COURSE SCHEME

FOR

B.E. - ELECTRONICS (INSTRUMENTATION AND CONTROL) ENGINEERING

2020

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

SEMESTER-I

S. No.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UPH004	APPLIED PHYSICS	CF	3	1	2	4.5
2	UMA010	MATHEMATICS-I	CF	3	1	0	3.5
3	UTA003	COMPUTER PROGRAMMING	CF	3	0	2	4.0
4	UEC001	ELECTRONIC ENGINEERING	CF	3	1	2	4.5
5	UTA015	ENGINEERING DRAWING	CF	2	0	4	4.0
6	UHU003	PROFESSIONAL COMMUNICATION	CF	2	0	2	3.0
		Total		**16**	**3**	**12**	**23.5**

SEMESTER-II

S. No.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UCB008	APPLIED CHEMISTRY	CF	3	1	2	4.5
2	UEE001	ELECTRICAL ENGINEERING	CF	3	1	2	4.5
3	UEN002	ENERGY AND ENVIRONMENT	CF	3	0	0	3.0
4	UMA004	MATHEMATICS-II	CF	3	1	0	3.5
5	UES009	MECHANICS	CF	2	1	2*	2.5
6	UTA018	OBJECT ORIENTED PROGRAMMING	CF	3	0	2	4.0
7	UTA016	ENGINEERING DESIGN PROJECT-I (2 self effort hours)	PR	1	0	2	3.0
		Total		**18**	**4**	**8+2***	**25.0**

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

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SEMESTER-III

S. No.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UMA033	NUMERICAL AND STATISTICAL METHODS	CF	3	0	2	4.0
2	UTA025	INNOVATION AND ENTREPRENEURSHIP (2 self effort hours)	CF	1	0	2*	3.0
3	UHU005	HUMANITIES FOR ENGINEERS	CF	2	0	2	3.0
4	UES012	ENGINEERING MATERIALS	CF	3	1	2	4.5
5	UEI403	ELECTRICAL AND ELECTRONIC MEASUREMENTS	CP	3	1	2	4.5
6	UEI407	SIGNALS AND SYSTEMS	CP	3	1	0	3.5
7	UTA024	ENGINEERING DESIGN PROJECT-II	PR	1	0	4	3.0
		Total		**16**	**3**	**12+2***	**25.5**

*Alternate week

SEMESTER-IV

S. No.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UES018	MANUFACTURING TECHNIQUES	CF	2	0	2	3.0
2	UMA035	OPTIMIZATION TECHNIQUES	CF	3	0	2	4.0
3	UEE503	NETWORK ANALYSIS AND SYNTHESIS	CP	3	1	0	3.5
4	UEI601	INDUSTRIAL INSTRUMENTATION	CP	3	1	2	4.5
5	UEI501	CONTROL SYSTEMS	CP	3	1	2	4.5
6	UEI408	ANALOG DEVICES AND CIRCUITS	CP	3	1	2	4.5
		Total		**17**	**4**	**10**	**24.0**

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SEMESTER-V

S. No.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UEI607	DIGITAL SIGNAL PROCESSING AND APPLICATIONS	CP	3	1	2	4.5
2	UEI610	FUNDAMENTALS OF MICROPROCESSORS AND MICROCONTROLLERS	CP	3	0	2	4.0
3	UEI608	BIO-MEDICAL INSTRUMENTATION	CP	3	0	2	4.0
4	UEI509	DIGITAL SYSTEMS	CP	3	1	2	4.5
5	UEE701	POWER ELECTRONICS AND DRIVES	CP	3	1	2	4.5
6		GENERIC ELECTIVE	GE	2	0	0	2.0
		Total		**17**	**3**	**10**	**23.5**

SEMESTER-VI

S. No.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UEI844	VIRTUAL INSTRUMENTATION	CP	2	0	3	3.5
2	UEI604	PROCESS DYNAMICS AND CONTROL	CP	3	1	2	4.5
3	UEI701	DATA ACQUISITION AND SYSTEM DESIGN	CP	3	0	2	4.0
4	UCS540	DATA STRUCTURE AND ALGORITHMS	CP	3	0	2	4.0
5	UCS411	ARTIFICIAL INTELLIGENCE	CF	3	0	2	4.0
6		ELECTIVE-1	PE	-	-	-	3.0
7		ELECTIVE-II	PE	-	-	-	3.0
	UEI793	CAPSTONE PROJECT (START)	PR	1*	0	2	--
		Total		**13+1***	**1**	**13**	**26.0**

*Alternate week

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SEMESTER-VII

S. No.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UEI704	SOFT COMPUTING TECHNIQUES	CP	3	0	2	4.0
2	UEI801	ADVANCED PROCESS CONTROL	CP	3	1	2	4.5
3	UEI793	CAPSTONE PROJECT	PR	1*	0	2	8.0
4		ELECTIVE-III	PE	-	-	-	4.0
5		ELECTIVE-IV	PE	-	-	-	3.0
		Total		**6+1***	**1**	**6**	**23.5**

*Alternate week

SEMESTER-VIII

S. No.	COURSE NO.	TITLE	CODE	L	T	P	CR
1	UEI896	PROJECT SEMESTER	PR	-	-	-	**15.0**
		OR					
1	UEI852	LINEAR INTEGRATED CIRCUITS	CP	3	0	2	4.0
2	UEI897	DESIGN PROJECT	PR	-	-	-	8.0
3	UEI805	ENVIRONMENTAL INSTRUMENTATION	CP	3	0	0	3.0
		Total		**6**	**0**	**2**	**15.0**
		OR					
1	UEI898	START- UP SEMESTER	PR	-	-	-	**15.0**

TOTAL CREDITS: 186.0

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

BASKETS OF THE SUBJECTS TO BE OFFERED UNDER THE SPECIALIZATION

S.No.	Industrial Automation (basket 1)	Biomedical Instrumentation (basket 2)	Smart Systems (basket 3)
1	Robotics	Biometrics	IOT based systems
2	Robust controls	Prosthetics and rehabilitation	Data Analytics
3	Advanced Control systems	Biomedical signal and image processing	Embedded system design
4	Real Time Control Systems	Medical devices	Smart Sensor Networks

LIST OF ELECTIVES

ELECTIVE I

S. No.	COURSE NO.	TITLE	L	T	P	CR
1	UEI612	ROBOTICS **(basket 1)**	2	0	2	3.0
2	UEI613	BIOMETRICS **(basket 2)**	2	0	2	3.0
3	UEI514	IOT BASED SYSTEMS **(basket 3)**	2	0	2	3.0
4	UEI515	ANALOG AND DIGITAL COMMUNICATION	3	0	0	3.0
5	UEI516	ANALYTICAL INSTRUMENTATION	3	0	0	3.0
6	UCS312	DATA BASE MANAGEMENT SYSTEM	2	0	2	3.0

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ELECTIVE II

S. No.	COURSE NO.	TITLE	L	T	P	CR
1	UEI845	ROBUST CONTROLS **(basket 1)**	3	0	0	3.0
2	UEI626	PROSTHETICS AND REHABILITATION **(basket 2)**	3	0	0	3.0
3	UEI627	DATA ANALYTICS **(basket 3)**	3	0	0	3.0
4	UEI628	OPTICAL INSTRUMENTATION	3	0	0	3.0
5	UCS414	COMPUTER NETWORKS	2	0	2	3.0
6	UEC859	Integrated System Design	2	0	2	3.0

ELECTIVE III

S. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UEI731	ADVANCED CONTROL SYSTEMS **(basket 1)**	3	0	2	4.0
2	UEI732	BIOMEDICAL SIGNAL AND IMAGE PROCESSING **(basket 2)**	3	0	2	4.0
3	UEI733	EMBEDDED SYSTEM DESIGN **(basket 3)**	3	0	2	4.0
4	UEI734	DIGITAL IMAGE PROCESSING	3	0	2	4.0
5	UCS303	OPERATING SYSTEMS	3	0	2	4.0
6	UEC637	VLSI Testing and Verification	3	0	2	4.0

ELECTIVE IV

S. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UEI848	REAL TIME CONTROL SYSTEMS **(basket 1)**	3	0	0	3.0
2	UEI741	MEDICAL DEVICES **(basket 2)**	3	0	0	3.0
3	UEI742	SMART SENSOR NETWORKS **(basket 3)**	3	0	0	3.0

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4	UEI743	BIOSENSORS AND MEMS	3	0	0	3.0
5	UCS753	DEEP LEARNING AND COMPUTER VISION	2	0	2	3.0

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GENERIC ELECTIVES

S. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UHU016	INTRODUCTORY COURSE IN FRENCH	2	0	0	2.0
2	UCS002	INTRODUCTION TO CYBER SECURITY	2	0	0	2.0
3.	UTD002	EMPLOYABILITY DEVELOPMENT SKILL	2	0	0	2.0
4.	UHU017	INTRODUCTION TO COGNITIVE SCIENCE	2	0	0	2.0
5.	UHU018	INTRODUCTION TO CORPORATE FINANCE	2	0	0	2.0
6.	UEN006	TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT	2	0	0	2.0
7.	UPH064	NANO SCIENCE AND NANO-MATERIALS	2	0	0	2.0
8.	UMA069	GRAPH THEORY AND APPLICATIONS	2	0	0	2.0
9.	UMA070	ADVANCED NUMERICAL METHODS	2	0	0	2.0
10.	UBT510	BIOLOGY FOR ENGINEERS	2	0	0	2.0

Semester	EL Activity**
I	Design and development of power supplies
II	House wiring
III	Design and development of IOT based measurement system
IV	Design and development of IOT based monitoring and decision making
V	Microcontroller based data acquisition system design

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

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SEMESTER-I

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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.

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

Course Learning Outcomes (CLO):

On completion of the course, the students would 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 HallTM (2008) 3rd ed.

Evaluation Scheme:

S.No	Assessment	Weightage (%)
1	MST	25
2	EST	35
3	Tut/Sessional	7
4	Lab + Project	25
5	Quiz	8
Total		**100**

UMA010: MATHEMATICS – I

L	T	P	Cr
3	1	0	3.5

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

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

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

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

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

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

Course Learning Outcomes (CLO):

Upon completion of this course, the students would 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	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

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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: Classification of Computers; Application of Computers; Basic organization of computer; Input and Output Devices; Binary Number System; Computer memory; Computer Software.

Algorithms and Programming Languages: Algorithm; Flowcharts; Pseudocode; 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.

Linear and Non-Linear Data Structures: Linked lists; stacks and queues.

Laboratory work:

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

Course Learning Outcomes (CLO):

On completion of the Course, the student would be able to:

1. comprehend concepts related to computer hardware and software, draw flowcharts and write algorithm/pseudocode.
2. write, compile and debug programs in C language, use different data types, operators and console I/O function in a computer program.
3. design programs involving decision control statements, loop control statements, case control structures, arrays, strings, pointers, functions and implement the dynamics of memory by the use of pointers.
4. comprehend the concepts of linear and Non-Linear data structures by implementing linked lists, stacks and queues.

Text Books:

1. *Kernighan, B.W. and Ritchie, D.M., The C Programming language, (2012) 2nd ed.*
2. *Balagurusamy, E., Programming in Ansi C, TMH Publications (2019) 8th ed.*

Reference Books:

1. *Perry, G. and Miller, D., C Programming Absolute Beginner's Guide, Pearson (2013), 3rd ed.*
2. *Griffiths, D., and Griffiths, D., Head First C, O'Reilly (2012), 1st ed.*

Evaluation scheme:

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

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UEC001: ELECTRONIC ENGINEERING

L	T	P	Cr
3	1	2	4.5

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

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

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

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

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

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

Laboratory Work:

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

Course Learning Outcomes (CLO):

On completion of the Course, the student would be able to:

1. demonstrate the use of semiconductor diodes in various applications.
2. discuss and explain the working of transistors and operational Amplifiers, their configurations and applications.
3. recognize and apply the number systems and Boolean algebra.

4. reduce Boolean expressions and implement them with Logic Gates.
5. analyze, design and implement combinational and sequential circuits.

Text Books:

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

Reference Books:

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

Evaluation Scheme:

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

UTA015: ENGINEERING DRAWING

L	T	P	Cr
2	0	4	4.0

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

Engineering Drawing

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

AutoCAD

1. Management of screen menus commands
2. Introduction to drawing entities
3. Co-ordinate systems: Cartesian, polar and relative coordinates
4. Drawing limits, units of measurement and scale
5. Layering: organizing and maintaining the integrity of drawings
6. Design of prototype drawings as templates.
7. Editing/modifying drawing entities: selection of objects, object snap modes, editing commands,
8. Dimensioning: use of annotations, dimension types, properties and placement, adding text to drawing

Micro Projects /Assignments:

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

b. Using wax blocks or soap bars to develop three dimensional object, section it and color the section
c. Use of AUTOCAD as a complementary tool for drawing the projections of the objects created in (1) and (2).

4. Develop the lateral surface of different objects involving individual or a combination of solids like Prism, Cone, Pyramid, Cylinder, Sphere etc.
5. To draw the detailed and assembly drawings of simple engineering objects/systems with due sectioning (where ever required) along with bill of materials.e.g. Rivet joints, simple bearing, wooden joints, Two plates connected with nut and bolt etc.

Course Learning Outcomes (CLO):

On completion of the Course, the student would be able to:

1. creatively comprehend geometrical details of common engineering objects
2. draw dimensioned orthographic and isometric projections of simple engineering objects
3. draw sectional views of simple engineering objects.
4. interpret the meaning and intent of toleranced dimensions and geometric tolerance symbolism
5. create and edit dimensioned drawings of simple engineering objects using AutoCAD
6. organize drawing objects using layers and setting up of templates in AutoCAD

Text Books:

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

Reference Books:

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

Evaluation Scheme:

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

UHU003: PROFESSIONAL COMMUNICATION

L	T	P	Cr
2	0	2	3.0

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

Effective communication: Meaning; Barriers; Types of communication and Essentials. Interpersonal Communication skills.
Effective Spoken Communication: Understanding essentials of spoken communication; Public speaking; Discussion Techniques; Presentation strategies.
Effective Professional and Technical writing: Paragraph development; Forms of writing; Abstraction and Summarization of a text; Technicalities of letter writing; internal and external organizational communication. Technical reports and proposals.
Effective non verbal communication: Knowledge and adoption of the right non verbal cues of body language; interpretation of the body language in professional context. Understanding Proxemics and other forms of non verbal communication.
Communicating for Employment: Designing Effective Job Application letter and resumes.
Communication Networks in organizations: Types; barriers and overcoming the barriers.

