory architecture along with instruction set, interrupts, pipelining and different types of DSP processors.

An Introduction to DSP Processors: Advantages of DSP, characteristics of DSP systems, classes of DSP applications, DSP processor embodiment and alternatives, Fixed and floating point number representation, IEEE 754 format representation, Fixed Vs Floating point processors,.

DSP Architecture: An introduction to Harvard Architecture, Differentiation between Von-Neumann and Harvard Architecture, Quantization and finite word length effects, Bus Structure, Central Processing Unit, ALU, Accumulators, Barrel Shifters, MAC unit, compare, select, and store unit (CSSU), data addressing and program memory addressing.

Memory Architecture: Memory structures, features for reducing memory access required, wait states, external memory interfaces, memory mapping, data memory, program memory and I/O memory, memory mapped registers.

Addressing and Instruction Set: Various addressing modes - implied addressing, immediate data addressing, memory direct addressing, register direct and indirect addressing, and short addressing modes, Instruction types, various types registers, orthogonality, assembly language and application development.

Interrupts and Pipelining: Interrupts, pipelining and performance, pipelining depth, interlocking, interrupt effects, instruction pipelining.

Processors: Architecture and instruction set of TMS320C3X, TMS320C5X, TMS320C67XX, some example programs. Development tools for Programmable DSPs, An introduction to Code Composer Studio.

Familiarization with standards: *IEEE 754, ANSI standard TMS320*

Micro Project: Audio amplification with the help of DSP kit.

Laboratory Work

Introduction to code composer studio, Using CCS write program to compute factorial, dot product of two arrays, Generate Sine, Square and Ramp wave of varying frequency and amplitude, Design various FIR and IIR filters, Interfacing of LED, LCD, Audio and Video Devices with the DSP processor.

Course Learning Outcomes (CLO):

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

1. Differentiate between generalised processor and DSP processor.
2. Analyze special characteristics and features of generalized DSP processors.
3. Understand the software model and pipelining for generalized DSP processor.
4. Understand detailed architectures and instruction sets of TMS 320C3X, 5X and 67XX.
5. Understand the Programming concepts for TMS 320C3X, 5X and 67XX.

Text Books

1. *Lapsley, P., Bier, J., Shoham, A. and Lee, E.A., DSP Processor Fundamentals: Architecture and Features, IEEE Press Series on Signal Processing, IEEE (2000).*
2. *Venkataramani, B. and Bhaskar, M., Digital Signal Processor: Architecture, Programming and Applications, Tata McGraw Hill (2003).*
3. *TI DSP reference set (www.ti.com).*

Reference Books:

1. *Padmanabhan, K., Ananthi, S. and Vijayarajeswaran, R., A practical Approach to Digital Signal Processing, New Age International Pvt. Ltd (2001).*
2. *Babast, J., Digital Signal Processing Applications using the ADSP-2100 family, PHI (1992).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessional (May include Assignments/Projects/Tutorials/ Quizes/Lab Evaluations)	40

UEC852: WIRELESS SENSOR NETWORKS

L	T	P	Cr
3	0	0	3.0

Course Objective: To provide a succinct introduction to the field of wireless sensor networks by introducing the fundamentals of network architectures, protocols and deployment methods. To familiarise with various networks platforms and tools for wireless sensor networks.

Introduction and Overview of Wireless Sensor Networks: Background of Sensor Network Technology, Application of Sensor Networks, Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks.

Sensor Node Hardware and Network Architecture: Single-node Architecture: Hardware Components, Operating Systems and Execution Environments, Network Architecture: Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts.

Network Protocols: MAC Protocols: Requirement and design constraints for MAC Protocols, Important classes of MAC Protocols, MAC Protocols for Wireless Sensor Networks, Routing Protocols: Classification of Routing Protocols, Energy-Efficient Routing, Geographic Routing.

Deployment and Configuration: Localization and Positioning, Single-hop Localization, Positioning in Multi-hop environments, Coverage and Connectivity, Naming and Addressing in Sensor Networks, Assignment of MAC addresses.

Sensor Network Platforms and Tools: Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level Software Platforms, Node-level Simulators.

Familiarization with standards: *IEEE 1451.0 and IEEE 1451.5-802.11.*

Micro Project: WSN based monitoring of Temperature

Course Learning Outcomes (CLOs):

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

1. introduced to the concept of Wireless Sensor Networks and its applications
2. able to understand various architectures of Wireless Sensor Networks, its related hardware and protocols
3. familiarised with deployment and configuration methods.
4. acquainted to Node-level Software Platforms.

Text Books:

1. HolgerKarl andAndreasWillig, *Protocols andArchitecturesforWireless Sensor Networks*,JohnWiley,2005.
2. FengZhao&LeonidasJ.Guibas,*WirelessSensorNetworks - An Information ProcessingApproach*,Elsevier,2007.

Reference Books:

1. Kazem Sohraby, Daniel Minoli, and Taieb Znati, *Wireless Sensor Networks- Technology, Protocols and Applications*, John Wiley, (2007).

2. *Raghavendra, Cauligi S, Sivalingam, Krishna M., Zanti Taieb, Wireless Sensor Network, Springer 1st Ed, (2004) (ISBN: 978-4020-7883-5).*
3. *Anna Hac, Wireless Sensor Network Designs, John Wiley, (2003).*

Evaluation Scheme:

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

SEMESTER-VIII

ELECTIVE - V

Course Objective: The aim of this course is to familiarize the student with cardiovascular, nervous, neuromuscular, visual and auditory system, along with the detailed signal processing filtering and spectral analysis of the associated signals.

Basic neurology: Nervous System, neuron, Resting potential, Nernst equation, electrical equivalents

Electrical activity of heart: Introduction to ECG Lead system and recording, ECG wave component detection and analysis, Vector cardiography, Inverse cardiography, Signal conditioning & processing.

Electrical activity of neuromuscular System: Muscular system, Electrical signals of motor unit and gross muscle, Human motor coordination system, Electrodes, Correlation of force and work; EMG integrators, Signals conditioning & processing.

Electrical activity of brain: Sources of brain potentials, Generation of signals, component waves, EEG recording electrodes, 10-20 electrode system, EEG under normal, Grand mal and Petit mal seizures, Signal conditioning & processing.

Electrical signals from Visual System: Sources of electrical signals in eye, Generation of signals, Electroretinogram, Electrooculogram, Analysis of signals.

Electrical signals from Auditory System: Generation of cochlear potentials and nature; Evoked responses, Auditory nerves, Signal conditioning & processing.

Noise and Interference: Sources of noise in bioelectrical signal recordings; Grounding & shielding, **Problems related to noise and artifacts related to EEG and ECG signals**

Filtering of Biomedical Signals: Filtering techniques-active and passive filters; Digital filtering, **Order-statistic filters, Optimal Filtering, Adaptive Filters, Selection of an appropriate filter.**

Frequency analysis of Signals: z-Transform; Fourier transform; Fast Fourier transform; Frequency analysis; Filtering of signals in frequency domain, **Homomorphic filtering, Spectral analysis.**

Familiarization with standards: *European prestandard CEN ENV 1064, ASTM E-1467-94, IEEE 1073.*

Course Learning Outcomes (CLOs): The student will be able to:

1. Describe bioelectric ECG, EMG, EEG signals and their measurements.
2. Describe the common properties of biosignals and identify the basic challenges in processing and analysing them.
3. Apply digital signal processing techniques in the analysis of bioelectric signals.
4. Explain and apply filtering and spectral analysis to evaluate the electroencephalographic biosignals and heart rate variability.

Text Books:

1. Rangaraj M. Rangayyan, "Biomedical Signal Analysis", John Wiley & Sons.

2. Willis J. Tompkins, "Biomedical Digital Signal Processing: C Language Examples and Laboratory Experiments for the IBM PC", Prentice Hall India.

Reference Books:

1. Eugene N. Bruce, "Biomedical Signal Processing and Signal Modeling", John Wiley & Sons.
2. John L. Semmlow, "Biosignal and Biomedical Image Processing : MATLAB-Based Applications", CRC press.
3. S. Cerutti and C. Marchesi , "Advanced Methods of Biomedical Signal Processing", John Wiley & Sons.

Evaluation Scheme:

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

UEC742: MEMS

L	T	P	Cr
3	0	0	3.0

Course Objective: To educate the student to understand the fundamentals of Micro Electro Mechanical Systems (MEMS), different materials used for MEMS, semiconductors and solid mechanics to fabricate MEMS devices, various sensors and actuators, applications of MEMS to disciplines beyond Electrical and Mechanical engineering.

Introduction:History of Micro-Electro-Mechanical Systems (MEMS), Market for MEMS, MEMS materials: Silicon, Silicon Dioxide, Silicon Nitride, Polysilicon, Silicon Carbide, Polymers, Thin metal films, Clean rooms.

Process Technologies: Wafer cleaning and surface preparation, Oxidation, Deposition Techniques: Sputter deposition, Evaporation, Spin-on methods and CVD, Lithography: Optical, X-ray and E-Beam, Etching techniques, Epitaxy, Principles of bulk and surfacemicromachining, Lift-off process, Doping: Diffusion and Ion Plantation, Wafer Bonding: Anodic bonding and Silicon fusion bonding, Multi User MEMS Process (MUMPs), Introduction to MEMS simulation and design tools, Lumped element modeling and design, Electrostatic Actuators, Electromagnetic Actuators, Linear and nonlinear system dynamics.

Sensing and Actuation Principles: Mechanical sensor and actuation: Principle, Beam and Cantilever, Microplates, Capacitive effects, Piezoelectric Materials as sensing and actuating elements, Starin Measurement, Pressure measurement, Thermal sensor and actuation, Micro-Opto-Electro mechanical systems (MOEMS), Radio Frequency (RF) MEMS, Bio-MEMS.

Application case studies: Pressure Sensor, Accelerometer, Gyroscope, Digital Micromirror Devices (DMD), Optical switching, Capacitive Micromachined Ultrasonic Transducers (CMUT)

Familiarization with standard: *IEEE 2700-2017*.

Course Learning Outcomes (CLOs):

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

1. integrate the knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
2. analyze operation of micro devices, micro systems and their applications
3. design the micro devices using the MEMS fabrication process
4. apply different materials used for MEMS

Text Books:

1. Franssila Sami, *Introduction to Micro Fabrication*, WILEY, 2nd Edition, 2010
2. NadimMaluf, *An Introduction to MicroelectromechanicalSystemsEngineering*,Artech House, 3rd edition, 2000.
3. MahalikNitaigourPremchand,*MEMS*, McGraw-Hill, 2007.

Reference Books:

1. Senturia Stephen D., *Microsystem Design*, Springer US, (2013).
2. Madou Marc J., *Fundamentals of Microfabrication*, CRC Press, (2002).
3. StephrnBeeby, Graham Ensell, Michael Kraft, Neil White, *MEMS Mechanical Sensors*, artech House (2004).
4. Chang Liu, *Foundations of MEMS*, Pearson Education Inc., (2012)
5. Tai Ran Hsu,*MEMS& Micro systems Design and Manufacture* Tata McGraw Hill, NewDelhi, 2002.

Evaluation Scheme:

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

UEC854: ASICs and FPGAs

L	T	P	Cr
3	0	0	3.0

Course Objective: This course covers the different types of programming technologies and logic devices, the design flow of different types of ASIC and the architecture of different types of FPGA. To gain knowledge about partitioning, floor planning, placement and routing including circuit extraction of ASIC. To know about different high performance algorithms and its applications in ASICs.

Introduction: Course outline, Logistics introduction to ASICs, FPGAs, Economics.

HDL: Logic design Review, Behavior, Dataflow, Structural modeling, Control statements, FSM modeling.

CMOS Review: Classical, CMOS (Deep Sub-micron), ASIC Methodologies (classical) ASIC Methodologies (aggressive).

Combinational Circuit Design: Components of Combinational Design - Multiplexer and Decoder, Multiplexer Based Design of Combinational Circuits, Implementation of Full Adder using Multiplexer, Decoder Implementation of Full Adder using Decoder.

Programmable Logic Devices: Types of Programmable Logic Devices, Combinational Logic Examples, PROM - Fixed AND Array and Programmable OR Array, Implementation of Functions using PROM, PLA - Programmable Logic Array (PLA) – Implementation Examples.

Programmable Array Logic: PAL - Programmable Array Logic, Comparison of PROM, PLA and PAL, Implementation of a Function using PAL, Types of PAL Outputs, Device Examples.

Introduction to Sequential Circuits: R-S Latch and Clocked R-S Latch, D Flip Flop, J-K Flip Flop, Master Slave Operation, Edge Triggered Operation.

FPGA: Programmable logic FPGA, Configuration logic blocks, Function Generator, ROM implementation, RAM implementation, Time skew buffers, FPGA Design tools, Network-on-chip, Adaptive System-on-chip.

System Design Examples using FPGA Board: Design Applications using FPGA Board - Traffic Light Controller and Real Time Clocked, XSV FPGA Board Features, Testing of FPGA Board, Setting the XSV Board Clocked Oscillator Frequency, Downloading Configuration Bit Streams.

Logic Synthesis: Fundamentals, Logic synthesis with synopsis, Physical design compilation, Simulation, implementation. Floor planning and placement, Commercial EDA tools for synthesis.

Familiarization with standard: ISO 26262.

Course learning outcome (CLOs):

The students will be able to:

1. To utilize the top-down design methodology in the design of complex digital devices such as FPGAs/ ASICs.
2. To learn modern hardware/software design tools to develop modern digital Systems
3. Ability to design and verification of integrated circuits chips
4. To design and implement different Field Programmable Gate Array (FPGA)
5. architectures and their applications to real life

Text Books:

1. *Smith, Michael.,Application-Specific Integrated Circuits, Addison-Wesley Professional, (2008) 1st ed.*
2. *Wolf, W., FPGA-based System Design, PH/Pearson, (2004) Cheap ed.*

Reference Books:

1. *Steve Kilts, Advanced FPGA Design, Wiley Inter-Science, Jhon weilly & sons, (2007) 4th ed.*

Evaluation Scheme:

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

UEC862: IC FABRICATION TECHNOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: To gain knowledge about crystal growth and wafer preparation techniques. Subsequently, the thoroughly understanding of different integral steps needed for IC components fabrication mainly bipolar and field effect transistors. To acquire knowledge of various linear and nonlinear ICs and the various packaging techniques.