Laboratory work:

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

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

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.

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Text Books:

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

Reference Books:

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

Evaluation Scheme:

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

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SEMESTER-II

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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:

1. **Electrochemical measurements**: Experiments involving use of pH meter, conductivity meter, potentiometer.
2. **Acid and Bases**: Determination of mixture of bases.
3. **Spectroscopic techniques**: Colorimeter, UV-Vis spectrophotometer.
4. **Water and its treatment**: Determination of hardness, alkalinity, chloride, chromium, iron and copper in aqueous medium.

Course Learning Outcomes (CLO):

On completion of the Course, the student would be able to:

1. concepts of electrodes in electrochemical cells, migration of ions, liquid junctionpotential 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) 1st ed.*
2. *Puri, B.R., Sharma,L.R., and Pathania, M.S. Principles of Physical Chemistry, Vishal Publishing Co. (2008).*
3. *Aggarwal, S. Engineering Chemistry: Fundamentals and Applications, Cambridge University Press (2015).*

Reference Books:

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

Evaluation Scheme:

S.No	Assessment	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals	35

UEE001: ELECTRICAL ENGINEERING

L	T	P	Cr
3	1	2	4.5

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

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

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

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

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

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

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

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

Course Learning Outcome (CLO):

On completion of the Course, the student would 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 No	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessional (Assignments/Projects/Tutorials/Quizzes /Lab Evaluations)	40

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UEN002 ENERGY AND ENVIRONMENT

L	T	P	Cr
3	0	0	3.0

Course Objectives: The exposure to this course would facilitate the students in understanding the terms, definitions and scope of environmental and energy issues pertaining to current global scenario; understanding the value of regional and global natural and energy resources; and emphasize on need for conservation of energy and environment.

Introduction: Natural Resources & its types, Concept of sustainability and sustainable use of natural resources, Pollution based environmental issues and case studies

Conventions on Climate Change: Origin of Conference of Parties (COPs), United Nations Framework Convention on Climate Change (UNFCCC) and Intergovernmental Panel on Climate Change (IPCC); Kyoto Protocol, instruments of protocol – CDM, JI and IET; Montreal Action Plan; Paris Agreement and post-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 Harow (2006).*
5. *O'Callagan, P.W., Energy Management, McGraw Hill Book Co. Ltd. (1993).*
6. *Peavy H.S. and Rowe D.R. Environmental Engineering, McGraw Hill (2013).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	50
3.	Sessionals/Quizzes/Projects Evaluations	20

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; Convolution theorem; 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 (CLO):

On completion of the course, the students would 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.

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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).*

Recommended Books:

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

Evaluation Scheme:

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

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UES009: MECHANICS

L	T	P	Cr
2	1	2*	2.5

(*Two hours lab once in a 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):
On completion of the course, the students would 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).*

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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	Weightage (%)
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.

Objects and Classes: Structure in C and C++, Class specification, Objects, Data hiding, Encapsulation and abstraction, namespaces, Array of objects, Passing objects as arguments, Returning object from a function, inline functions, Static data member and member function, 'const' member function.

Constructor and Destructor: Constructors, Parameterized Constructors, Constructor Overloading, Constructors in array of objects, Constructors with default arguments, Dynamic Initialization, Pointer to objects, this pointer, Dynamic memory allocation, Array of pointer to objects, Copy Constructor, Static objects, Friend function, and Friend classes.

Operator Overloading and Type Conversion: Syntax of operator overloading, Overloading Unary operator and Binary operator, overloading arithmetic operator, relational operator, Overloading Unary operator and Binary operator using friend function, Data conversion, Overloading some special operators like (), []

Inheritance: Derived Class declaration, Public, Private and Protected Inheritance, friend function and Inheritance, Overriding member function, Forms of inheritance, virtual base class, Abstract class, Constructor and Inheritance, Destructor and Inheritance, Advantage and disadvantage of Inheritance.

Polymorphism: Classification of Polymorphism, Compile time and Run time Polymorphism, Pointers to derived class object, Virtual functions, Pure virtual functions.

File handling: Formatted I/O, Hierarchy of file stream classes, Opening and closing a file, Working with multiple files, file modes, file pointers, Text vs Binary Files.

Templates: Need of template, Function templates, Function template with non-type parameter, Overloading function templates, Class templates, Class template with non-type parameter.

Exception Handling: Exception handling mechanism, Multiple Catch Blocks, Catch All exceptions, Throw an exception, Exception Specification.

Standard Template Library: Fundamental idea about string, iterators, hashes and other types, The String and Vector classes vs C-style pointers

Laboratory work:

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

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Course Learning Outcomes (CLOs):

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

1. Understand the basic concept of Classes, objects and Object Orientation, with basic layout of an object oriented program.
2. Comprehend the concept of constructors and destructors.
3. Demonstrate the prime concepts *viz.* overloading, polymorphism, abstraction and Inheritance of an object oriented paradigm.
4. Grasp the File handling concepts and be able to use files.
5. Use template and Exception handling in an object oriented programming.

Text Books:

1. *Schildt H., C++: The Complete Reference, Tata Mcgraw Hill (2003) 4th ed.*
2. *Lippman B. S., Lajoie J., and Moo E. B., C++ Primer, Addison-Wesley Professional (2013) 5th ed.*

Reference books:

1. *Lafore R., Object-Oriented Programming in C++, Pearson Education (2002) 4th ed.*
2. *E Balagurusamy, Object Oriented Programming with C++ (2017) 7th ed.*
3. *Stroustrup B., The C++ programming language, Pearson Education India (2013) 4th ed.*

Evaluation scheme

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

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UTA016: ENGINEERING DESIGN PROJECT-I

L	T	P	Cr
1	0	2	3.0

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

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

Breakup of lecture details to be taken up by MED:

Lec No.	Topic	Contents
Lec 1	Introduction	The Mangonel Project. History. Spreadsheet.
Lec 2	PROJECTILE MOTION	no DRAG, Design spread sheet simulator for it.
Lec 3	PROJECTILE MOTION	with DRAG, Design spread sheet simulator for it.
Lec 4	STRUCTURES FAILURE	STATIC LOADS
Lec 5	STRUCTURES FAILURE	DYNAMIC LOADS

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

Breakup of lecture details to be taken up by ECED:

Lec No.	Topic	Contents
Lec 1-5	Digital Electronics	Prototype, Architecture, Using the Integrated Development Environment (IDE) to Prepare an Arduino Sketch, structuring an Arduino Program, Using Simple Primitive Types (Variables), Simple programming examples. Definition of a sensor and actuator.

Tutorial Assignment / Laboratory Work:

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

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

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

Project: The Project will facilitate the design, construction and analysis of a "Mangonel". In addition to some introductory lectures, the content of the students' work during the semester will consist of:

1. the assembly of a Mangonel from a Bill Of Materials (BOM), detailed engineering drawings of parts, assembly instructions, and few prefabricated parts;
2. the development of a software tool to allow the trajectory of a "missile" to be studied as a function of various operating parameters in conditions 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):

On completion of the Course, the student would be able to:

1. simulate trajectories of a mass with and without aerodynamic drag using a spreadsheet based software tool to allow trajectories be optimized;
2. perform a test to acquire an engineering material property of strength in bending and analyze the throwing arm of the "Mangonel" under conditions of static and dynamic loading;
3. develop and test 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 Mc Roberts, 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 Electronics Hardware and software Practical work in Laboratory Assessment of Mechanical contents in Lectures and Tutorials and Electronics contents in Lectures and Practical. Project (Assembly of the "Mangonel", innovative redesign with reflection, prototype competition, Final Presentation and viva-voce	30 30 10 30

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SEMESTER-III

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UMA033: Numerical and Statistical Methods

(Only for BE-Electrical and BE- Electronics (Instrumentation and Control)

L	T	P	Cr
3	0	2	4.0

Prerequisite(s): None

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

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

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

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

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

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

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

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

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

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

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

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

1. learn how to obtain numerical solution of nonlinear equations using bisection, Newton, and fixed-point iteration methods.
2. solve system of linear equations numerically using direct and iterative methods.
3. analyze the correlated data using the least square and regression curves.
4. solve integration and initial value problems numerically.
5. solve real life problems using various probability distributions.
6. approximate the data and functions using interpolating polynomials

Texts books:

1. K. Atkinson and W. Han, Elementary Numerical Analysis, 3rd Edition, John Willey &Sons, 2004.
2. Brian Bradie, A friendly Introduction to Numerical Analysis, prentice Hall, 2007
3. Richard L. Burden and J. Douglas Faires, Numerical Analysis, 8th edition, Brooks Cole, 2004
4. Richards A. Johnson, Probability and Statistics for Engineers, 8th edition, PHI learning, 2011.
5. Meyer, P. L., Introductory Probability and Statistical applications, 2nd edition, Oxford, 1970

References:

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

Evaluation Scheme:

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

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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.*

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

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UHU005: HUMANITIES FOR ENGINEERS

L	T	P	Cr
2	0	2	3.0

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

Detailed Content:

Unit 1: Human Values and Ethics

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

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

Kohlberg's Theory of Moral Development

Professional Ethics: Profession: Attributes and Ethos, Whistle-blowing.

Unit 2: Organizational Behavior

Introduction to the Field of Organizational Behaviour

Individual Behaviour, Personality, and Values

Perceiving Ourselves and Others in Organizations

Workplace Emotions, Attitudes, and Stress

Foundations of Employee Motivation and Leadership

Performance Appraisal

Conflict and Negotiation in the Workplace

Unit 3: Economics

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

Elasticity and its types

Production & Cost Analysis – Short run & Long Run Production Functions, Short run & Long run cost functions, Economies & Diseconomies of Scale

Competitive Analysis & Profit Maximization – Perfect competition, Monopoly, Monopolistic & Oligopoly Markets

Strategy & Game Theory – Pure Strategy & Mixed Strategy Games, Dominance, Nash Equilibrium, & Prisoner's Dilemma

Capital Budgeting – Capital Projects, Net Present Value (NPV) & IRR techniques.

Practical:

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

Course learning Outcomes (CLOs)

The student after completing the course will be able to:

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

Text Books

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

Reference Books

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

Evaluation Scheme:

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

UES012: ENGINEERING MATERIALS

L	T	P	Cr
3	1	2	4.5

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

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

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

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

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

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

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

Laboratory Work and Micro-Project:

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

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

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

Course Outcomes: Student will be able to:

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

Text Books:

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

Reference Books:

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

Evaluation Scheme

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

UEI403 ELECTRICAL AND ELECTRONIC MEASUREMENTS

L	T	P	Cr
3	1	2	4.5

Course Objectives: To understand concepts of various electrical and electronic measuring instruments. To familiarize with different electromechanical and electronic instruments. To introduce instruments for power and energy measurements. To explain instrument transformers and magnetic measurements. To be able to measure different physical parameters with the help of AC bridges.

Electrical Standards: Standards of E.M.F. and resistance, Frequency dependence of resistance, Inductance and Capacitance, Time and frequency standards.

Electromechanical Indicating Instruments: PMMC galvanometer, Ohmmeter, Electrodynamometer, Moving iron meter, Rectifier and thermo-instruments, Comparison of various types of indicating instruments.

Power and Energy Measurement: Electrodynamometer type of wattmeter and power factor meter, Power in poly phase system: two wattmeter method, Single-phase induction and Electronic energy meters.

Instrument Transformers: Current & Voltage transformers, Constructional features, Ratio & Phase angle errors.

Magnetic Measurements: Determination of B-H curve and hysteresis loop, Measurement of iron losses with Llyod Fisher square.

Bridge Measurements: AC bridges: Applications and conditions for balance, Maxwell's bridge, Hay's bridge, Schering Bridge, Wien's bridge, De Sauty's bridge, Insulation testing, Ground resistance measurement, Varley and Murray loop test.

Electronic Instruments: Electronic multimeter, Digital voltmeters, General characteristics ramp type voltmeter, Quantization error, Digital frequency meter/Timer, Q meter and its applications, Distortion meter, Wave meter and Spectrum Analyzer, Block diagram and Applications of oscilloscopes, Storage type digital oscilloscopes.

Error Analysis: Types of errors, Uncertainty analysis, Statistical analysis, Gaussian error distribution, Chi-Square test, Correlation coefficient, Student's t-test, Method of least square, Curve fitting.

Laboratory Work: Experiments around sensitivity of wheat stone bridge, Comparison of various types of indicating instruments, Single-phase induction type energy meter, AC bridges, Measurement of iron losses with Llyod Fisher square, Storage type digital oscilloscopes.

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

1. Exhibit the knowledge of working of different electromechanical indicating instruments
2. Elucidate the working and application of several AC bridges for inductance and capacitance
3. Exhibit the knowledge of working and applications of instrument transformers

4. Measure power and energy with the help of wattmeter and energy meter
5. Exhibit the knowledge of working principle and applications of various electronic instruments

Text Book:

1. *Golding, E.W., and Widdis, F.C., Electrical Measurements and Measuring Instruments, Pitman (2003).*
2. *Helfrick, A.D., and Cooper, W.D., Modern Electronic Instrumentation and Measurement Techniques, Prentice Hall of India (2007).*

Reference Books:

1. *Kalsi, H.S., Electronic Instrumentation, Tata McGrawHill (2007).*
2. *Nakra, B.C., Chaudhry, K.K., Instrumentation Measurement and Analysis, Tata McGrawHill (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

UEI407 SIGNALS AND SYSTEMS

L	T	P	Cr
3	1	0	3.5

Course Objectives: To introduce the basic concepts and processing of analog and digital signals.
Introduction: Signals and Systems, Classification of signals, Continuous time signals and its classifications, Standard continuous time signals, Classification of continuous time systems, Discrete time signals and its classifications, Concept of frequency in discrete time signals, Standard discrete time signals, Discrete time systems, Classification of discrete time systems, Nyquist rate, Sampling theorem, Aliasing, Convolution, Correlation.
Fourier Transform: Introduction, Condition for existence of Fourier Integral, Fourier Transform and its properties, Energy density and Power Spectral Density, Nyquist Theorem, System Analysis using Fourier Transform.