Integrated Circuits: Introduction, Impact of ICs on Industry, Advantages over discrete components, Monolithic and Hybrid ICs, Scales of integration and related issues.

Growth of Single Crystals wafers: Crystal growth using Czochralski's method, Float Zone method and Bridgeman technique, Zone refining, characteristics and crystal evaluation, Wafer Shaping operations, Slicing, polishing and etching.

Epitaxy Film Formation: Importance of epitaxial layer growth, Types of epitaxy: VPE, MBE, MOCVD Defects in epitaxial layers and their removal.

Diffusion: Impurity diffusion in a semiconductor crystal. Fick's Laws, Gaussian and Complementary Error Function Distribution of Impurities. Properties of diffusion.

Subsequent Processes: Oxidation, Ion-implantation, Photolithography, Electron beam and X-Ray lithography, Different printing techniques, +ve & -ve Photo resist, dry and wet Etching, Metallization, and Clean room: Standards, Exposure Tools.

MOSFET Technology: Design of junction diode, Transistor, FET and MOSFETs Polysilicon gates and Well Structures.

Passive Components for IC's: Analog, Linear and Non-linear I.C's. Digital I.C's. Digital I.C's like TTL, ECL, HTL, Video I.C's, Tuners like 555 and 556: internal circuits and their operation.

Packaging of I.C's: Mountings in packages using Dual-in-line (DIP) or TO packages. Packages using surface-mount-technology (SMT).

Familiarization with standards: *IEEE 62659-2015*.

Course Learning Outcomes (CLOs):

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

1. Acquire knowledge about crystal growth and wafer preparation techniques.
2. Learn about different fabrication process used in ICs industry.
3. Understand various linear and non-linear ICs.
4. To understand the various packaging techniques.

Text Books:

1. Sze, S. M., *VLSI Technology, Wiley Eastern, USA (1999) 2nd ed.*
2. Sze, S. M., *Semiconductor Devices, Physics & Technology, (2001) 3rd ed.*

Reference Books:

1. Pucknell and Eshraghian, *Basic VLSI Design*, (2000) 2nd edition
2. Nagchoudhri, D., *Principles of Microelectronics Technology* (2002) 4th edition.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	50
3.	Sessional (May include Assignments/Projects/Tutorials/Quizes)	20

ELECTIVE - VI

UEC863: VLSI INTERCONNECTS

L	T	P	Cr
3	0	0	3.0

Course Objectives: In this course the students will learn interconnect models, device models, interconnect analysis and interconnect materials.

Introduction: Technology trends, Device and interconnect scaling ,Interconnect Models: RC model and RLC model, Effect of capacitive coupling, Effect of inductive coupling, Transmission line model, Power dissipation, Interconnect reliability.

Device Models: Introduction, device I-V characteristics, General format of device Models, device models in explicit expression, device model using a table-Lookup model and effective capacitive model.

Interconnect Analysis: Time domain analysis: RLC network analysis, RC network analysis and responses in time domain, S domain analysis, circuit reduction via matrix approximation, Analysis using moment matching, transmission lines: step input response.

Crosstalk Analysis: Introduction, Capacitive coupled and inductive coupled interconnect model and analysis, Transmission line based model.

Advanced Interconnect Materials: Basic materials: Copper and aluminium. Problem with existing material in deep submicron: Electro-migration effect, surface and grain boundary effect. CNT as an interconnect, impedance parameters of CNT, types of CNT, GNR and Optical interconnects.

Familiarization with standard: *IEEE 1650-2005*.

Course Learning Outcomes(CLOs):

Upon the completion of this course, the students are able to:

1. understand the advanced interconnect materials
2. acquire knowledge about Technology trends, Device and interconnect scaling.
3. identify basic device and Interconnect Models.
4. perform RLC based Interconnect analysis.
5. analyse the problem with existing material in deep submicron.

TextBooks:

1. Chung-Kang Cheng, John Lillis, Shen Lin and Norman H. Chang, "Interconnect Analysis and Synthesis", A Wiley Interscience Publication (2000).
2. Sung-Mo (Steve) Kang, Yusuf Leblebici, "CMOS Digital integrated circuits analysis and design", by Tata McGraw-Hill, (2007).

Reference Books:

1. L.O. Chua, C.A. Desoer, and E.S. Kuh, "Linear and Non linear circuits", McGraw-Hill, 1987.
2. R.E. Matrick, "Transmission lines for digital and communication networks", IEEE press, 1995.

3. Mauricio Marulanda, "Electronic properties of Carbon Nanotubes", InTech publisher 2011.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	50
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	20

Course Objective: To enhance comprehension capabilities of students through understanding power electronics devices, phase controlled converters, choppers, inverters, AC voltage controllers and Cyclo converters with their operation and types.

Introduction: Review of power semiconductor devices, Their characteristics, Thyristors, Their static and dynamic characteristics, Turn-on and Turn - off methods and circuits, Ratings and protection of SCR'S, Other members of thyristor family, Series and parallel operation of thyristors, Firing circuits for SCRs.

Phase Controlled Converters: Principle of phase control, Single phase half wave circuit with different types of loads, Single phase and three phase semi converter and full converter bridge circuits with line commutation, Continuous and discontinuous conduction effect of source inductance on single phase and three phase full converters, Single phase and three phase dual converters and their operation with circulating and non circulating currents.

DC Choppers: Principle of chopper operation, Control strategies, Types of choppers, Step up and step down choppers, Types of choppers, Steady state time domain analysis with R, L, and E type loads, Voltage, Current and Load commutated choppers.

Inverters: Single phase VSI, Half bridge and full bridge inverters and their steady state analysis, Modified Mc Murray half bridge inverter, Series and parallel inverters, and Three phase bridge inverters with 180° and 120° modes. Single-phase PWM inverters. Current source inverters, CSI with R load (qualitative approach).

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

Cyclo Converters: Principles of operation, Single phase to single phase step up and step down cyclo converters. Three phase to single phase and three-phase to three-phase cyclo converters, Output voltage equation for a cyclo converter.

Familiarization with standard: *IEEE 1662-2016.*

Course Learning Outcomes (CLOs):

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

1. analyze the characteristics of power semiconductor devices.
2. understand the operation and types of Phase Controlled Converters.
3. understand the operation and types of DC Choppers.
4. understand differences between different types of inverters
5. understand the operation and types of AC Voltage Controllers and Cyclo converters.

Text Books:

1. *Dubey, G.K., Doradla, S.R., Joshi, A. and Sinha, R.N.K., Thyristorised Power Controllers, New Age International (P) Limited, Publishers (2004).*
2. *Rashid, M., Power Electronics, Prentice Hall of India Private Limited (2006).*

Reference Books:

1. *Mohan, N., Undel, T.M. and Robbins, W. P., Power Electronics: Converter Applications and Design, John Wiley and Sons (2007).*
2. *Jain, A., Power Electronics and its Applications, Penram International Publishing (India) Pvt. Ltd. (2008).*

Evaluation Scheme:

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

UEC851: VLSI DIGITAL SIGNAL PROCESSING

L	T	P	Cr
3	0	0	3.0

Course Objective: To introduce techniques for designing efficient DSP architectures, to realize architectures that will process high throughput data and/or require less power and/or less chip area, techniques for altering the existing DSP structures to suit VLSI implementations, to introduce efficient design of DSP architectures suitable for VLSI.

Introduction to DSP Systems: Pipelining and Parallel Processing for FIR Filters: Introduction to DSP systems – Typical DSP algorithms, Data flow and Dependence graphs – critical path, Loop bound, Iteration bound, Longest path matrix algorithm, Pipelining and Parallel processing of FIR filters, Pipelining and Parallel processing for low power.

Retiming, Algorithmic Strength Reduction: Retiming – definitions and properties, Unfolding – an algorithm for unfolding, properties of unfolding, sample period reduction and parallel processing application, Algorithmic strength reduction in filters and transforms – 2-parallel FIR filter, 2-parallel fast FIR filter, DCT architecture, rank-order filters, Odd-Even merge-sort architecture, parallel rank-order filters.

Fast Convolution, Pipelining and Parallel Processing of IIR Filters: Fast convolution – Cook-Toom algorithm, modified Cook-Toom algorithm, Pipelined and parallel recursive filters – Look-Ahead pipelining in first-order IIR filters, Look-Ahead pipelining with power-of-2 decomposition, Clustered look-ahead pipelining, Parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters.

Bit-Level Arithmetic Architectures: Bit-level arithmetic architectures – parallel multipliers with sign extension, parallel carry-ripple and carry-save multipliers, Design of Lyon's bit-serial multipliers using Horner's rule, bit-serial FIR filter, CSD representation, CSD multiplication using Horner's rule for precision improvements Distributed Arithmetic fundamentals and FIR filters.

Numerical Strength Reduction, Synchronous, Wave and Asynchronous Pipelining: Numerical strength reduction – subexpression elimination, multiple constant, iterative matching, synchronous pipelining and clocking styles, Clock skew in edge-triggered single phase Clocking, two-phase Clocking, wave pipelining.

Familiarization with standard: *IEEE-754*.

Course Learning Outcomes (CLOs):

The student will be able to:

1. Acquired knowledge about VLSI design methodology for signal processing systems.
2. Ability to acquire knowledge about VLSI algorithms and DSP architectures, retiming techniques, folding and register minimization path problems.
3. Ability to understand the concepts of systolic architecture and its methodology.
4. Ability to have knowledge about algorithmic strength reduction techniques and parallel processing of FIR and IIR digital filters.

5. To understand asynchronous and wave pipelines.
6. To understand scaling and round-off noise issues and their impact on performance.
7. To modify the existing or new DSP architectures suitable for VLSI.

Text Books:

1. Parhi, K. K., *VLSI Digital Signal Processing: Design and Implementation*, John Wiley (2007) 2nd ed.
2. Wanhammar, L., *DSP for Integrated Circuits*, Academic Press (1999) 4th ed.

Reference Books:

1. U. Meyer-Baese, *Digital Signal Processing with Field Programmable Gate Arrays*, Springer, 2nd Edition, 2004.
2. W. Wolf, *High-performance embedded computing architectures, applications, and methodologies*, Morgan Kaufman Publishers (2007).
3. S. Y. Kung, H. J. White House, T. Kailath, *VLSI and Modern Signal Processing*, Prentice-Hall, 1985.
4. *IEEE Journal papers on Signal processing, VLSI and Embedded Systems.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	50
3	Sessional (May include Assignments/Quizzes)	20

UEC864: RADAR AND REMOTE SENSING

L T P Cr
3 0 0 3.0

Course Objectives: To introduce the basic functioning of a radar system and to make the students understand this by taking a specific example of MTI and PULSE Doppler radar. Implement the usage of these systems with the help of specific sensors for gaining knowledge about inaccessible areas (remote sensing).

Introduction to Radar: Basic Radar – The simple form of the Radar Equation – Radar Block Diagram – Radar Frequencies – Applications of Radar – The Origins of Radar

The Radar Equation: Introduction – Detection of Signals in Noise – Receiver Noise and the Signal-to-Noise Ratio – Probability Density Functions – Probabilities of Detection and False Alarm – Integration of Radar Pulses – Radar Cross Section of Targets – Radar cross Section Fluctuations – Transmitter Power – Pulse Repetition Frequency – Antenna Parameters – System losses – Other Radar Equation Considerations

MTI and Pulse Doppler Radar: Introduction to Doppler and MTI Radar – Delay – Line Cancelers – Staggered Pulse Repetition Frequencies – Doppler Filter Banks – Digital MTI Processing – Moving Target Detector – Limitations to MTI Performance – MTI from a Moving Platform (MTI) – Pulse Doppler Radar – Other Doppler Radar Topics – Tracking with Radar – Monopulse Tracking – Conical Scan and Sequential Lobing – Limitations to Tracking Accuracy - Low-Angle Tracking – Tracking in Range – Other Tracking Radar Topics – Comparison of Trackers – Automatic Tracking with Surveillance Radars.

Fundamentals of Remote Sensing: Definition of terms, Concepts and types of remote sensing; evolution of remote sensing Technology, stages in remote sensing technology, spatial data acquisition, interdisciplinary nature and relation with other disciplines, applications of remote sensing, advantages of RS over conventional methods of survey and inventorying.

Basic Principles of Remote Sensing: Types of remote sensing with respect to wavelength regions; Definition of radiometry; Black body radiation; Spectral characteristics of solar radiation; EMR Interaction with Earth materials; Spectral signature concepts spectral reflectance and emittance specular reflection and nonspecular reflectance Albedo of materials EMR interaction with rocks, minerals, vegetation and water -Factors affecting spectral reflectance of materials. Instruments used to study the spectral reflectance spectrophotometer spectro-radiometer.

Sensors - Types of sensors- passive sensors and active sensors; imaging systems, photographic sensors; Sensor resolution- spectral, spatial, radiometric and temporal; Imaging sensors and non-imaging radiometers; photograph v/s image, Panchromatic, Multispectral, hyperspectral, stereo images, Optical mechanical line scanner; Pushbroom scanner; Imaging spectrometer; spaceborne imaging sensors, active and passive microwave sensors; Thermal sensors; Atmospheric sensors; Sonar; Laser, Radar, hyperspectral sensors.

Platforms - Principles of satellite Missions; Types of platforms- airborne remote sensing, space borne remote sensing; Orbital elements of satellite; satellites for Land, Ocean, and atmospheric studies IRS, Landsat, SPOT, Radarsat, quick bird, Ikonos and ESA satellite series.

Image Interpretation and Analysis - Fundamentals of satellite image interpretation; Types of imaging, elements of interpretation; Techniques of visual interpretation; Generation of Thematic maps.