Laplace Transform: Laplace and inverse transform of some common signals, Parseval's theorem, Application of Laplace Transform Properties on analog and digital signals, unilateral Laplace Transform. Analysis and characterization of LTI systems using Laplace transform: Computation of impulse response and transfer function using Laplace transform

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

Random Signals: Definitions, Random variables, distribution & density functions, mean values & moments, random processes, spectral densities, response of LTI systems to random inputs.

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

1. Enlighten the concepts to analyze signals
2. Apply Fourier transform for different applications
3. Apply Laplace transform for different applications
4. Apply z-transform transform for system characterization
5. Elucidate the concepts of random signal

Text Books:

1. *Oppenheim, A.V. and Willsky, A.S., Signals and Systems, Prentice Hall of India (1997).*
2. *Proakis, J.G. and Manolakis, D.G., Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall (2007).*

Reference Books:

1. *Lathi, B.P., Signal Processing and Linear System, Oxford University Press (2008).*
2. *Roberts, M.J., Fundamentals of Signals and Systems, McGraw Hill (2007).*

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Evaluation Scheme:

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

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UTA024: ENGINEERING DESIGN PROJECT-II (Buggy Lab)

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

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Laboratory Work:

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

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

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

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

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

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

Text Books:

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

Reference Books:

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

Evaluation Scheme:

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

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SEMESTER-IV

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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. *L. Holland, "Vacuum deposition of thin films", Chapman and Hall.*

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 (all branches except for Mechanical)

L	T	P	Cr
3	0	2	4.0

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

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

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

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

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

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

Nonlinear Programming:

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

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

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

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

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

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

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UEE503 NETWORK ANALYSIS AND SYNTHESIS

L	T	P	Cr
3	1	0	3.5

Course Objective: To make the students understand concepts of graph theory, two port networks, and network synthesis. To provide familiarity with different network theorems. To explain passive network synthesis.

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

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

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

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

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

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

1. Describe various laws and theorems related to electric networks
2. State the concept of two port networks
3. Familiarize with network synthesis
4. Elucidate Foster and Cauer forms of LC Networks
5. Interpret passive network synthesis

Text Books:

1. *Hayt, W., Engineering Circuit Analysis, Tata McGraw–Hill (2006).*
2. *Hussain, A., Networks and Systems, CBS Publications (2004).*
3. *Valkenberg, Van, Network Analysis, Prentice–Hall of India Private Limited (2007).*

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4. *Gayakwad, A. Op-Amps and Linear Integrated Circuits, Prentice–Hall of India (2006).*

Reference Books:

1. *Chakarbarti,A., Circuit Theory, DhanpatRai and Co. (P) Ltd. (2006).*
2. *Roy Chowdhuary, D., Networks and Systems, New Age International (P) Limited, Publishers (2007).*
3. *Sudhakar, A., Circuits and Networks, Tata McGraw–Hill (2006).*
4. *Suresh Kumar, K.S. Electrical circuits and Networks, Pearson Education, (2009).*

Evaluation Scheme:

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

UEI601: INDUSTRIAL INSTRUMENTATION

L	T	P	Cr
3	1	2	4.5

Course objectives: To provide the knowledge for the measurement of length, angle and area. To familiarize with motion and vibration measurement. To explain different methods for pressure and flow measurement. To introduce different methods of temperature, level and humidity measurement.

Sensors/Transducers: Basic principle and applications of Resistive, Inductive, Capacitive, Piezoelectric and their Dynamic performance, Hall-Effect, Photoemissive, Photo Diode/ Photo Transistor, Photovoltaic, LVDT, Strain Gauge.

Pressure Measurement: Moderate pressure measurement, Bourdon tube, Bellows and diaphragms, High pressure measurement: Piezoelectric, Electric resistance, Low pressure measurement: Mcleod gauge, Knudsen Gauge, Viscosity gauge, Pirani Gauge, Thermal conductivity, Ionization gauge, Dead weight gauges.

Flow Measurement: Obstruction meter, Orifice, Nozzle, Venturi, Pitot tube, Rotameter, Turbine, Electromagnetic, Vortex, Positive displacement, Anemometers, Weirs and flumes, Laser Doppler anemometer, Ultrasonic flow meter, Mass flow meter, Coriolis Effect based Mass Flowmeter.

Temperature Measurement: Resistance Temperature Detector, 3 and 4 wire systems, Thermocouples, Cold junction compensation**,** Bimetallic thermometers, Liquid-in-glass, Pressure thermometer, Semiconductor sensors, Digital thermometers, Pyrometers.

Level Measurement: Visual level indicators, Purge method, Buoyancy method, Resistance, Capacitance and inductive probes, Ultrasonic, Laser, Optical fiber, Thermal, Radar, Radiation.

Miscellaneous Measurements: Accelerometers, Humidity, Viscosity, Dimensional measurement, density measurement, Gauge blocks, Comparators, Flatness and roughness measurement, Optical flats, Sine bar, Angle gauges

.

Laboratory work: Experiments around Measurement of Length, Angle, Pressure, Temperature, Flow, Level, Humidity, Vibration, viscosity using different techniques.

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

1. Exhibit the knowledge of Resistive, Inductive, Capacitive, Hall effect and photo electric based sensors.
2. Elucidate construction & working of various industrial devices used to measure pressure, sound & flow
3. Recapitulate different methods for level and temperature measurement.
4. Explicate the construction and working of various industrial devices used to measure density, viscosity and humidity
5. Illustrate the different methods for the measurement of vibration, roughness, length and angle.

Text Books:

1. *Doeblin, E.O., Measurement systems, Applications and Design, McGraw−Hill (1982).*
2. *Nakra, B. C. and Chaudhry, K. K., Instrumentation Measurement and Analysis, TMHl (2003).*

Reference Books:

1. *Murthy, D.V.S., Transducers and Instrumentation, Prentice−Hall of India Private Limited (2003).*
2. *Sawhney, A.K., A Course in Electrical and Electronic Measurements and Instrumentation, DhanpatRai and Co. (P) Ltd. (2007).*

Evaluation Scheme:

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

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UEI501: CONTROL SYSTEMS

L	T	P	Cr
3	1	2	4.5

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

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

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

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

Text Books:

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

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Reference Books:

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

Evaluation Scheme:

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

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UEI408 ANALOG DEVICES AND CIRCUITS

L	T	P	Cr
3	1	2	4.5

Course Objective: To enhance comprehension capabilities of students through understanding of analog electronic devices, BJT, FET and working of power supplies, amplifiers, oscillators and wave shaping circuits.

Bipolar Junction Transistors (BJT): CE configuration as two port network: h–parameters, h–parameter equivalent circuit. The Hybrid-pi (II) Common-emitter Transistor Model, Hybrid-II conductances, The Hybrid-II Capacitances, The CE short-circuit current gain, Current gain with resistive load, Single-stage CE transistor amplifier response, The gain-bandwidth product, Emitter follower at high frequencies

Transistors Amplifier: Multistage Amplifier: Classification of amplifiers, Analysis of transistor amplifier using h – parameter, Frequency response of single stage RC coupled CE amplifier, Effect of an emitter Bypass capacitor on low-frequency response, Feedback Amplifiers: Classification of amplifiers, Positive and negative feedback, Effect of feedback on gain, input and output impedances.

Field-Effect Transistors (FET): Structure and working of JFET and MOSFET, output and transfer characteristics, FET as voltage variable resistor and MOSFET as a switch. Biasing the FET, The FET small signal model, the low-frequency common-source and common-drain amplifiers

Oscillator Circuits: Condition for sustained oscillation, R-C phase shift, Wien Bridge, Hartley, Colpitts and Crystal Oscillators, Frequency stability, Multivibrators, High pass and low pass filters using R-C Circuits and R-L, R-L-C Circuits, Attenuators, Clamping Circuit theorem, Schmitt Trigger, Comparator.

Signal Conditioning: Operational Amplifiers: application in instrumentation, Charge amplifier, Carrier amplifier, Introduction to active filters, Classification, Butterworth, Chebyshev, Couir filters, First order, Second order and higher order filters, Voltage to frequency and frequency to voltage converters.

Course Learning Outcomes (CLO):

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

1. Differentiate between different of diodes on the basis of their working principle.
2. Elucidate the working principle of BJT and FET
3. Analysis transistor amplifier using h-model and analyse the effect of feedback on amplifiers.
4. Design the oscillator circuit.
5. Elucidate the concept of active filters

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Text Books

1. *Boylestad R. L., Electronic Devices and Circuit Theory, Pearson Education (2007) 9th ed.*
2. *Millman, J. and Halkias, C.C., Integrated Electronics, Tata McGraw Hill (2006).*

Reference Books

1. *Neamen, Donald A., Electronic Circuit Analysis and Design, McGraw Hill (2006) 3rd ed.*
2. *Sedra A. S. and Smith K. C., Microelectronic Circuits, Oxford University Press (2006) 5th ed.*

Evaluation Scheme:

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

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SEMESTER-V

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UEI607 : DIGITAL SIGNAL PROCESSING AND APPLICATIONS

L	T	P	Cr
3	1	2	4.5

Course Objective: To understand the basic concepts and techniques of digital signal processing, familiarization with DSP concepts by studying the design of different digital filters and transform-domain processing.

Introduction: Review of Discrete Time Signals and Systems and z-Transforms, Solution of Difference Equations using One-sided z-Transform, Frequency domain Characteristics of LTI Systems, LTI Systems as Frequency-Selective Filters.

Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT): Discrete-time Fourier Transform, Discrete Fourier Transform and its Properties, Divide and Conquer Approach, Decimation in Time and Decimation in Frequency FFT Algorithms.

Digital Filter Structure: Describing Equation of digital filter, Structures for FIR Systems: Direct Form Structure, Cascade Form Structure, Structure for IIR Systems: Direct Form Structures, Cascade Form Structure, Parallel Form Structure and Lattice Structure.

Design of Digital Filters: Causality and its Implications, Difference between analog filters and digital filters, FIR filter design using windows, Design of IIR filters from analog filters using: Approximation of Derivatives, Impulse Invariance and Bilinear Transformation, Frequency transformations.

Analysis of Finite Word length Effects: Introduction, The quantization process and errors, Input quantization error, product quantization error, Analysis of coefficient quantization effects in FIR filters, A/D noise analysis, Analysis of arithmetic round off errors, Limit cycles in IIR filters.

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

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

1. Analyze the signals in time and frequency domain
2. Apply the transformation tools on signals and systems and analyze their significance and applications
3. design the structures of different types of digital filters
4. design various digital filters and analyze their frequency response
5. Analyse finite word length effects

Text Books

1. *Proakis, J.G. and Manolakis, D.G., Digital Signal Processing, Prentice Hall of India Private Limited (2006).*
2. *Rabiner, C.R. and Gold, B., Theory and Applications of Digital Signal Processing,Prentice Hall of India Private Limited (2000).*

Reference Books:

1. *Antonion, A., Digital Filters: Analysis Design and Application, Prentice Hall of India Private Limited (1999).*
2. *Oppenhein, A.V. and Schafer, R.W., Digital Signal Processing, Prentice Hall of India Private Limited (1998).*

Evaluation Scheme:

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

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UEI610 : FUNDAMENTALS OF MICROPROCESSORS AND MICROCONTROLLERS

L	T	P	Cr
3	0	2	4.0

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

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

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

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

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

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

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

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

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

1. Elucidate the architecture of various types of processors.
2. Foster the ability to write programs using PIC microcontrollers.
3. Write ARM processor based programs.
4. Elucidate the pipeline structures and hazards
5. Interface peripherals and develop applications based on PIC/ARM processors

Text Books:

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

Reference Books:

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

Evaluation Scheme:

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

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UEI608 : BIO-MEDICAL INSTRUMENTATION

L	T	P	Cr
3	0	2	4.0

Course Objectives: The objective of this course is to introduce student to basic biomedical engineering technology and introduce different biological signals, their acquisition, measurements and related constraints.

Introduction of Bio-medical Instrumentation, Sources of Bioelectric Potentials and Electrodes: Introduction to man-instrument system, components of the man-instrument system, Physiological system of the body, Problems encountered in measuring a living system. Resting and action potentials, Propagation of action potentials, bioelectric potentials, Bio potential electrodes, Biochemical transducers. Review of transducers

Cardiovascular System and Measurements: The heart and cardiovascular system, ECG, blood pressure and its measurement, respiration and pulse rate, characteristics and measurement of blood flow meter, cardiac output, plethysmography, pacemaker, defibrillators, heart sounds and its measurement,

Respiratory and Neuro-muscular System: The physiology of the respiratory system, test and instrument for the mechanics of breathing, the somatic nervous system, EEG, EMG and GSR.

Measurement and Recording of Non-invasive Diagnostic Instrumentation, Patient Care and Electrical Safety: Principle of ultrasonic measurement, ultrasonic, thermography, elements of intensive care monitoring, X-ray, CT – Scan and MRI, tonometer, dialysis**,** diathermy, Shock hazards from electrical equipment.

Laboratory work: Study the variance in pulse rate of subject in a batch, use Spiro meter on the subject, auditory system check-up using Audiometer, Measurement of Heart Rate using Stethoscope, Blood pressure using Sphygmomanometer, Pulse Rate and SpO_2 using Pulse Oximeter, Skin Conductance and Skin Potential using Galvanic Skin Response Module, Pulse Rate using Polyrite machine, Respiration Rate using Polyrite. Electromygram test using EMG biofeedback Trainer.

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

1. Differentiate and analyse the biomedical signal sources
2. Elucidate cardiovascular system and related measurements
3. Exhibit the knowledge of working principle and applications of the respiratory and nervous related measurements

4. Measure the parameters non-invasive diagnostic
5. Elucidate electrical safety, related to biomedical Instruments

Text Books:

1. *Cromwell, L. and Weibell, F.J. and Pfeiffer, E.A., Biomedical Instrumentation and Measurement, Dorling Kingsley (2006) 2nd ed.*
2. *Carr, J.J. and Brown, J.M., Introduction to Biomedical Equipment Technology, Prentice Hall (2000) 4th ed.*

Reference Books:

1. *Geddes, L.A., and Baker, L.E., Principles of Applied Biomedical Instrumentation, Wiley InterScience (1989) 3rd ed.*
2. *Khandpur, R.S., Handbook of Biomedical Instrumentation, McGraw Hill (2003) 2nd ed.*
3. *Webster, J.G., Medical Instrumentation Application and Design, John Wiley (2007) 3rd 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

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UEI509: DIGITAL SYSTEMS

L	T	P	Cr
3	1	2	4.5

Course Objectives: To familiarize the student with the analysis and design of various digital systems

Introduction: Difference between analog and digital systems, Advantages and Disadvantages of digital system. Binary codes: Weighted and non-weighted codes, Sequential codes, Self-complementing codes, Excess-3 code, Gray code, Error-detecting codes, Error-correcting codes, Hamming code.