Introduction to advanced Remote Sensing Technologies: Synthetic Aperture Radar; Side Looking Airborne Radar; Hyper spectral Imaging Spectrometer; Lidar; Thermal Imaging System; Advanced Laser Terrain Mapping

Familiarization with standards: *IEEE P2936, IEEE 686-1997.*

Course Learning Outcomes (CLOs):

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

1. Understand the basic working of a RADAR.
2. Understand the working of a Moving target Indicator (MTI) on the basis of Doppler shift.
3. Recognize the advantages of RS over conventional methods of survey and inventorying.
4. Distinguish among various sensors for specific Remote sensing applications.
5. Understand the types of sensing and interpret the results obtained.

Text Books:

1. Skolnik, Merrill I., *Introduction to Radar Systems, Tata McGraw-Hill (2003) 3rd ed.*
2. Peebles, Peyton Z., *Radar Principles, John Wiley, (2004) 2nd ed.*
3. *Microwave Radar and Radiometric Remote Sensing by F.T. Ulaby, D.G. Long University of Michigan Press, 2013, ISBN0472119354.*

Reference Books:

1. Toomay, J.C., *Principles of Radar, PHI, (2004) 2nd ed.*
2. *Microwave Remote Sensing: Active and Passive, Volume I: Microwave remote sensing fundamentals and radiometry by F. Ulaby, R. Moore, A. Fung Artech House, 1981, ISBN 0890061904.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	50
3.	Sessional (May include Assignments/Projects/Tutorials/Quizes)	20

GENERIC ELECTIVES

UPH063 NANOSCIENCE AND NANOMATERIALS

L T P Cr
3 0 0 3.0

Course Objectives: To introduce the basic concept of Nanoscience and advanced applications of nanotechnology,

Fundamental of Nanoscience: Features of Nanosystem, Free electron theory and its features, Idea of band structures, Density of states in bands, Variation of density of state and band gap with size of crystal,

Quantum Size Effect: Concepts of quantum effects, Schrodinger time independent and time dependent equation, Electron confinement in one-dimensional well and three-dimensional infinite square well, Idea of quantum well structure, Quantum dots and quantum wires,

Nano Materials: Classification of Nano Materials their properties, Basic concept relevant to application, Fullerenes, Nanotubes and nano-wires, Thin films chemical sensors, Gas sensors, Vapour sensors and Bio sensors,

Synthesis and processing: Sol-gel process, Cluster beam evaporation, Ion beam deposition, Chemical bath deposition with capping techniques and ball milling, Cluster assembly and mechanical attrition, Sputtering method, Thermal evaporation, Laser method,

Characterization: Determination of particle size, XRD technique, Photo luminescence, Electron microscopy, Raman spectroscopy, STEM, AFM,

Applications: Photonic crystals, Smart materials, Fuel and solar cells, Opto-electronic devices

Course outcomes:

Upon completion of the course, Students will be able to

1. discriminate between bulk and nano materials,
2. establish the size and shape dependence of Materials' properties,
3. correlate 'quantum confinement' and 'quantum size effect' with physical and chemical properties of nanomaterials,
4. uses top-down and bottom-up methods to synthesize nanoparticles and control their size and shape
5. characterize nanomaterials with various physico-chemical characterization tools and use them in development of modern technologies

Recommended Books:

1. Booker, R., Boysen, E., *Nanotechnology*, Wiley India Pvt, Ltd, (2008)
2. Rogers, B., Pennathur, S., Adams, J., *Nanotechnology*, CRS Press (2007)
3. Bandyopadhyay, A.K., *Nano Materials*, New Age Int., (2007)
4. Niemeyer, C. N., and Mirkin, C, A., *Nanobiotechnology: Concepts, Applications and Perspectives*, Wiley VCH, Weinheim, Germany (2007)

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	45
2	EST	55

UEN004 TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT

L T P Cr
3 0 0 3.0

Course Objectives: To provide acquaintance with modern cleaner production processes and emerging energy technologies; and to facilitate understanding the need and application of green and renewable technologies for sustainable development of the Industry/society

Concepts of Sustainability and Industrial Processes: Industrialization and sustainable development; Cleaner production (CP) in achieving sustainability; Source reduction techniques - Raw material substitution; Process modification and equipment optimization; Product design or modification; Reuse and recycling strategies; Resources and by-product recovery from wastes; Treatment and disposal; CDM and Pollution prevention programs; Good housekeeping; CP audits,

Green Design: Green buildings - benefits and challenges; public policies and market-driven initiatives; Effective green specifications; Energy efficient design; Passive solar design; Green power; Green materials and Leadership in Energy and Environmental Design (LEED)

Renewable and Emerging Energy Technologies: Introduction to renewable energy technologies- Solar; wind; tidal; biomass; hydropower; geothermal energy technologies; Emerging concepts; Biomolecules and energy; Fuel cells; Fourth generation energy systems,

Course Learning Outcomes (CLOs):

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

1. comprehend basic concepts in source reduction, waste treatment and management
2. Identify and plan cleaner production flow charts/processes for specific industrial sectors
3. examine and evaluate present and future advancements in emerging and renewable energy technologies

Recommended Books

1. Kirkwood, R,C, and Longley, A,J, (Eds.), *Clean Technology and the Environment*, Chapman & Hall, London (1995),
2. *World Bank Group; Pollution Prevention and Abatement Handbook – Towards Cleaner Production*, World Bank and UNEP; Washington DC (1998),
3. Modak, P,, Visvanathan, C, and Parasnis, M,, *Cleaner Production Audit, Course Material on Cleaner Production and Waste Minimization; United Nations Industrial Development Organization (UNIDP) (1995),*
4. Rao, S, and Parulekar, B,B,, *Energy Technology: Non-conventional; Renewable and Conventional; Khanna Pub,(2005) 3rd Ed,*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	45

2	EST	55
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UHU009 INTRODUCTION TO COGNITIVE SCIENCE

L T P Cr
3 0 0 3.0

Course Objectives: This course provides an introduction to the study of intelligence, mind and brain from an interdisciplinary perspective, It encompasses the contemporary views of how the mind works, the nature of reason, and how thought processes are reflected in the language we use, Central to the course is the modern computational theory of mind and it specifies the underlying mechanisms through which the brain processes language, thinks thoughts, and develops consciousness,

Overview of Cognitive Science: Newell's big question, Constituent disciplines, Interdisciplinary approach, Unity and diversity of cognitive science,

Philosophy: Philosophy of Mind, Cartesian dualism Nativism vs, empiricism, Mind-body problem, Functionalism, Turing Test, Modularity of mind, Consciousness, Phineas Gage, Physicalism.

Psychology: Behaviorism vs, cognitive psychology, The cognitive revolution in psychology, Hardware/software distinction , Perception and psychophysics, Visual cognition, Temporal dynamics of visual perception, Pattern recognition, David Marr's computational theory of vision, Learning and memory, Theories of learning, Multiple memory systems, Working Memory and Executive Control, Memory span, Dissociations of short- and long-term memory, Baddeley's working memory model.

Linguistics:Components of a grammar, Chomsky, Phrases and constituents, Productivity, Generative grammars, Compositional syntax, Productivity by recursion, Surface- and deep structures, Referential theory of meaning, Compositional semantics, Semantics, Language acquisition, Language and thought.