Realization of Logic Gates Using Diodes & Transistors: AND, OR and NOT Gates using Diodes and Transistors, DCTL, RTL, DTL, TTL, CML and CMOS Logic Families and its Comparison, Classification of Integrated circuits, comparison of various logic families, standard TTL NAND GateAnalysis & characteristics, TTL open collector O/Ps, Tristate TTL, MOS & CMOS open drain and tristate outputs, CMOS transmission gate, IC interfacing- TTL driving CMOS & CMOS driving TTL.

Sequential Circuits: Basic Bistable element, Latches, SR latch, Application of SR latch, A Switch debouncer. The SR latch, The gated SR latch. The gated D Latch, The Master-Slave Flip-Flops (Pulse-Triggered Flip-Flops): The master-slave SR Flip-Flops, The master-slave JK Flip-Flop, Edge Triggered Flip-flop: The Positive Edge-Triggered D Flip-Flop, Negative-Edge Triggered D Flip-Flop. Characteristic equations, Registers, Counters-Binary Ripple Counter, Synchronous Binary counters, Counters based on Shift Registers, Design of a Synchronous counters, Design of a Synchronous Mod-N counters using clocked JK FlipFlops Design of a Synchronous Mod-N counter using clocked D, T, or SR Flip-Flops

Sequential Systems: Introduction, Mealy and Moore models, State machine notation, synchronous sequential circuit analysis and design. Construction of state Diagrams, Counters Design.

Asynchronous Sequential Logic: Analysis Procedure, Design procedure, reduction of state and flow table, race free state assignments, hazards, Design of Asynchronous sequential circuits.

Converters: Digital to Analog conversion, R-2R ladder DAC, Weighted Resistor DAC, Analog to Digital (A/D or ADC) conversion, Flash type, Counter type ADC, Dual-slope ADC, Successive approximation type ADC.

Memories: Memory Units, Memory Addressing, Introduction and classification of ROM, Static and Dynamic RAM, Flash memory, Memory Expansion, FIFO Memory, LIFO Memory.

Introduction to HDL: Introduction, A brief history of HDL, 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.

Laboratory Work:

To consider various important codes and the logic for converting from one to another, Understanding of ICs 74146, 7476, 7483, 7485, 7490, 7492, 7495, 74121, 74123, 74126, 74151, 74163, 74180, 74181, 74190,

74192, 74195, 74196, Shift register and binary counting using JK flip flop, asynchronous/synchronous up/down counters, Variable modulus counters, HDL and VHDL programming

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

1. Differentiate between different number systems and various codes
2. Design the asynchronous sequential Logic circuits
3. Exhibit the knowledge of different analog to digital converters, logic families and realization of logic gates
4. Elucidate the concept of counters and sequence generators memories and logic circuits

Text Books:

1. *Floyd, T.L. and Jain, R. P., Digital Fundamentals, Pearson Education (2008).*
2. *Tocci, R. and Widmer, N., Digital Systems: Principles and Applications, Pearson Education (2007).*
3. HDL Programming (VHDL and Verilog) Nazeih M. Botros Cengage Learning 1 st Edition, 2011

Reference Book:

3. *Mano, M. M. and Ciletti, M., Digital Design, Pearson Education (2008).*
4. *Kumar, A., Fundamentals of Digital Circuits, Prentice Hall (2007).*
5. *Digital Logic Design and VHDL A.A.Phadke S.M.Deokar Wiley India 1st Edition, 2009*
6. *Digital Circuits and Design D.P.Kothari J.S.Dhillon Pearson First Print 2015*
7. *Circuit Design and Simulation with VHDL Volnei A Pedroni PHI 2nd 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

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UEE701: POWER ELECTRONICS AND DRIVES

L	T	P	Cr.
3	1	2	4.5

Course objective: To review the operational aspects of power electronic devices and principle of conversion and control of AC and DC voltages, concept of rotating machines, and drives.

Introduction: Introduction to Thyristors and its family, turn-on and turn - off methods , BJT, MOSFET, IGBT, GTO, selection of devices for various applications.

Phase Controlled Converters: Principle of phase control, Single phase and three phase converter circuits with different types of loads.

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

DC Choppers: Principle of chopper operation, types of choppers, step up and step down choppers.

Cycloconverters: Principles of operation, single phase to single phase step up and step down cycloconverters.

Electrical Machines: Principle and characteristics of DC machines, speed control of DC motor, Principle of operation of single phase and three phase Induction motor.

Control Theory: Importance of Feedback control, requirement of feedback loops in drive applications, current-limit control.

DC Motor Drives: EMF and torque production of DC motor, four quadrant operation, thyristor and chopper fed dc motor drives.

Induction Motor Drives:, torque-speed and torque-slip characteristics, methods of starting of squirrel cage motors, generating and braking modes, variable frequency operation.

Laboratory Work: SCR V-I characteristics, Gate firing circuit, DC -DC chopper, Semi converter and Full converter with R , RL and RLE type of loads, DC shunt motor speed control, Single phase AC voltage controller with R load, Inverters, Simulation of power electronics converters.

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Course learning Outcomes (CLO):

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

1. Exhibit the knowledge of various power semiconductor devices related to its characteristics, and to select semiconductor devices for various applications
2. Exhibit the knowledge of working principle and applications of phase controlled converters, Ac voltage controllers
3. Explicate the working and applications DC choppers and cycloconverters
3. Elucidate the concepts of feedback control theory
4. Analyze and compare the performance of DC and AC machines in various drive applications

Text Books:

1. *Dubey, G.K., Doradla, S.R., Joshi, A. and Sinha, R.M.K., Thyristorised Power Controllers, New Age International (P) Limited, Publishers (2004).*
2. *Rashid, M., Power Electronics,* Prentice–Hall of India *(2006).*
3. *Bimbhra,P.S., Power Electronics, Khanna Publishers(2012).*
4. *N. Mohan, T. M. Undeland, W.P Robbins, ―Power Electronics, Converters, Applications & Design, Wiley India Pvt. Ltd.*
5. *Daniel.W.Hart, "Power Electronics", Mc GrawHill Publications 2010.*
6. *Joseph Vithayathil, ―Power Electronics‖, Tata McGraw Hill.*
7. *Simon Ang, Alejandro Oliva, "Power-Switching Converters" Taylor and Francis group*
8. *Krishnan, R., Electric Motor Drives: Modeling, Analysis, and Control. Prentice Hall, (2001).*

Reference Books:

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

Evaluation Scheme:

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

SEMESTER-VI

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

UEI844: VIRTUAL INSTRUMENTATION

L	T	P	Cr
2	0	3	3.5

Course Objective: The objective of this course is to introduce the concept of virtual instrumentation and to develop basic VI programs using loops, case structures etc. including its applications in image, signal processing and motion control.

Review of Virtual Instrumentation: Historical perspective, Block diagram and Architecture of Virtual Instruments

Data-flow Techniques: Graphical programming in data flow, Comparison with conventional programming.

VI Programming Techniques: VIs and sub-VIs, Loops and Charts, Arrays, Clusters and graphs, Case and sequence structures, Formula nodes, Local and global variables, Strings and file I/O.

Data Acquisition Basics: ADC, DAC, DIO, Counters and timers.

Common Instrumentation Interfaces: RS232C/ RS485, GPIB, PC Hardware structure, DMA software and hardware installation.

Use of Analysis Tools: Advanced analysis tools such as Fourier transforms, Power spectrum, Correlation methods, Windowing and filtering and their applications in signal and image processing, Motion Control.

Additional Topics: System buses, Interface buses: PCMCIA, VXI, SCXl, PXI, etc.

Laboratory Work : Components of Lab VIEW, Celsius to Fahrenheit conversion, Debugging, Sub-VI, Multiplot charts, Case structures, ASCII files, Function Generator, Property Node, Formula node, Shift registers, Array, Strings, Clusters, DC voltage measurement using DAQ

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

1. Demonstrate the working of LabVIEW
2. Exhibit the knowledge of the various types of structures used in LabVIEW
3. Analyze and design different type of programs based on data acquisition
4. Demonstrate the use of LabVIEW for signal processing, image processing etc.
5. Use different analysis tools

Text Books:

1. *Johnson, G., LabVIEW Graphical Programming, McGraw−Hill (2006).*
2. *Sokoloft, L., Basic Concepts of LabVIEW 4, Prentice Hall Inc. (2004).*
3. *Wells, L.K. and Travis, J., LabVIEW for Everyone, Prentice Hall Inc. (1996).*

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Reference Book:

1. *Gupta, S. and Gupta, J.P., PC Interfacing for Data Acquisition and Process Control, Instrument Society of America (1988).*

Evaluation Scheme:

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

UEI604: PROCESS DYNAMICS AND CONTROL

L	T	P	Cr
3	1	2	4.5

Course objective: To make the students understand basic ideas, challenges, techniques, and applications of process control for controlling various processes. To familiarize with different actuators. To classify among different control modes.

Introduction: Historical perspective, Incentives of process control, Synthesis of control system. Classification and definition of process variables.

Mathematical Modeling: Need and application of mathematical modeling, Lumped and distributed parameters, Analogies, Thermal, Electrical and chemical systems, Modeling of CSTR, Modeling of heat exchanger, Interacting and non-interacting type of systems, Dead time elements

Control Modes: Definition, Characteristics and comparison of on-off, Proportional (P), Integral (I), Differential (D), PI, PD, PID, Dynamic behavior of feedback controlled processes for different control modes ,Control system quality, IAE, ISE, IATE criterion, Tuning of controllers Ziegler-Nichols, Cohen-Coon methods

Realization of Control Modes: Realization of different control modes like P, I, D, In Electric, Pneumatic, Hydraulic controllers.

Actuators: Hydraulic, Pneumatic actuators, Solenoid, E-P converters, Control valves, Types, Functions, Quick opening, Linear and equal percentage valve, Ball valves, Butterfly valves, Globe valves, Pinch valves, Valve application and selection

Advanced Controls: Introduction to advanced control schemes like Cascade, Feed forward, Ratio, Selective, Override, Split range and Auctioneering control.

Laboratory Work: I to P, P to I, Valve characteristics, Simulation of different control modes, Experiments around Basic Process RIG.

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

1. Demonstrate fundamental understanding of process control
2. Develop the mathematical model of various chemical processes
3. Exhibit the knowledge of different control modes and their application in controlling various processes
4. Exhibit the knowledge of the working of electric, hydraulic and pneumatic controllers and actuators

Text Books:

1. *Johnson, C.D., Process Control Instrumentation Technology, Prentice–Hall of India Private Limited (1992).*
2. *Stephanopoulos, G., Chemical Process Control, Prentice–Hall of India Private Limited (1983).*

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Reference Books:

1. *Harriot, P., Process Control, Tata McGraw–Hill (1982).*
2. *Liptak, B.G., Instrument Engineers Handbook, Butterworth, Heinemann (2002).*
3. *Seborg, D.E. and Edgar, T., Process Dynamics and Control, John Wiley and Sons (1989).*

Evaluation Scheme:

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

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UEI701: DATA ACQUISITION AND SYSTEM DESIGN

L	T	P	Cr
3	0	2	4.0

Course Objectives: To understand concepts of acquiring the data from transducers/input devices, their interfacing and instrumentation system design. To familiarize with different data transfer techniques.

Data Acquisition Techniques: Analog and digital data acquisition, Sensor/Transducer interfacing, unipolar and bipolar transducers, Sample and hold circuits, Interference, Grounding and Shielding.

Data Acquisition with Op-Amps: Operational Amplifiers, CMRR, Slew Rate, Gain, Bandwidth. Zero crossing detector, Peak detector, Window detector. Difference Amplifier, Instrumentation Amplifier AD 620, Interfacing of IA with sensors and transducer, Basic Bridge amplifier and its use with strain gauge and temperature sensors, Filters in instrumentation circuits.

Data Transfer Techniques: Serial data transmission methods and standards RS 232-C: specifications connection and timing, 4-20 mA current loop, GPIB/IEEE-488, LAN, Universal serial bus, HART protocol, Foundation-Fieldbus, ModBus, Zigbee and Bluetooth.

Data Acquisition System (DAS): Single channel and multichannel, Graphical Interface (GUI) Software for DAS, RTUs, PC-Based data acquisition system.

Laboratory Work: Op-amp as a comparator and its application, Integrator and differentiator, Active filters, Simulation of the above applications using ORCAD, Instrumentation Amplifier/AD 620, Interfacing of sensors and transducers using DAQ cards.

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

1. Elucidate the elements of data acquisition techniques
2. Design and simulate signal conditioning circuits
3. Exhibit the knowledge of various data transfer techniques
4. Exhibit the knowledge of the components of data acquisition system
5. Differentiate in between single channel and multi-channel

Text Books:

1. *Coughlin, R.F., Operational Amplifiers and Linear Integrated Circuits, Pearson Education (2006).*
2. *Kalsi, H.S., Electronic Instrumentation, Tata McGraw Hill (2002).*
3. *Gayakwad, R.A., Op-Amp and Linear Integrated Circuits, Pearson Education (2002).*
4. *Mathivanan, N., Microprocessor PC Hardware and Interfacing, Prentice Hall of India Private Limited (2007).*

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Reference Books:

1. *Ananad, M.M.S., Electronic Instruments and Instrumentation Technology, Prentice Hall of India Private Limited (2004).*
2. *Murthy, D.V.S., Transducers and Instrumentation, Prentice Hall of India Private Limited (2006).*

Evaluation Scheme:

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

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UCS540: DATA STRUCTURE AND ALGORITHMS

L	T	P	Cr
3	0	2	4.0

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

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

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

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

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

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

Course learning outcomes (CLOs):

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

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

Text Books:

1. Seymour Lipschutz Data Structures, TATA McGraw Hill (2016).

2. Corman, Leiserson&Rivest, Introduction to Algorithms, MIT Press (2009).

3. Narasimha Karumanchi, Data Structures and Algorithms Made Easy (2014).

Reference Books:

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

Evaluation Scheme:

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

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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.