Neuroscience: Brain anatomy, Hierarchical functional organization, Decorticate animals, Neuroimaging, Neurophysiology, Neuron doctrine, Ion channels, Action potentials, Synaptic transmission, Synaptic plasticity, Biological basis of learning, Brain damage, Amnesia, Aphasia, Agnosia, Parallel Distributed Processing(PDP), Computational cognitive neuroscience, The appeal of the PDP approach, Biological Basis of Learning, Cajal's synaptic plasticity hypothesis, Long-term potentiation (LTP) and depotentiation (LTD), NMDA receptors and their role in LTP, Synaptic consolidation, Vertical integration, The Problem of representation, Shannon's information theory.

Artificial Intelligence: Turing machines, Physical symbol systems, Symbols and Search Connectionism, Machine Learning,, Weak versus strong AI, Subfields, applications, and recent trends in AI, Turing Test revisited, SHRDLU, Heuristic search, General Problem Solver (GPS), Means-ends analysis.

Cognitive architectures:Tripartite architecture, Integration, ACT-R Architecture Modularity.

Course Learning Outcomes (CLOs):

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

1. identify cognitive science as an interdisciplinary paradigm of study of cross-cutting areas such as Philosophy, Psychology, Neuroscience, Linguistics, Anthropology, and Artificial Intelligence.
2. explain various processes of the mind such as memory and attention, as well as representational and modelling techniques that are used to build computational models of mental processes;
3. acquire basic knowledge of neural networks, linguistic formalism, computing theory, and the brain.
4. apply basic Artificial Intelligence techniques to solve simple problems.

Recommended Books

1. *Bermúdez, J.L., Cognitive Science: An Introduction to the Science of the Mind (2nd Ed.), Cambridge, UK: Cambridge (2014).*
2. *Friedenberg, J.D, and Silverman, G, Cognitive Science: An Introduction To The Study Of Mind, Sage Publications:, London (2014)*
3. *Thagard, P., Mind: An introduction to Cognitive Science, MIT Press, (2005)*
4. *Thagard, P., (1998) Mind Readings: Introductory Selections on Cognitive Science, MIT Press, Cambridge, Mass,*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	45
2	EST	55

UHU008 INTRODUCTION TO CORPORATE FINANCE

L	T	P	Cr
3	0	0	3.0

Course Objective: This course aims to provide the students with the fundamental concepts, principles and approaches of corporate finance, enable the students to apply relevant principles and approaches in solving problems of corporate finance and help the students improve their overall capacities.

Introduction to corporate finance: Finance and corporate finance. Forms of business organizations, basic types of financial management decisions, the goal of financial management, the agency problem; the role of the financial manager; basic types of financial management decisions.

Financial statements analysis: Balance sheet, income statement, cash flow, fund flow financial statement analysis Computing and interpreting financial ratios; conducting trend analysis and Du Pont analysis.

The time value of money: Time value of money, future value and compounding, present value and discounting, uneven cash flow and annuity, discounted cash flow valuation.

Risk and return: Introduction to systematic and unsystematic risks, computation of risk and return, security market line, capital asset pricing model.

Long-term financial planning & Financial Decisions: Various sources of long term financing, the elements and role of financial planning, financial planning model, percentage of sales approach, external financing needed. Cost of capital, financial leverage, operating leverage. Capital structure, theories of capital structure net income, net operating income & M&M proposition I and II.

Short-term financial planning and management: Working capital, operating cycle, cash cycle, cash budget, short-term financial policy, cash management, inventory management, credit management.

Capital budgeting : Concepts and procedures of capital budgeting, investment criteria (net present value, payback, discounted payback, average accounting return, internal rate of return, profitability index), incremental cash flows, scenario analysis, sensitivity analysis, break-even analysis,

Dividend policy: Dividend, dividend policy, Various models of dividend policy (Residual approach, Walter model, Gordon Model, M&M, Determinants of dividend policy.

Security valuation: Bond features, bond valuation, bond yields, bond risks, stock features, common stock valuation, and dividend discount & dividend growth models. Common stock yields, preferred stock valuation.

Recommended Books:

1. Brealey, R. A., Myers. S.C., Allen, F., Principles of Corporate Finance (9th edition), The McGraw-Hill, London, (2006).
2. Ehrhardt, M.C., Brigham, E.F., Financial Management: Theory and Practice (10th edition) South Western-Cengage, New York (2011)
3. Van Horne, J.C., Wachowicz, J.M., Kuhlemeyer, G.A., 2005, Fundamentals of Financial Management, Pearson, Vancouver (2010)
4. Pandey, I. M., Financial management, Vikas Publishing House Pvt. Ltd., Noida (2011)
5. Elton, E.J. and Gruber, M.J., Modern Portfolio Theory and Investment Analysis, (7th Edition), John Wiley and Sons, New York (2007)

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	45
2	EST	55

UMA062 GRAPH THEORY AND APPLICATIONS

L	T	P	Cr
3	0	0	3.0

Course Objective: The objective of the course is to introduce students with the fundamental concepts in graph Theory, with a sense of some its modern applications. They will be able to use these methods in subsequent courses in the computer, electrical and other engineering,

Introduction: Graph, Finite and infinite graph, incidence and degree, Isolated vertex, Pendent vertex and null graph, Isomorphism, Sub graph, Walks, Paths and circuits, Euler circuit and path, Hamilton path and circuit, Euler formula, Homeomorphic graph, Bipartite graph, Edge connectivity, Computer representation of graph, Digraph.

Tree and Fundamental Circuits: Tree, Distance and center in a tree, Binary tree, Spanning tree, Finding all spanning tree of a graph, Minimum spanning tree.

Graph and Tree Algorithms: Shortest path algorithms, Shortest path between all pairs of vertices, Depth first search and breadth first of a graph, Huffman coding, Cuts set and cut vertices, Warshall's algorithm, topological sorting.

Planar and Dual Graph: Planar graph, Kuratowski's theorem, Representation of planar graph, five-color theorem, Geometric dual.

Coloring of Graphs: Chromatic number, Vertex coloring, Edge coloring, Chromatic partitioning, Chromatic polynomial, covering.

Application of Graphs and Trees: Konigsberg bridge problem, Utilities problem, Electrical network problem, Seating problem, Chinese postman problem, Shortest path problem, Job sequence problem, Travelling salesman problem, Ranking the participant in a tournament, Graph in switching and coding theory, Time table and exam scheduling, Applications of tree and graph in computer science.

Course Learning Outcomes:

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

- 1) understand the basic concepts of graphs, directed graphs, and weighted graphs and able to present a graph by matrices.
- 2) understand the properties of trees and able to find a minimal spanning tree for a given weighted graph.
- 3) understand Eulerian and Hamiltonian graphs.
- 4) apply shortest path algorithm to solve Chinese Postman Problem .
- 5) apply the knowledge of graphs to solve the real life problem.