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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.

SEMESTER-VII

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UEI704: SOFT COMPUTING TECHNIQUES

L	T	P	Cr
3	0	2	4.0

Course Objectives: To introduce the concept of Soft-computing techniques and their applications

Fuzzy Logic: The concept and importance of Artificial Intelligence, Human intelligence vs. Machine intelligence. Classical and Fuzzy sets, Membership functions, Fuzzy set operations, properties and laws, Fuzzy relations, Sagittal diagram, Fuzzification, Membership value assignment, Automated methods of fuzzy systems, Fuzzy rule generation, Defuzzification, Application of Fuzzy logic in process control etc. Introduction to Type -2 Fuzzy logic and Fuzzy cognitive mapping.

Artificial Neural Networks: Structure and function of a single neuron, Artificial neuron models, Perceptron, Types of activation functions, Neural network architectures, Neural Network learning rules, Supervised and Unsupervised learning method, Linear Regression, Gradient Descent Algorithm, ADALINE, Back propagation algorithm, Radial Basis Function ,Unsupervised learning: Self Organising Map, Counter Propagation Network, Adaptive Resonance Theory, Application of neural networks for Classification, Clustering, Pattern Recognition etc. Basic concept and understanding of deep learning techniques and its applications.

Support Vector Machine:
Introduction, Large Margin Intuition, Kernels, Optimal hyperplane for linearly separable patterns, XOR problem

Genetic Algorithms: Introduction and concept, Operators in Genetic Algorithm,: representation/encoding, selection, crossover and mutation scaling, Objective function, Fitness, Applications of GA, Introduction to swarm intelligence and Ant Colony optimization.

Laboratory work: Fuzzy set representation, fuzzy relation, fuzzy logic demonstration using GUI and coding, Fuzzy logic application. Perceptron model using coding, logic gates implementation using perceptron, Training of network using Gradient descent algorithm and Back propagation algorithm, Neural network application, Optimization of generalized sphere function using GA.
Implementation of soft computing techniques in the form of simulated project

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

1. Exhibit the knowledge of fuzzy sets, membership functions and knowledge representation using fuzzy rules.
2. Exhibit the concept of artificial neural networks and its learning techniques
3. Elucidate the concept of support vector machine
4. Apply genetic algorithms for single objective optimization problems

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Text Books:

1. *Ross, T.J., Fuzzy logic with engineering applications, TMH*
2. *Symon Haykin, Neural Networks: A Comprehensive Foundation, 2nd Edition, Pearson*
3. *Hagan, M.T., Neural network design, Prentice Hall of India.*
4. *S.N. Sivanandam, S. N. Deepa, Principles of Soft computing", Wiley India*
5. *David E Goldberg, Genetic Algorithms in Search, Optimization & machine Learning, Pearson Education*

Reference Books:

1. *Yegnanarayana, B., Artificial Neural Networks, Prentice–Hall of India Private Limited.*
2. *Zurada, J.M., Introduction to Artificial Neural Network System, Jaico Publication.*
3. *Christoper M. Bishop, Neural Networks for pattern Recognition, Oxford*

Evaluation Scheme:

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

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UEI801 ADVANCED PROCESS CONTROL

L	T	P	Cr
3	1	2	4.5

Course Objectives: To make the students understand the basic concepts of advanced process control schemes, DCS, Artificial intelligence techniques used in Process Control, PLC and digital control system. To introduce artificial intelligence in process control. To explain programmable logic controller.

Introduction to advanced Control Schemes: Cascade, Feed-forward, Feed-forward plus Feedback, Ratio control, Inferential control, Dead time and Inverse response compensation, Adaptive control, Model reference adaptive control, Self tuning regulator Interactions and Decoupling of Control Loops: Design of cross controllers and selection of loops using Relative Gain Array.

Supervisory Control and Data Acquisition (SCADA) and Distributed Control System (DCS): Evolution and advantages of computer control, Configuration of Supervisory, Direct digital control (DDC), SCADA and DCS.

Artificial Intelligence in Process Control: Application of Expert systems, Neural networks, Fuzzy logic, Neuro Fuzzy , Genetic algorithm and Virtual instrumentation in process control.

Programmable Logic Controllers: Comparison with hard wired relay and semiconductor logic, Hardware, Ladder diagram programming, Case studies, Introduction to **SPLD, CPLD, FPGA.**

Digital Process Control: Sampling and reconstruction in view of process control, Discrete systems analysis, Stability and controller design using z transform and difference equations, Smoothing filter realization in process control applications using difference equations.

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

1. Elucidate and apply the concept of advanced control schemes used in process control
2. Select, program and develop the application of distributed control system and PLC as in process control
3. Apply the knowledge of CPLD, SPLD, FPGA and artificial intelligence techniques in process control
4. Apply the knowledge of digital control system

Text Books:

2. *Stephanopoulos, G., Chemical Process Control, Prentice–Hall of India Private Limited (1983).*
3. *Liptak, B.G., Instrument Engineers Handbook , Chilton Book Company (1994).*

Reference Books:

1. *Deb, S.R., Robotics Technology and Flexible Automation, Tata McGraw–Hill (1994).*
2. *Johnson, C.D., Process Control Instrumentation Technology, Prentice–Hall of India Private Limited (2007).*
3. *Zaidi, A., SPC Concepts, Methodologies and Tools, Prentice–Hall of India Private Limited (1995).*

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Evaluation Scheme:

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

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UEI793: CAPSTONE PROJECT

	L	T	P	Cr
UEI793: Semester VI (starts)	**1***	**0**	**2**	**–**
UEI793: Semester VII (Completion)	**1***	**0**	**2**	**8.0**

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

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

Course Learning Outcomes:

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

1. To identify design goals and analyze possible approaches to meet given specifications with realistic engineering constraints
2. To design an instrumentation engineering project implementing an integrated design approach applying knowledge accrued in various professional courses
3. To perform simulations and incorporate appropriate adaptations using iterative synthesis
4. To use modern engineering hardware and software tools
5. To work amicably as a member of an engineering design team
6. To improve technical documentation and presentation skills

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SEMESTER-VIII

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UEI896: PROJECT SEMESTER

L	T	P	Cr
-	-	-	15.0

Course Objectives

The project semester is aimed at developing the undergraduate education programme in Instrumentation Engineering to include a practical training in a professional engineering set up (a company, top educational institution, research institute etc.) hereafter referred to as host "organization" as deemed appropriate. The participating organizations are selected that are either already visiting Thapar Institute for placement or are forming new relationships of mutual benefit. The project semester gives the student the opportunity to translate engineering theory into practice in a professional engineering environment. The technical activity in the project semester should be related to both the student's engineering studies and to the host organization's activities and it should constitute a significant body of engineering work at the appropriate level. It should involve tasks and methods that are more appropriately completed in a professional engineering environment and should, where possible, make use of human and technology resources provided by the organization. It consolidates the student's prior learning and provides a context for later research studies. The student remains a full time registered student at Thapar Institute during the project semester and this activity is therefore wholly distinct from any industrial interactions which may occur over vacation periods.

Assessment Details

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

Course learning Outcomes (CLO):

Upon completion of project semester, the students will be able to:

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

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UEI852: Linear Integrated Circuit

L	T	P	Cr
3	0	2	4.0

Course Objectives: The objective of the course is: To provide the basic building blocks of linear integrated circuits. To learn the linear and non-linear applications of operational amplifiers. To introduce the theory and applications of analog multipliers and PLL. To learn the theory of ADC and DAC. To introduce the concepts of waveform generation and introduce some special function ICs.

Basics of Operational Amplifiers: Current mirror and current sources, Current sources as active loads, Voltage sources, Voltage References, BJT Differential amplifier with active loads, General operational amplifier stages - and internal circuit diagrams of IC 741, DC and AC performance characteristics, Open and closed loop configurations.

Applications of Operational Amplifiers: Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector, clipper and clamper.

Analog Multiplier and PLL: Analog Multiplier using Emitter Coupled Transistor Pair – Gilbert Multiplier cell – Variable transconductance technique, analog multiplier ICs and their applications, Operation of the basic PLL, Closed loop analysis, Voltage controlled oscillator, Monolithic PLL IC 565, application of PLL for AM detection, FM detection, FSK modulation and demodulation and Frequency synthesizing.

Analog to Digital and Digital to Analog Converters: Analog and Digital Data Conversions, D/A converter – specifications – weighted resistor type, R-2R Ladder type, Voltage Mode and Current-Mode R − 2R Ladder types – switches for D/A converters, high speed sample-and-hold circuits, A/D Converters – specifications – Flash type – Successive Approximation type – Single Slope type – Dual Slope type – A/D Converter using Voltage-to-Time Conversion – Over-sampling A/D Converters.

Waveform Generators and Special Function ICs: Sine-wave generators, Multivibrators and Triangular wave generator, Saw-tooth wave generator, ICL8038 function generator, Timer IC 555, IC Voltage regulators – Three terminal fixed and adjustable voltage regulators – IC 723 general purpose regulator – Monolithic switching regulator, Switched capacitor filter IC MF10, Frequency

to Voltage and Voltage to Frequency converters, Audio Power amplifier, Video Amplifier, Isolation Amplifier, Opto-couplers and fibre optic IC.

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

1. Exhibit the knowledge of basic building blocks of linear integrated circuits such as op-amps
2. Design linear and non-linear applications of op-amps
3. Design applications using analog multiplier and PLL
4. Design ADC and DAC using OP – AMPS
5. Exhibit the knowledge of waveforms generation using op-amp circuits and analyze special function ICs

List of Experiments:

1. Operational Amplifiers (IC741)-Characteristics and Application.
2. Waveform Generation using Op-Amp (IC741).
3. Applications of Timer IC555.
4. Design of Active filters.
5. Study and application of PLL IC's
6. Design of binary adder and subtractor.
7. Design of counters.
8. Study of multiplexer and demultiplexer /decoders.
9. Implementation of combinational logic circuits.
10. Study of DAC and ADC
11. Op-Amp voltage Regulator- IC 723

Text Books:

1. D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 2000.
2. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", 3rd Edition, Tata Mc Graw-Hill, 2007.

REFERENCES:

1. Ramakant A. Gayakwad, "OP-AMP and Linear ICs", 4th Edition, Prentice Hall / Pearson Education, 2001.
2. Robert F.Coughlin, Frederick F.Driscoll, "Operational Amplifiers and Linear Integrated Circuits", Sixth Edition, PHI, 2001.
3. B.S.Sonde, "System design using Integrated Circuits" , 2nd Edition, New Age Pub, 2001
4. Gray and Meyer, "Analysis and Design of Analog Integrated Circuits", Wiley International, 2005.
5. Michael Jacob, "Applications and Design with Analog Integrated Circuits", Prentice Hall of India,1996.

6. William D.Stanley, “Operational Amplifiers with Linear Integrated Circuits”, Pearson Education,2004.
7. S.Salivahanan & V.S. Kanchana Bhaskaran, “Linear Integrated Circuits”, TMH, 2008.

Evaluation Scheme:

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

UEI897: DESIGN PROJECT

	L	T	P	Cr
Course Objectives	**-**	**-**	**-**	**8.0**

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

Assessment Details

Each student is assigned a faculty supervisor who is responsible for managing and assessment of the alternate project semester. The faculty supervisor guides the students till the end of semester and monitors the student's progress throughout the same. This includes a Reflective Diary which is updated throughout the alternate project semester, an Interim Project Report, a Final Report with Learning Agreement/Outcomes and a Final Presentation & Viva which involves the faculty Supervisor and some other faculty members from the department.

Course learning Outcomes (CLO):
Upon completion of project semester, the students will be able to:

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

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UEI805: ENVIRONMENTAL INSTRUMENTATION

L	T	P	Cr
3	0	0	3.0

Course Objectives: To understand the concepts of pollution monitoring, to enable select, design and configure pollution monitoring instruments

Air Pollution: Impact of man of the environment: An overview of air pollution sources and effects, Metrological aspect of air pollutant dispersion, Air pollution sampling and measurement, Air pollution control methods and equipment, Air sampling techniques, soil pollution and its effects, Gas analyzer, Gas chromatography, Control of specific gaseous pollutants, Measurement of automobile pollution, Smoke level meter, CO/HC analyzer.

Water pollution: Sources And classification of water pollution, Waste water sampling and analysis, Waste water sampling techniques and analyzers: Gravimetric, Volumetric, Calometric, Potentiometric, Flame photometry, Atomic absorption spectroscopy, Ion chromatography, Instruments used in waste water treatment and control, Latest methods of waste water treatment plants.

Pollution Management: Management of radioactive pollutants, Noise level measurement techniques, Noise pollution and its effects. Instrumentation techniques in solid waste management, social and political involvement in the pollution management system.

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

1. Exhibit the knowledge of sources and effects of air and water pollutants
2. Exhibit the knowledge of air pollution sampling and measurement techniques
3. Exhibit the knowledge of water sampling and analysis techniques
4. Exhibit the knowledge of solid waste management and noise level measurement techniques

Reference Books:

1. *Bhatia, H.S., A Text Book in Environmental Pollution and control, Galgotia Publication (1998).*
2. *Dhameja, S.K., Environmental Engineering and Management, S.K Kataria (2000).*
3. *Rao, M.N. and Rao, H.V., Air Pollution, Tata McGraw Hill (2004).*
4. *Rao. C.S., Environmental Pollution Control, New Age International (P) Limited, Publishers (2006) 2nd ed.*

Evaluation Scheme:

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

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UEI898: STARTUP SEMESTER

L	T	P	Cr
0	0	0	15.0

Course Objective: This course provides the students with competence building workshops and need based skill trainings that enable them to develop their prototype/working model/software application, which is supported by a Business Plan. This semester long interaction with entrepreneurial ecosystem, will provide ample opportunity to students to lay a strong foundation to convert their idea into a startup immediately or in the near future.
This course would include a practical training in a professional set up (a startup or a company, Business incubator, Startup Accelerator etc.) hereafter referred to as host "organization" as deemed appropriate.

Activities during the Startup semester

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

Assessment Details

Each student is assigned a faculty supervisor and industry mentor. Faculty supervisor is responsible for managing and assessment of the Startup semester. The faculty supervisor monitors the student's progress in a semester and interacts with the industry mentor during his/her visit to the host organizationtwice.