Recommended Books

1. Deo, N., *Graph Theory with Application to Engineering with Computer Science*, PHI, New Delhi (2007)
2. West, D. B., *Introduction to Graph Theory*, Pearson Education, London (2008)
3. Bondy, J. A. and Murty, U.S.R., *Graph Theory with Applications*, North Holland Publication, London (2000)

4. Rosen, K. H., *Discrete Mathematics and its Applications*, Tata-McGraw Hill, New Delhi (2007)

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	45
2	EST	55

UMA061 ADVANCED NUMERICAL METHODS

L	T	P	Cr
3	0	0	3.0

Course Objective: The main objective of this course is to motivate the students to understand and learn various advanced numerical techniques to solve mathematical problems governing various engineering and physical problems.

Non-Linear Equations: Methods for multiple roots, Muller's, Iteration and Newton-Raphson method for non-linear system of equations and Newton-Raphson method for complex roots.

Polynomial Equations: Descartes' rule of sign, Birge-vieta, Giraffe's methods.

System of Linear Equations: Cholesky and Partition methods, SOR method with optimal relaxation parameters.

Eigen-Values and Eigen-Vectors: Similarity transformations, Gerschgorin's bound(s) on eigenvalues, Given's and Rutishauser methods.

Interpolation and Approximation: Cubic and B – Spline and bivariate interpolation, Least squares approximations, Gram-Schmidt orthogonalisation process and approximation by orthogonal polynomial, Legendre and Chebyshev polynomials and approximation.

Differentiation and Integration: Differentiation and integration using cubic splines, Romberg integration and multiple integrals.

Ordinary differential Equations: Milne's, Adams-Moulton and Adam's Bashforth methods with their convergence and stability, Shooting and finite difference methods for second order boundary value problems.

Course Learning Outcomes:

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

- 1) find multiple roots of equation and apply Newton -Raphson's method to obtain complex roots as well solution of system of non - linear equations.
- 2) learn how to obtain numerical solution of polynomial equations using Birge - Vitae and Giraffe's methods.
- 3) apply Cholesky, Partition and SOR methods to solve system of linear equations.
- 4) understand how to approximate the functions using Spline, B- Spline, least square approximations
- 5) learn how to solve definite integrals by using cubic spline, Romberg and initial value problems and boundary value problems numerically.

Recommended Books

1. *Gerald, C.F. and Wheatley, P.O., Applied Numerical Analysis, Pearson Education (2008) 7th ed.*
2. *Gupta, S.R., Elements of Numerical Analysis, MacMillan India (2009).*
3. *Atkinson, K.E., An introduction to Numerical Analysis, John Wiley (2004) 2nd ed.*
4. *S.D. Conte, S.D. and Carl D. Boor, Elementary Numerical Analysis: An Algorithmic Approach, Tata McGraw Hill (2005).*
5. *Jain M. K., Iyengar. S.R.K. and Jain, R.K. Numerical Methods for Scientific and Engineering Computation, New Age International (2008) 5th ed.*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	45
2	EST	55

UHU006 INTRODUCTORY COURSE IN FRENCH

L T P Cr
3 0 0 3.0

Course Objectives: The objectives of the course is to introduce to the students:

1. The basics of French language to the students. It assumes that the students have minimal or no prior knowledge of the language.
2. To help them acquire skills in writing and speaking in French, comprehending written and spoken French.
3. The students are trained in order to introduce themselves and others, to carry out short conversation, to ask for simple information, to understand and write short and simple messages, to interact in a basic way.
4. The main focus of the students will be on real life language use, integration of French and francophone culture, & basic phrases aimed at the satisfaction of needs of concrete type.
5. During class time the students are expected to engage in group & pair work.

Communicative skills: Greetings and Its Usage, Asking for and giving personal information, How to ask and answer questions, How to talk over the phone, Exchange simple information on preference, feelings etc. Invite, accept, or refuse invitation, Fix an appointment, Describe the weather, Ask for/give explanations, Describe a person, an object, an event, a place.

Grammar : Pronouns: Pronom sujets (Je/ Tu/Il/Elle/Nous/Vous/Ils/Elles), Nouns: Genders, Articles: Definite article and Indefinite articles, Verbs: Regular verbs (-er, -ir ending) Irregular verbs (-re ending), Auxiliary verbs (avoir, être, aller). Adjective: Description, Adjective possessive, Simple Negation, Tense: Present, Future, Questions, Singular & plural.

Vocabulary: Countries and Nationalities, Professions, Numbers (ordinal, cardinal), Colours, Food and drinks, Days of the week, Months, Family, Places.

Phonetics: The course develops the ability, to pronounce words, say sentences, questions and give orders using the right accent and intonation. To express surprise, doubt, fear, and all positive or negative feelings using the right intonation. To distinguish voiced and unvoiced consonants. To distinguish between vowel sounds.

Course Outcomes:

Upon the completion of the course:

1. The students begin to communicate in simple everyday situations acquiring basic grammatical structure and vocabulary.
2. The course develops oral and reading comprehension skills as well as speaking and writing.
3. Students can demonstrate understanding of simple information in a variety of authentic materials such as posters, advertisement, signs etc.
4. Discuss different professions, courses and areas of specialisation.
5. Write simple messages, letters, composition and dialogues. Complete simple forms and documents.
6. Express feelings, preferences, wishes and opinions and display basic awareness of francophone studies.
7. Units on pronunciation and spelling expose students to the different sounds in the French language and how they are transcribed.

Recommended Books :

1. *Alter ego-1 : Méthode de français* by Annie Berthet, Catherine Hugot, Véronique M. Kizirion, Beatrix Sampsonis, Monique Waendendries, Editions Hachette français langue étrangère.
2. *Connexions-1 : Méthode de français* by Régine Mérieux, Yves Loiseau, Editions Didier
3. *Version Originale-1: Méthode de français* by Monique Denyer, Agustin Garmendia.
4. *Marie-Laure Lions-Olivieri*, Editions Maison des Langues, Paris 2009
5. *Latitudes-1 : Méthode de français* by Régine Mérieux, Yves Loiseau, Editions Didier
6. *Campus-1 : Méthode de français* by Jacky Girardet, Jacques Pécheur, Editions CLE International.
7. *Echo-1 : Méthode de français* by J. Girardet, J. Pécheur, Editions CLE International.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	45
2	EST	55

UBT509 BIOLOGY FOR ENGINEERS

LT P Cr
3 0 0 3.0

Course Objective: To learn about living world and basic functioning of biological systems. The course encompasses understanding of origin of life, its evolution and some of its central characteristics. It also aims to familiarize engineering students to some of the intricate biological phenomena and mechanisms.

Characteristics of life: Living versus non-living organisms, origin of life, theory of evolution, diversity of life, classification of life into animals, plants, fungi, protists, archea and bacteria. Phylogenetics and its relationship with evolution.

Introduction to biological systems: Cell as basic unit of life, cellular organelles and their functions, important biomacromolecules (carbohydrates, lipids, proteins and nucleic acids) and their properties.

Cell membrane: Membrane structure, selective permeability, transport across cell membrane, active and passive transport, membrane proteins, type of transport proteins, channels and pumps, examples of membrane transport in cell physiology.

Classical and molecular genetics: Heredity and laws of genetics, genetic material and genetic information, Structure and properties of DNA, central dogma, replication of genetic information, universal codon system, encoding of genetic information via transcription and translation.