The semester includes maintenance of a Reflective Diary, which is updated throughout the startup semester, an Interim Project Report, a Final Report with Learning Agreement/Outcomes and a Final Presentation & Viva, which involves the faculty Supervisor, and some other members from the department.

The mentor from the host organization is asked to provide the assessment on a designated form. The faculty supervisor is responsible for managing and performing the assessment of the startup semester experience.

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Course learning outcome (CLO):

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

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

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Elective–I

UEI612: ROBOTICS

L	T	P	Cr
2	0	2	3.0

Course Objectives: To introduce the concepts of Robotic system, its components and instrumentation and control related to robotics.

Basic Concepts in Robotics: Automation and robotics, Robot anatomy, Basic structure of robots, Resolution, Accuracy and repeatability.

Classification and Structure of Robotic System: Point to point and continuous path systems. Control loops of robotic systems, The manipulators, The wrist motion and grippers.

Drives and Control Systems: Hydraulic systems, Dc servo motors, Basic control systems concepts And models, Control system analysis, Robot activation and feedback components. Positional and velocity sensors, actuators. Power transmission systems, Robot joint control design.

Robot arm Kinematics and Dynamics: The direct kinematics problem, The inverse kinematics solution, Lagrange-Euler formation, Generalized D'Alembert equations of motion, DenavitHartenberg convention and its applications.

Motion planning and control Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link, Independent joint PID control, Control of a multi-link manipulator,

Robotic Sensors: Sensors and Instrumentation in robotics: Tactile sensors, proximity and range sensors, Force and torque sensors, Uses of sensors in robotics. Vision Systems: Vision equipment, Image processing, Concept of low level and high level vision.

Course Learning Outcomes (CLO):
Student will be able to:

1. Demonstrate the basic concepts of robotics, their classification and structure
2. Exhibit the knowledge of type of the drive and control systems used in robotics
3. Design the kinematics and dynamics of robotic arm for motion control
4. Describe the type of sensors and other instruments used in robotics

Text Books:

1. *Nikku, S.B., Introduction to Robotics, Prentice Hall of India Private-2002*
2. *Schilling. R. J., Fundamentals of Robotics: Analysis and Control, Prentice Limited (2006)*

Reference Books:

1. *Criag, J., Fundamentals of Robotics: Analysis and Control, Prentice Limited (2006).*
2. *Gonzalex, R. C. and Fu, K. S., Robotics Control Sensing, Vision and Intelligence, Hill (1985).Hill (2004).Koren,Y., Robotics for Engineers, McGraw-McGraw*

Evaluation Scheme:

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

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UEI613: BIOMETRICS

L	T	P	Cr
2	0	2	3.0

Course Objectives: To understand the concepts of Biometrics and to design biometric system

Introduction: Overview of Biometrics, Biometric Identification, Biometric Verification, Biometric Enrollment, Biometric, System Security, Introduction of biometric traits and its aim, image processing basics, basic image operations, filtering, enhancement, sharpening, edge detection, smoothening, enhancement, thresholding, localization. Fourier Series, DFT, inverse of DFT

Authentication and Biometrics: Secure Authentication Protocols, Authentication Protocols, Biometric system, identification and verification. FAR/FRR, system design issues. Positive/negative identification. Biometric system security, authentication protocols, matching score distribution, ROC curve, DET curve, FAR/FRR curve. Expected overall error, EER, biometric myths and misrepresentations.

Common biometrics: Finger Print Recognition, Face Recognition, Speaker Recognition, Iris Recognition, Hand Geometry, Signature Verification, Positive and Negative of Biometrics.

Selection of suitable biometric: Biometric attributes, Zephyr charts, types of multi biometrics. Verification on multimodel system, normalization strategy, Fusion methods, Multimodel identification.

Course Learning Outcomes (CLO):
Student will be able to:

1. Elucidate the basics of Biometric Identification
2. Analyse different error measures used in biometric identification and verification
3. Apply various biometrics for identification
4. Exhibit the knowledge of multimodel biometric identification system.

Text Books:

1. *Digital Image Processing using MATLAB, By: Rafael C. Gonzalez, Richard Eugene Woods, 2nd Edition, Tata McGraw-Hill Education 2010*
2. *Guide to Biometrics, By: Ruud M. Bolle, Sharath Pankanti, Nalini K. Ratha,Andrew W. Senior, Jonathan H. Connell, Springer 2009*
3. *Pattern Classification, By: Richard O. Duda, David G.Stork, Peter E. Hart, Wiley 2007*

Reference Books:

1. Bolle, Connell et. al., "Guide to Biometrics", Springer.

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Evaluation Scheme:

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

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UEI514: IOT BASED SYSTEMS

L	T	P	Cr
2	0	2	3.0

Course Objectives: The objective of the course is to provide basic understanding of Internet of Things, its architecture, Sensor modules, communication protocols, platforms and its deployment, applications, latest trends and one case study.

Introduction: Introduction to Internet of Things, characteristics and benefits of IoT, basic architecture, OSI reference model, IoT gateways and IoT cloud facilities and applications of IoT.

IoT Sensors modules and applications : Introduction to IoT based measurements, Smart sensors, MEMS based sensors, Pyroelectric PIR motion detector, Ultrasonic range finder, Gas sensor, 3-axis gyro sensor module. Digital transducers, Encoders, Touchpad. Finger print scanner. Hall-Effect, IR range finder, light dependent resistor LDR module,

IoT Actuators and Gateways : Solid state relay, dc motor, servo motor and stepper motors. Arduino and Rasberry Pi as IoT Gateways.

Simplified IoT Architecture : The core IoT Functional Stack, Layer 1: Things: Sensors and Actuators Layer, Layer 2: Communications Network Layer, Layer 3: Applications and Analytics Layer.

IoT Protocols and Clouds: Networking of sensors, Need of communication protocols for IoT systems, introduction and comparison of protocols like HTTP, CoAP, MQTT, AMQP, IFTTT, Li-Fi and BLE etc. IoT cloud, its need and characteristics. Introduction and comparison of various clouds like AWS, Azure, Blynk, Watson, Google cloud and Thinger.

Laboratory Work:

1. Interface various sensor modules like LDR.
2. Exhibit the knowledge Ultrasonic, Hall effect, PIR, Gyro, digital encoder etc. with Arduinoboard.
3. Deployment of an embedded system on IoT cloud using USB serial and /orWi-Fi modules.

Course Learning Outcomes (CLO):
Student will be able to:

1. Exhibit the concept and benefits of IoT
2. Exhibit the knowledge of sensor modules for IoT applications
3. Elucidate IoT actuator, gateways and architectures.
4. Implement IoT system using protocols and IoT cloud

Text Books:

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

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

Reference Books:

1. *Internet of Things, Abhishek S Nagarajan, RMD Sundaram Shriram K Vasudevan, Wiley India 2019.*
2. *Internet of Things, Raj Kamal, McGraw Hill Education 2017*

Evaluation Scheme:

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

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UEI515: ANALOG AND DIGITAL COMMUNICATION

L	T	P	Cr
3	0	0	3.0

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

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

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

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

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

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

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

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

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

Text Books: *Lathi.B.P., Modern Digital and Analog Communications Systems 3rd ed.*

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Reference Books:

1. *Taub, H., Principles of Communication Systems, McGraw-Hill (2008) 3rd ed.*
2. *Haykin, S., Communication Systems, John Willey (2009) 4th ed.*
3. *Proakis, J. G. and Salehi, M., Fundamentals of Communication Systems, Dorling Kindersley (2008) 2nd ed.*
4. *Kennedy, G., Electronic Communication Systems, McGraw-Hill (2008) 4th ed.*
5. *Proakis John G., Digital Communication System, McGraw, (2000) 4th ed.*
6. *Simon Haylein, Digital Communication Systems, Wiley India edition, (2009) 2nd 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

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UEI516: ANALYTICAL INSTRUMENTATION

L	T	P	Cr
3	0	0	3.0

Course objectives: To introduce the concept of analytical Instrumentation, methods, techniques and applications.

Introduction: Introduction to instrumental analysis-classification and its advantages, Sampling systems for gas analysis and liquid analysis.

Spectrometry: Introduction to atomic absorption spectrometer, emission spectrometer UV-visual spectrometer, infrared spectrometer, excitation sources: arc and spark, Nuclear magnetic resonance spectrometer, Mass spectrometry, biomedical applications of spectrometry.

Chromatography: Introduction to Chromatographic techniques, Liquid chromatography, Gas chromatography, Applications of chromatography. Introduction to optical Techniques and their Working, turbidimetry, Nephelometry, Polarimetry, Refractometry.

X- ray Analytical Methods: Introduction to X-ray spectral analysis, Fluorescence X-ray spectrometer Wavelength dispersive devices, Energy dispersive devices, Detectors, Scanning electron microscope, X-ray diffractometer, X ray absorption spectrometer Applications of X ray analytical methods in biomedical, industrial applications.

Potentiometry: Potential and standard potential, ion selective electrode, Glass electrode, Gas sensing electrode. Application of potentiometry.

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

1. Demostrate the knowledge of concept of spectrometry and optical techniques
2. elucidate the working of chromatography, elemental analyser
3. illustrate the working of X- ray diffractometer and scanning electron microscope
4. Exhibit the concept of potentiometry and its applications
5. Exhibit the knowledge of working principle and applications of different electrodes

Text Books:

1. *Braun, R.D., Introduction to Instrumental Analysis, Mc-Graw Hill (2008).*
2. *Khandpur, R.S., Handbook of Biomedical Instrumentation, Tata McGraw–Hill (2000)*
3. *Mathur, R.P., Water and Waste Water Testing Laboratory Manual, Nem Chand and Brothers (1982).*
4. *Patranabis D. Principles of Industrial & Instrumentation, Tata McGraw–Hill (1998)*

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Evaluation Scheme:

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

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UCS312: DATA BASE MANAGEMENT SYSTEMS

L	T	P	Cr
2	0	2	3.0

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

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

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

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

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

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

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

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

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

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

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

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

Text Books:

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

Reference Books:

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

Evaluation Scheme:

	Evaluation Elements	**Weightage(%)**
	MST	25
	EST	45
	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

Approved in 107th meeting of the Senate held on 16th June, 2022

Elective–II

UEI845: ROBUST CONTROLS

L	T	P	Cr
3	0	0	3.0

Course Objectives: The objective of the course is to provide basic Introduction to modern robust control theory techniques for large-scale uncertain multivariable systems: stability and performance; computer-aided tools for both system analysis and controller design.

Classical Control Review: Internal Stability, stationary behaviour of the feedback loop, requirements for feedback systems: performance, robust stability, robust performance.

Norms of Systems and Performance: Vector norms, signal norms, system norms, calculation of operator norms, specification for feedback systems, performance limitations. Multi-input multi- output (MIMO) systems: Singular values, structured singular value.

Feedback interconnection, stability, Uncertainty and robustness: Well-posedness; Internal stability; Coprime factorization and stabilizing controllers, uncertainty representations; Uncertain polynomials; Boundary crossing theorem; Kharitonov's result; Edge thorem; Stability of polytope of polynomials; Sensitivity and complementary sensitivity; Linear fractional transformation (LFT), Robust stability.

H_2 optimal control: LQ controllers, Kalman filter, LQG controllers, characterisation of H_2 optimal controllers.

H_∞ Optimal Control: Formulation of H_∞ problem, output feedback, case studies.

Course Learning Outcomes (CLO):
Student will be able to:

1. Analyze multivariable linear control system.
2. Analyze stability and robustness of control system
3. Characterize and formulate H_2 Optimal Control problem
4. Characterize and formulate H_∞ Optimal Control problem.

Text Books:

1. *Jeffrey B. Burl, Linear optimal control, $H2$ and $H\infty$ methods, Addison-Wesley, 1999.*
2. *K. Zhou, J. Doyle, and K. Glover. Robust and Optimal Control. Prentice Hall, Englewood Cliffs, New Jersey, 1996.*
3. *U. Mackenroth, Robust Control Systems: Theory and case studies. Springer, 2004.*
4. *D.W. Gu, P. Hr. Petkov and M.M. Konstantinov, Robust Control Design with MATLAB. Springer 2005.*

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Reference Books:

1. *Green M & Limebeer D.J., Linear robust control; Courier Corporation; 2012.*
2. *Zhou, Kemin, and John Comstock Doyle. Essentials of robust control. Vol. 104. Upper Saddle River, NJ: Prentice hall, 1998.*

Evaluation Scheme:

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

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UEI626: PROSTHETICS AND REHABILITATION

L	T	P	Cr
3	0	0	3.0

Course Objectives: The objective of the course is to provide basic understanding of rehabilitation technology and assistive technologies for physically impaired.

Introduction: Introduction to types of physical impairments, Rehabilitation Engineering, Motor, Sensor and Communication Disorders and Introduction to Artificial Organs

Seating Mechanics and Systems: Introduction to seating systems and interventions required, Design aspects of different wheel chairs such as Manual wheelchairs, electric power wheelchairs, Wheel chair standards & tests

Prosthetic Devices: Anatomy of human body, Pervasive assistive technologies, Computer assistive technologies, Cognitive assistive technologies, Artificial limb and hands, intelligent prosthetics, externally powered and controlled orthotics and prosthetics, Advanced hybrid assistive system, Myoelectric hand and arm prostheses, The MARCUS intelligent hand prostheses

Vision and Hearing Aid: Anatomy of eye and ear, Classes of ear and visual impairments and assistive technologies, Implants and aids for sight and hearing impaired

Advanced Rehabilitation Robotics: A case study of design of advanced robots for rehabilitation of physically and mentally impaired, Neural engineering in rehabilitation engineering.

Course Learning Outcomes (CLO):
Student will be able to:

1. Demonstrate the knowledge of assistive technologies for rehabilitation engineering
2. Establish the understanding of working principle and applications of seating mechanics and wheel chair designs
3. Select a prosthetic device for physically impaired
4. Exhibit understanding of the anatomy of different organs and implants and aids for respective impairments

Text Books:

1. *Rory A Cooper, Hisaichi Ohnabe, Douglas A Hodson: An Introduction to Rehabilitation Engineering, CRC Press, First edition, 2006*
2. *Marion A Hersh, Michael A Johnson, Assistive Technology for Visually impaired and blind people; Springer Publications, First edition, 2008*
3. *Suzanne Robitaille, "The illustrated guide to Assistive technology and devices–Tools and gadgets for living independently", Demos Health Newyork, First edition, 2010.*

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Evaluation Scheme:

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

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UEI627: DATA ANALYTICS

L	T	P	Cr
3	0	0	3.0

Course Objectives: To understand the various concepts involved in data analytics.

Introduction: Overview of Data analytics, Descriptive Statistics - Graphical Approaches, Measures of central Tendency, Measures of Dispersion, Random Variables and Probability Distributions.

Inferential Statistics: Single sample tests, two Sample Tests, Type 1 and Type 2 Errors, Confidence Intervals, ANOVA and Test of Independence, Modern Data ecosystem, analytics vs data analysis, Identifying data for analysis, Introduction to Regression, Least Squares Regression, Simple and Multiple Regression in Excel and Matlab, Regularization/Coefficient shrinkage, Data Modelling Approaches and Algorithmic Modelling Approaches. Machine learning with big data

Supervised Learning with regression and classification techniques: Logistic Regression, Training a Logistic Regression Classifier, Classification and Regression Trees, Bias Variance Dichotomy, Model Assessment and Selection.

Unsupervised Learning and Challenges for Big Data Analytics: Clustering, Associative Rule Mining, Challenges for big data analytics, Data Wrangling, Data cleaning and data visualization, Statistical Analysis in mining and visualizing data

Prescriptive analytics: Introduction to Experimentation and Active Learning, Reinforcement Learning.

Course Learning Outcomes (CLO):
Student will be able to:

1. Elucidate the basics of Data Analytics
2. Analyze different techniques of Inferential Statistics
3. Apply various regression techniques for modelling
4. Exhibit the understanding of techniques for data clustering and reinforcement learning.

Text Books:

3. *T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008.*
4. *Christopher Bishop. Pattern Recognition and Machine Learning. 2e.*

Evaluation Scheme:

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

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UEI628: OPTICAL INSTRUMENTATION

L	T	P	Cr
3	0	0	3.0

Course Objectives: To make the students able to understand different aspects of optical instrumentation. To introduce opto-electronic devices and optical components. To explain the concept of interferometry

Light Sourcing, Transmitting and Receiving: Concept of light, classification of different phenomenon based on theories of light, basic light sources and its characterization, polarization, coherent and incoherent sources, grating theory, application of diffraction grating, electro-optic effect, acousto-optic effect and magneto-optic effect.

Opto–Electronic devices and Optical Components: Photo diode, PIN, photo-conductors, solar cells, phototransistors, materials used to fabricate LEDs and lasers design of LED for optical communication, response times of LEDs, LED drive circuitry, lasers classification ruby lasers, neodymium lasers, CO_2 lasers, dye lasers, semiconductors lasers, lasers applications.

Interferometry: Interference effect, radiometry, types of interference phenomenon and its application, michelson's interferometer and its application refractometer, rayleigh's interferometers, spectrographs and monochromators, spectrophotometers, calorimeters, medical optical instruments

Optical Fiber Sensors: Active and passive optical fiber sensor, intensity modulated, displacement type sensors, multimode active optical fiber sensor (micro bend sensor) single mode fiber sensor-phase modulates and polarization sensors

Fiber optic fundamentals and Measurements: fundamental of fibers, fiber optic communication system, optical time domain reflectometer (OTDR), time domain dispersion measurement, frequency domain dispersion measurement.

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

5. Exhibit the knowledge of basic concepts of optical transmitting and receiving
6. Exhibit the knowledge of different opto- electronic devices
7. elucidate different methods of interferometry
2. Exhibit the knowledge of selection of the appropriate optical fiber sensors for industrial application
3. Exhibit the knowledge of fibre optic fundamentals

Text books:

1. *J.Wilson&J F B Hawkes, Opto Electronics: An Introduction, Prentice Hall of India, (2011),3rd ed.*
2. *RajpalS.Sirohi , Wave Optics and its Application, (2001),1st ed.*
3. *A Yariv , Optical Electronics/C.B.S. Collage Publishing, New York, (1985)*
4. *Pollock ,Fundamentals of OPTOELECTRONICS,(1994)*

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Evaluation Scheme:

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

UCS414: COMPUTER NETWORKS

L	T	P	Cr
2	0	2	3.0

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

Introduction: Computer Network and criteria, Classification of networks, Network performanceand Transmission Impairments. Networking Devices, OSIand TCP/IP Protocol Suite, Layering principles, Line Encoding, Switching and Multiplexing techniques.

Local Area Networks: Networking topologies: Bus, Star, Ring, Token passing rings, Ethernet, IEEE standards 802.3, 802.5. Wireless LANs: IEEE 802.11 and Bluetooth

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

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

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

Self Learning Contents:

Naming and address schemes (DNS, IP addresses, Uniform Resource Identifiers, etc.), Distributed applications (client/server, peer-to-peer, etc.), HTTP, Electronic mail, File transfer, Telnet.

Laboratory work:

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

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

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

1. Conceptualize and explain the functionality of the different layers within a network architecture
2. Understand the concept of data communication, error detection and correction, access and flowcontrol.
3. Demonstrate the operation of various routing protocols, subnetting and their performanceanalysis.
4. Illustrate design and implementation of datalink, transport and network layer protocols within asimulated/real networking environment.

Text Books:

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

Reference Books:

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

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UEC859: INTEGRATED SYSTEM DESIGN

L	T	P	Cr
2	0	2	3.0

Course Objective: To enhance comprehension capabilities of students through understandingon the use of **HDL (Verilog and VHDL)** 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 CLO sck 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 Verilog and VHDL constructs using, their testing by modeling and simulating test benches, Logic Synthesis using FPGA Advantage, Mapping on FPGA Boards.
Micro Poject: Design & Simulate a digital system in VHDL or Verilog and its implementation 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,*

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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

Elective–III

UEI731: ADVANCED CONTROL SYSTEMS

L	T	P	Cr
3	0	2	4.0

Course objective: To provide knowledge of methods for analyzing the behavior of nonlinear control systems and the designing of control systems. To introduce z-plane analysis of discrete time control systems. To familiarize with the design of discrete time control systems.

Nonlinear Control Systems: Introduction to Nonlinear systems and their properties, Common Non-linearities, Describing functions, Phase plane method, Lyapounov's method for stability study, concept of Limit Cycle.

Optimal Control Theory: Introduction, Optimal control problems, Mathematical procedures for optimal control design: Calculus of variations, Pontryagin's optimum policy, Bang-Bang Control, Hamilton-Jacobi Principle

z-Plane Analysis of Discrete-Time Control Systems: Introduction, Impulse sampling and data hold, Reconstructing original signal from sampled signals, concept of pulse transfer function, Realization of digital controllers.

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

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

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

1. Demonstrate non-linear system behavior by phase plane and describing function methods
2. Perform the stability analysis nonlinear systems by Lyapunov method develop design skills in optimal control problems
3. Derive discrete-time mathematical models in both time domain (difference equations, state equations) and z-domain (transfer function using z-transform).
4. Analyze and Predict transient and steady-state responses and stability and sensitivity of both open-loop and closed-loop linear, time-invariant, discrete-time control systems
5. Exhibit the knowledge of state space and state feedback in modern control systems, pole placement, design of state observers and output feedback controllers

Text Books:

1. *Slotine& Li, Applied Non-Linear Control, Englewood Cliffs, NJ: Prentice-Hall, (1991).*
2. *Bandyopadhyay, M.N., Control Engineering: Theory and Practice, Prentice-Hall of India Private Limited (2003).*
3. *Ogata, K., Discrete-time Control Systems, Pearson Education (2005).*

Evaluation Scheme:

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

UEI732: BIOMEDICAL SIGNAL AND IMAGE PROCESSING

L	T	P	Cr
3	0	2	4.0

Course Objectives: The objective of the course is to provide basic understanding of biomedical signals and image transforms enhancement, segmentation, and representation techniques.

Introduction to Biomedical Signals: ECG, EEG, EMG, ENG etc., Noise Filtering: Random noise structured noise and physiological interference- noise and artifacts in ECG. Time domain filters- Frequency domain Filters. Adaptive noise canceller- Interference cancellation in Electrocardiography- noise cancellation in electro surgery.

Wavelet and Speech Processing: Introduction to wavelets, Time frequency representation, Discrete wavelet transform, pyramid algorithm, Comparison of Fourier transform and wavelet transform, Speech analysis – Cepstrum – Homomorphic filtering of speech signals.

Analysis of Biomedical Signals: Detection of P, QRS and T waves in ECG- EEG rhythms- Correlation and coherence analysis of EEG channels- Detection of EEG spike and wave complexes Analysis of Heart Rate variability, Synchronized averaging of PCG envelopes, envelogram, Analysis of PCG signal, Analysis of EMG signal, EEG signal characteristics – EEG analysis

Fundamentals of Biomedical Image Processing: Image formation- Image reconstruction - Principles of Computed Tomography, Fourier methods-image reconstruction in: X - ray CT, Nuclear Emission Computed Tomography - SPECT and PET, Magnetic resonance imaging and ultrasound imaging.

Image Segmentation: Thresholding - Region based segmentation Active contour methods - Texture feature based Morphological operation - Erosion - dilation-Opening – Closing - Hit or Miss Transformation

Image Representation and Analysis: Feature extraction and representation, statistical, shape, texture, feature and image classification – statistical, rule based, neural network approaches.

Course Learning Outcomes (CLO):
Student will be able to:

1. Exhibit the knowledge of in-depth knowledge about the basic concepts of wavelet and speech analysis
2. apply various signal processing techniques in analysing the various bio- signal
3. Exhibit the knowledge of the different methods and modalities used for medical imaging
4. Exhibit the knowledge of basic principles of image segmentation and representation

Text Books:

1. *Reddy D.C, "Biomedical Signal Processing: Principles and Techniques", Tata McGraw-Hill, New Delhi,2nd edition ,2005.*
2. *Atam P. Dhawan, 'Medical Image Analysis', Wiley Interscience Publication, NJ, USA 2003. 2. R.C.Gonzalez and R.E.Woods, 'Digital Image Processing', Second Edition, Pearson Education, 2002.*

Reference Books:

1. *Sanjit.K, Mitra "Digital Signal Processing", A Computer Based Approach", Tata McGraw-Hill, New Delhi, fourth edition 2011.*
2. *Geoff Dougherty, "Digital Image Processing for Medical Applications", Cambridge University Press, India 2009.*

Evaluation Scheme:

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

Approved in 100th meeting of the Senate held on March 09, 2020

UEI733: EMBEDDED SYSTEM DESIGN

L	T	P	Cr
3	0	2	4.0

Introduction: Introduction to Embedded Systems, Its Architecture and system Model, Microprocessors &Microcontrollers, Introduction to the ARM Processor architecture, Embedded Hardware Building Block. Embedded System Attributes.

ARM Microprocessor Architecture: ARM Core M0+ Architecture, Power architecture, Low power modes, Registers, Memory organization and system, addressing modes, Thumb instructions, Input & Output port, RAM & ROM Allocation, Timer programming, Exceptions and Interrupts, Communications – SPI, RS232, I2C, and Ethernet.

EMBEDDED PROGRAMMING: C and Assembly language programming, Programming Style, Declarations and Expressions, Arrays, Qualifiers and Reading Numbers, Decision and Control Statements.

Development tools and Programming: Hardware and Software development tools, Codewarrior tools-Project IDE, Compiler, Assembler and Debugger, JTAG and Hardware Debuggers, Interfacing Real Time Clock and Temperature Sensors.

Real-time Operating Systems (RTOS) : Basic concepts of RTOS and its types, Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Concurrency, Reentrancy, Intertask communication, Inter process Communication – synchronization between processes - semaphores.

Laboratory Work:

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

Case study: Measuring Current, Power, and Energy on the FRDM-KL25Z board.

Course Learning Outcomes (CLO):

Student will be able to:

1. Exhibit the knowledge of ARM Microprocessor Architecture
2. Exhibit the knowledge of programming of C and assembly language
3. Program and exhibit the knowledge of development tools
4. Exhibit the knowledge of real-time operating systems

Text Books:

1. *Alexander G. Dean , Embedded Systems Fundamentals with Arm Cortex M Based Microcontrollers: A Practical Approach, ARM Education media, 2017.*
2. *Haung, H.W., The HCS12 / 9S12: An Introduction to Software and Hardware Interfacing, Delmar Learning (2007).*

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Reference Books:

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

Evaluation Scheme:

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

UEI734: DIGITAL IMAGE PROCESSING

L	T	P	Cr
3	0	2	4.0

Course Objectives: To introduce the concepts of image processing and basic analytical methods to be used in image processing. To familiarize students with image enhancement and restoration techniques, To explain different image compression techniques. To introduce segmentation and morphological processing techniques.

Introduction: Fundamentals of Image formation, components of image processing system, image sampling and quantization.

Image enhancement in the spatial domain: Basic gray-level transformation, histogram processing, arithmetic and logic operators, basic spatial filtering, smoothing and sharpening spatial filters.

Image restoration: A model of the image degradation/restoration process, noise models, restoration in the presence of noise–only spatial filtering, Weiner filtering, constrained least squares filtering, geometric transforms; Introduction to the image enhance in frequency domain.

Image Compression: Need of image compression, image compression models, error-free compression, lossy predictive coding, image compression standards.

Morphological Image Processing: Preliminaries, dilation, erosion, open and closing, basic morphologic algorithms, The Hit-or-Miss Transformation

Image Segmentation: Detection of discontinuous, edge linking and boundary detection, thresholding, Hough Transform Line Detection and Linking, region–based segmentation.

Object Recognition: Patterns and patterns classes, matching, classifiers.