Course Learning Outcomes (CLOs):

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

1. Describe living-systems and differentiate them from non-living systems
2. Explain the theory of evolution and apply it non-living world
3. Apply properties of nucleic acids in molecular recognition based diagnostics
4. Familiarized with various transport mechanisms across cell membranes
5. Explain how genetic information is stored, replicated and encoded in living organisms.

Recommended Books:

1. Nelson, D.L., Cox, M.M., Lehninger: Principles of Biochemistry, WH Freeman (2008) 5th ed.
2. Dhami, P.S., Srivastava, H.N. Chopra, G., A Textbook of Biology, Pradeep Publications (2008).
3. Das, H.K., Textbook of Biotechnology, John Wiley & Sons (2004) 3rd Edition.
4. Gardner, E.J., Simmons, M., Peter, S.D., Principles of Genetics, John Wiley & Sons (2008)
5. Albert, B., Essential Cell Biology, Taylor & Francis, London (2009)

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	45
2	EST	55

UCS001 INTRODUCTION TO CYBER SECURITY

L T P Cr

3 0 0 3.0

Course Objectives: In this course, the student will learn about the essential building blocks and basic concepts around cyber security such as Confidentiality, Integrity, Availability, Authentication, Authorization, Vulnerability, Threat and Risk and so on.

Introduction: Introduction to Computer Security, Threats, Harm, Vulnerabilities, Controls, Authentication, Access Control, and Cryptography, Authentication, Access Control, Cryptography

Programs and Programming: Unintentional (Non-malicious) Programming Oversights, Malicious Code—Malware, Countermeasures

Web Security: User Side, Browser Attacks, Web Attacks Targeting Users, Obtaining User or Website Data, Email Attacks

Operating Systems Security: Security in Operating Systems, Security in the Design of Operating Systems, Rootkit

Network Security: Network Concepts, Threats to Network Communications, Wireless Network Security, Denial of Service, Distributed Denial-of-Service Strategic Defenses: Security Countermeasures, Cryptography in Network Security, Firewalls, Intrusion Detection and Prevention Systems, Network Management

Cloud Computing and Security: Cloud Computing Concepts, Moving to the Cloud, Cloud Security Tools and Techniques, Cloud Identity Management, Securing IaaS

Privacy: Privacy Concepts, Privacy Principles and Policies, Authentication and Privacy, Data Mining, Privacy on the Web, Email Security, Privacy Impacts of Emerging Technologies, Where the Field Is Headed

Management and Incidents: Security Planning, Business Continuity Planning, Handling Incidents, Risk Analysis, Dealing with Disaster

Legal Issues and Ethics: Protecting Programs and Data, Information and the Law, Rights of Employees and Employers, Redress for Software Failures, Computer Crime, Ethical Issues in Computer Security, Incident Analysis with Ethics

Emerging Topics: The Internet of Things, Economics, Computerized Elections, Cyber Warfare.

Course Learning Outcomes:

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

1. Understand the broad set of technical, social & political aspects of Cyber Security and security management methods to maintain security protection
2. Appreciate the vulnerabilities and threats posed by criminals, terrorist and nation states to national infrastructure
3. Understand the nature of secure software development and operating systems
4. Recognize the role security management plays in cyber security defense and legal and social issues at play in developing solutions.

Recommended Books:

1. *Pfleeger, C.P., Security in Computing, Prentice Hall, 5th edition (2010)*
2. *Schneier, B., Applied Cryptography, Second Edition, John Wiley & Sons (1996)*

3. Rhodes-Ousley, M., *Information Security: The Complete Reference, Second Edition, Information Security Management: Concepts and Practice*. New York, McGraw-Hill, (2013).
4. Whitman, M.E. and Herbert J. M., *Roadmap to Information Security for IT and Infosec Managers*, Course Technology, Boston, MA (2011).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	45
2	EST	55

UTD007 EMPLOYABILITY DEVELOPMENT SKILLS

L	T	P	Cr
0	3	3	3.0

Course Objectives: This course aims to sensitize students with the gamut of skills which facilitate them to enhance their employability quotient and do well in the professional space. These skills are imperative for students to establish a stronger connect with the environment in which they operate. An understanding of these skills will enable students to manage the placement challenges more effectively.

Emotional Intelligence: Understanding Emotional Intelligence (EI); Daniel Goleman's EI Model: Self Awareness, Self-Regulation, Internal Motivation, Empathy, Social Skills; Application of EI during Group Discussions & Personal Interview; Application of EI in personal life, student life and at the workplace

Team Dynamics & Leadership: Understanding the challenges of working within a team format in today's complex organizational environments; Stages of team formation; Appreciating forces that influence the direction of a team's behaviour and performance; Cross-functional teams; Conflict in Teams- leveraging differences to create opportunity Leadership in the team setting & energizing team efforts; Situational leadership; Application of team dynamics & collaboration in Group Discussions; Application of team dynamics at the workplace

Complex Problem Solving: Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions; Understanding a working model for complex problem solving - framing the problem, diagnosing the problem, identifying solutions & executing the solutions; Appreciation of complex problem solving at the workplace through case studies

Lateral Thinking: Understanding lateral thinking & appreciating the difference between vertical & lateral thinking, and between convergent & divergent thinking; Understanding brain storming & mind-maps; Solving of problems by an indirect and creative approach, typically through viewing the problem in a new and unusual light; Application of lateral thinking during Group Discussions & Personal Interviews; Application of lateral thinking at the workplace

Persuasion: Role of persuasion in communication; Application of ethos-pathos-logos; Using persuasive strategies to connect with individuals & teams to create competitive advantage

Quantitative Reasoning: Thinking critically and applying basic mathematics skills to interpret data, draw conclusions, and solve problems; developing proficiency in numerical reasoning; Application of quantitative reasoning in aptitude tests

Verbal Reasoning: Understanding and reasoning using concepts framed in words; Critical verbal reasoning; Reading Comprehension; Application of verbal reasoning in aptitude tests

Group Discussion (GD): Illustrating the do's and don'ts in Group Discussions; Specific thrust on types of GD topics; GD evaluation parameters; Understanding the challenge in a case discussion; SPACER model

Personal Interview (PI): Interview do's and don'ts; PI evaluation parameters; The art of introduction; Managing bouncer questions; Leading the panel in a PI

Course Learning Outcomes (CLOs):

The students will be able to

1. appreciate the various skills required for professional & personal success.
2. bridge the gap between current and expected performance benchmarks.
3. competently manage the challenges related to campus placements and perform to their utmost potential.

Recommended Books:

1. *Harvard Business Essentials; Creating Teams with an Edge; Harvard Business School Press (2004)*
2. *Edward de B., Six Thinking Hats; Penguin Life (2016)*
3. *Daniel, G., Working with Emotional Intelligence; Bantam Books (2000)*
4. *Aggarwal, R.S., Quantitative Aptitude for Competitive Examinations; S Chand (2017)*
5. *Agarwal, A., An expert guide to problem solving: with practical examples; CreateSpace Independent Publishing Platform (2016)*
6. *William, D., The Logical Thinking process; American Society for Quality (2007)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	45
2	EST	55