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

1. Exhibit the knowledge of fundamentals of digital image and its processing
2. Exhibit the knowledge of image enhancement techniques in spatial and frequency domain
3. Elucidate the mathematical modelling of image restoration and compression
4. Apply the concept of image segmentation
5. Exhibit the knowledge of object detection and recognition techniques

Text Books:

1. Digital Image Processing, RafealC.Gonzalez, Richard E.Woods, Second Edition, Pearson Education/PHI.

Reference Books

1. *Image Processing, Analysis, and Machine Vision, Milan Sonka, Vaclav Hlavac and Roger Boyle, Second Edition, Thomson Learning.*
2. *Introduction to Digital Image Processing with Matlab, Alasdair McAndrew, Thomson Course Technology*
3. *Computer Vision and Image Processing, Adrian Low, Second Edition, B.S.Publications*
4. *Digital Image Processing using Matlab, RafealC.Gonzalez, Richard E.Woods, Steven L. Eddins, Pearson Education.*

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Evaluation Scheme:

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

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UCS303: OPERATING SYSTEMS

L	T	P	Cr
3	0	2	4.0

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

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

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

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

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

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

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

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

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Concurrency: The Critical-section problem, Peterson's solution, Synchronization, Hardware, MutexLocks, Semaphores, Classic Problems of Synchronization, Monitors.

Laboratory work:

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

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

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

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

Text Books:

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

Reference Books:

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

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UEC637: VLSI Testing and Verification

L	T	P	Cr
3	0	2	4.0

Course Objective: In this course students will learn test economics, fault modelling, logic and fault simulation, ATPG concepts for combinational and sequential circuits. Students will also be able towrite test bench for the complex VLSI design.

Introduction: Role of testing in VLSI design, Issues in test and verification of complex chips, VLSItest process and equipment, Test economics, Yield analysis and product quality.

Faults modelling and fault simulation: Physical faults and their modelling, Stuck-at faults, Bridging faults, Fault collapsing, Fault simulation, Deductive, Parallel and Concurrent fault simulation,Combinational and sequential SCOAP measures.

ATPG for combinational circuits: D-Algorithm, Boolean Difference, PODEM, Random, Exhaustive and Weighted Test Pattern Generation, Aliasing and its effect on Fault coverage.

ATPG for sequential circuits: ATPG for Single-Clock Synchronous Circuits, Time frame expansion Method, Simulation-Based Sequential Circuit ATPG.

Memory testing and BIST: Permanent, Intermittent and pattern sensitive faults, March test notion, Memory testing using march tests, PLA testing, Ad-Hoc DFT methods, Scan design, Partial scan design, Random logic for BIST, Memory BIST.

Verification: Design verification techniques based on simulation, Analytical and formal approaches, Functional verification, Timing verification, Formal verification, Basics of equivalence checking and Model checking, Hardware emulation.

Laboratory Work:

Familiarization with development of testbenches using Verilog/System Verilog on Mentor/Cadence/Xilinx-ISE tools, Logic simulation, Logic level diagnosis, ATPG, development of Verification plan for the given design and writing testcases, computation of fault coverage/code coverage index

Text Books:

1. M. Bushnell and Vishwani Agrawal, Essentials of Electronic Testing for Digital, Memory andMixed-Signal VLSI Circuits, Springer, ISBN 978-0792379911.

2. Chris Spear, System Verilog for Verification, Springer, ISBN 978-1-4614-0714-0

Reference Books:

1. M. Abramovici, M. Breuer, and A. Friedman, Digital System Testing and Testable Design, IEEEPress, 1994

2. Diraj K. Pradhan, "Fault Tolerant Computer System Design", Prentice Hall.

3. L. T. Wang, C. W. Wu, and X. Wen, VLSI Test Principles and Architectures, Morgan Kaufmann,2006, ISBN-13: 978-0-12-370597-6, ISBN-10: 0-12-370597-5.

4. System-on-a-Chip Verification-Methodology and Techniques, P. Rashinkar, Paterson and L.Singh, Kluwer Academic Publishers, 2001

5. Janick Bergeron, "Writing test benches functional verification of HDL models" Kluwer Academic Publishers, New York, Boston, Dordrecht, London, Moscow, 2002.

Course Learning Outcomes:

The student will able to

1. Acquire knowledge about fault modelling and collapsing.
2. Learn about various combinational and sequential automatic test pattern generationtechniques.
3. Analyze different memory faults and its testing methods.
4. Develop the verification plan for the small to complex VLSI designs.
5. Develop test bench using HVL for testing and verification of VLSI designs.

Elective–IV

UEI848: REAL TIME CONTROL SYSTEMS

L	T	P	Cr
3	0	0	3.0

Course Objectives: The objective of the course is to provide basic understanding of real time control systems.

Introduction: Computer based control: History and Trends, Need of Digital control, Basic digital control scheme, Principles of signal conversion, basic discrete time signals, time domain models for discrete time systems, Sampling and Reconstruction, zero order hold and first order hold.

Mathematical Models: Pulse transfer function models, state equation of discrete data system with sample and hold devices, decomposition of discrete data transfer function, Direct, cascade and parallel decompositions, multi-rate discrete data systems.

Design of Digital Control Algorithms: Introduction to digital P, PI, PID controller, tuning rules (Ziegler-Nichols, IMC, Skogestad Method), lag-lead compensator design, pole placement design

Digital Simulation: Digital modeling with sample and hold devices, state variable formulation, numerical integration, rectangular integration, realization of digital controllers with digital programming

Real-time Implementation: Real-time Systems Implementation Techniques, Analog Controller realization, circuit implementation, microprocessor control of control system, Digital signal processor-based implementation, effect of quantization, Time delays in control system realization. Concurrent Programming.

Course Learning Outcomes (CLO):
Student will be able to:

1. Demonstrate the basic understanding of real-time control system
2. design of digital control algorithms
3. Solve the problems related to digital simulation for control system analysis
4. Demonstrate the knowledge of Implementation Techniques of real-time systems

Text Books:

1. Tian Seng Ng, "Real Time Control Engineering: Systems And Automation;Springer, 2016

Reference Books:

1. *Peng Zhang, Industrial Control Technology: A Handbook for Engineers and Researchers; William Andrel, 2007.*
2. *C.A. Rabbath, N. Léchevin, "Discrete-Time Control System Design with Applications"; Springer.*

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Evaluation Scheme:

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

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UEI741: MEDICAL DEVICES

L	T	P	Cr
3	0	0	3.0

Course Objectives: The objective of the course is to provide basic understanding of common medical instruments that are routinely used in clinics. It will also discuss basic design considerations of biomedical instrumentation.

MEASUREMENT DEVICES: Ambulatory Blood Pressure Monitor, Ambulatory Cardiac Monitor: Holter Analyser, Event Recorder, Real-Time Cardiac Monitoring Systems, ECG Patch Monitoring, Ambulatory Glucose Monitor, Ambulatory Sleep Monitor, Thyroid Uptake System, Heart-Lung Machine (HLM) – Oxygenators.

PATIENT MONITORING SYSTEMS AND BIOTELEMETRY: Heart Rate Monitor, Respiration Rate Monitor, Endoscope, Bronchoscope, Spirometer, Apnea detectors, Oximetry -Pulse oximeter, Ear oximeter, Ventilator, Computerized patient monitoring system, Bedside, Central Monitoring system, Biotelemetry: Basics components, and its different types.

SENSORY INSTRUMENTATION: Mechanism of Hearing, Sound Conduction System, Basic Audiometer, Pure tone audiometer, Audiometer system Bekesy, Hearing Aids, Ophthalmoscope, Tonometer - Measurement of Basal Skin response and Galvanic skin response, Instruments for testing Motor responses, Experimental Analysis of Behavior, Biofeedback Instrumentation.

MEDICAL IMAGING DEVICES: Ultrasound, Mammography, Echocardiography, Fundus camera, Radiographs, Computed tomography, Magnetic Resonance Imaging System, Optical Coherence Tomography, positron emission tomography.

Course Learning Outcomes (CLO):
Student will be able to:

1. Exhibit the knowledge of Electrocardiography system
2. Demonstrate the knowledge of instrumentation concerned with measuring various parameters and the principle of working
3. Exhibit the knowledge of instruments used for sensory measurements and able to design sensors
4. Exhibit the knowledge of the principle and working of different medical imaging systemand their applications

Text Books:

1. *J. Carr and J. Brown, Introduction to Biomedical Equipment and Technology, 4th edition. [ISBN-10: 0130104922 | ISBN-13: 978-0130104922]*
2. *R. Aston, Principles of Biomedical Instrumentation and Measurement, 1st edition. [ISBN-10: 0675209439 | ISBN13: 978-0675209434].*

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Reference Books:

1. *Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, BioMedical Instrumentation and Measurements, 2nd edition, Pearson Education. [ISBN-10: 0130764485 | ISBN-13: 978-0130764485]*
2. *John G. Webster, Medical Instrumentation: Application and Design, 4th edition, Wiley, New York. [ISBN-10: 0471676004 | ISBN-13: 978-0471676003].*

Evaluation Scheme:

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

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UEI742: SMART SENSOR NETWORKS

L	T	P	Cr
3	0	0	3.0

Course Objectives: The objective of the course is to provide basic understanding of sensor networks, standards and protocols, application and latest trends.

Introduction: Basics of wireless sensor network, Sensor network architecture, Open Systems Interconnection model, components of sensor network nodes, Advantage of Sensor Networks, Applications of Sensor Networks, Reconfigurable Sensor Networks, Military application, Habitat monitoring, Wireless sensor network as embedded system, Tiered architecture in sensor network, Routing and addressing in tiered architecture, Energy efficient design of Wireless sensor nodes.

Fundamentals of Medium Access Control Protocols, Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, A survey of MAC protocol for sensor network, IEEE 802.xx standard, IEEE 802.15.4 standard and Zig Bee, IEEE 1451 Family of Smart Transducer Interface Standards

Taxonomy of routing techniques in sensor networks: Routing Protocols/ strategies in WSN, Sensor Protocols for information vis negotiation, Low energy adaptive clustering, hierarchy (LEACH), Data dissemination and gathering, Power efficient gathering sensor information system, Reliable Transport in Sensor Networks, Dissemination Protocols for large sensor networks.

Survey of Latest Protocol: Features of recent networks such as WAN – GPRS, WAN - 3G, WAN-4G, WAN, Wi Fi/WLAN 802.11xx, Wi Fi/WLAN – AP, Wi Fi/WLAN – STA, Wi Fi/WLAN - P2P, Wi Fi/WLAN – WPS, Wi Fi/WLAN - WPA personal, Wi Fi/WLAN - WPA enterprise, Bluetooth Classic Vx.x, Bluetooth Low Energy Vx.x, Dual mode Bluetooth Vx.x, 6LoWPAN, Brillo, Echo, Homekit, iAP1, iAP2, LoRaWAN V1.0, Neul, NFC, SigFox, Thread, ZigBee 3.0, Z-wave.

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

1. Exhibit the knowledge of the concept of sensor network and its application
2. Classify the communication Protocols in sensor networks
3. Exhibit the knowledge of the concept of routing techniques in sensor networks
4. Implement the concept of sensor networks in the current advance applications like WiFi, Bluetooth, Homekit, ZigBee and Z-wave etc.

Text Books:

1. *H. Karl and A. Willig, Protocols and Architectures for Wireless Sensor Networks.*
2. *John Wiley & Sons, June 2005.*
3. *K. Sohraby, D.Minoli, and T. Znati.Wireless Sensor Networks: Technology, Protocols, and Applications. John Wiley & Sons, March 2007.*

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4. *C. S. Raghavendra, K. M. Sivalingam, and T. Znati, Wireless Sensor Networks. Springer Verlag, Sep. 2006.*
5. *B. Krishnamachari , Networking Wireless Sensors.. Cambridge University Press, Dec. 2005.*
6. *D.P. Agrawal, Embedded Sensor Systems, Springer, 2017.*

Reference Books:

1. *Mohammad Ilyas and Imad Mahgoub, Handbook of Sensor Networks: Compact Wireless and Wired Sensing systems, CRC PRESS, 2004*

Evaluation Scheme:

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

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UEI743: BIOSENSORS AND MEMS

L	T	P	Cr
3	0	0	3.0

Course Objectives: To introduce the concept of biosensors and MEMS, design and fabrication, types and their applications. To explain biosensors and bioelectronics devices. To introduce MEMS technology.

Overview of biosensors and their electrochemistry: Molecular reorganization: Enzymes, Antibodies and DNA, Modification of bio recognition molecules for Selectivity and sensitivity, Fundamentals of surfaces and interfaces

Bioinstrumentation and bioelectronics devices: Principles of potentiometry and potentiometric biosensors, Principles of amperometry and amperometric biosensors, Optical Biosensors based on Fiber optics, FETs and Bio-MEMS, Introduction to Chemometrics, Biosensor arrays; Electronic nose and electronic tongue

MEMS Technology: Introduction Nanotechnology and MEMS, MEMS design, and fabrication technology – Lithography, Etching, MEMS material, Bulk micromachining, Surface micromachining, Microactuator, electrostatic actuation, Micro-fluidics.

MEMS types and their applications : Mechanical MEMS – Strain and pressure sensors, Accelerometers etc., Electromagnetic MEMS – Micromotors, Wireless and GPS MEMS etc.

Magnetic MEMS – all effect sensors, SQUID magnetometers, Optical MEMS – Micromachinedfiber optic component, Optical sensors, Thermal MEMS – thermo-mechanical and thermo-electrical actuators, Peltier heat pumps.

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

1. Exhibit the knowledge of the concept of molecular reorganization, fundamentals of surfaces and interfaces
2. Elucidate the principles of different types of biosensors
3. Demonstrate the knowledge of the concept of MEMS design, and fabrication technology
4. Exhibit the knowledge of bioinstrumentation and bioelectronics devices
5. Exhibit the understanding of the different types of MEMS and its applications

Text books:

4. *Gardner, J.W., Microsensors, Principles and Applications, John Wiley and Sons (1994).*
5. *Kovacs, G.T.A., Micromachined Transducer Sourcebook, McGraw–Hill (2001).*
6. *Turner, A.P.F., Karube,I., and Wilson G.S., Biosensors–Fundamentals and Applications, Oxford University Press (2008).*

Reference Book:

1. *Trimmer, W., Micromechanics and MEMS, IEEE Press (1990)*

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Evaluation Scheme:

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

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UCS753: DEEP LEARNING

L	T	P	Cr
2	0	2	3.0

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

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

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

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

Self Learning Content:

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

Laboratory Work:

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

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

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

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

Text Books:

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

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Reference Books:

1. Le Deng and Dong Yu, “Deep Learning: Methods and Applications”, Foundations and Trends in Signal Processing, 2013.
2. Charu C. Aggarwal, “Neural Networks and Deep Learning”, Springer, 2018

Evaluation Scheme:

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

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