COURSE SCHEME AND SYLLABUS

FOR

B.E. Electronics (Instrumentation and Control) Engineering

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

2024

Approved in 2nd meeting of the Academic Council held on December 08, 2025 and revised in the 3rd meeting held on 18th March, 2026

SEMESTER-I

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UPH013	PHYSICS	BSC	3	1	2	**4.5**
2.	UES101	ENGINEERING DRAWING	ESC	2	4	0	**4.0**
3.	UHU003	PROFESSIONAL COMMUNICATION	HSS	2	0	2	**3.0**
4.	UES102	MANUFACTURING PROCESSES	ESC	2	0	2	**3.0**
5.	UMA022	CALCULUS FOR ENGINEERS	BSC	3	1	0	**3.5**
6.		BOOTCAMP		-	-	-	**1**
		TOTAL		12	6	6	**19.0**

CODE** For filling code in this column refer to the table titled "**Nature of course and code**" given below (on next page)

SEMESTER-II

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UCB009	CHEMISTRY	BSC	3	0	2	**4.0**
2.	UES103	PROGRAMMING FOR PROBLEM SOLVING	ESC	3	0	2	**4.0**
3.	UES013	ELECTRICAL & ELECTRONICS ENGINEERING	ESC	3	1	2	**4.5**
4.	UEN008	ENERGY AND ENVIRONMENT	HSS	2	0	0	**2.0**
5.	UMA023	DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA	BSC	3	1	0	**3.5**
		TOTAL		14	2	6	**18.0**

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SEMESTER-III

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UES034	MEASUREMENT SCIENCE AND TECHNIQUES	ESC	3	1	2	**4.5**
2.	UMA302	MATHEMATICS FOR SIGNALS	BSC	3	1	0	**3.5**
3.	UEI408	ANALOG DEVICES & CIRCUITS	PCC	3	1	2	**4.5**
4.	UTA030	ENGINEERING DESIGN PROJECT (BUGGY)	PRJ	1	0	4	**3.0**
5.	UEI301	DIGITAL ELECTRONICS	PCC	3	1	2	**4.5**
6.	UTD003	APTITUDE SKILLS BUILDING	HSS	2	0	0	**2.0**
7.	UCS321	AI FOR ENGINEERS	ESC	2	0	2	**3.0***
		TOTAL		17	4	12	**25**

SEMESTER-IV

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UEE410	DATA STRUCTURE AND ALGORITHMS	ESC	3	0	2	**4.0**
2.	UMA028	MATHEMATICS FOR DATA SCIENCE	BSC	3	0	2	**4.0**
3.	UEI403	ELECTRICAL AND ELECTRONIC MEASUREMENTS	PCC	3	1	2	**4.5**
4.	UEI501	CONTROL SYSTEMS	PCC	3	1	2	**4.5**
5.	UTA018	OBJECT-ORIENTED PROGRAMMING	ESC	3	0	2	**4.0**
6.	UMA035	OPTIMIZATION TECHNIQUES	BSC	3	0	2	**4.0**
7.	UHU052	EVOLUTIONARY BASIS OF HUMAN BEHAVIOUR FOR ENGINEERS	HSS	1*	0	0	**1.0**
8.	UCS421	ETHICS AND RISK MITIGATION IN AI	ESC	3	0	0	**3.0***
		TOTAL		22	2	12	**26**

***** UCS321 (AI for Engineers)

The 3 credits shall be added to the total credit requirement of all Bachelor's degree schemes**.** UCS421 and Domain-Specific AI Course (3 + 3 credits). These 6 credits shall not be added to the total credit requirement of the Bachelor's degree schemes.

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Together with UCS321, they shall constitute a 9-credit Micro-Credential Certification in AI Literacy, to be awarded by the Thapar School of Advanced AI and Data Science.

SEMESTER-V

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UEIXXX	FUNDAMENTALS OF MICROPROCESSORS AND MICROCONTROLLERS	PCC	3	1	2	**4.5**
2.	UEI608	BIO-MEDICAL INSTRUMENTATION	PCC	3	0	2	**4.0**
3.	UEI601	INDUSTRIAL INSTRUMENTATION	PCC	3	1	2	**4.5**
4.	UEIXXX	ARTIFICIAL INTELLIGENCE AND APPLICATIONS	PCC	2	0	2	**3.0***
5.	UEI604	PROCESS DYNAMICS & CONTROL	PCC	3	1	2	**4.5**
6	UTA025	INNOVATION & ENTREPRENEURSHIP	OTH	1	0	2*	**2.0**
7.	UEI306	NETWORK ANALYSIS	PCC	2	1	0	**2.5**
		TOTAL		17	4	12	**22**

SEMESTER-VI

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UEI844	VIRTUAL INSTRUMENTATION	PCC	2	0	3	**3.5**
2.	UEI701	DATA ACQUISITION AND SYSTEM DESIGN	PCC	3	0	2	**4.0**
3.	UEI607	DIGITAL SIGNAL PROCESSING AND APPLICATIONS	PCC	3	1	2	**4.5**
4.		ELECTIVE-1					**3.0**
5.		ELECTIVE-II					**3.0**
6.	UEI793	CAPSTONE PROJECT (START)	PRJ	1*	0	2	**---**
7	UHU005	HUMANITIES FOR ENGINEERS	HSS	2	0	2	3.0
		TOTAL					**21 .0**

*Alternate week

SEMESTER-VII

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S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UEI801	ADVANCED PROCESS CONTROL	PCC	3	1	2	**4.5**
2.		ELECTIVE-III					**4.0**
3.		ELECTIVE-IV					**3.0**
4.		GENERIC ELECTIVE		2	0	0	**2.0**
5.	UEI793	CAPSTONE PROJECT	PRJ	1*	0	2	**8.0**
		TOTAL					**21.5**

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SEMESTER-VIII

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UEI896	PROJECT SEMESTER	PRJ				**15**
OR							
1.	UEI897	DESIGN PROJECT	PRJ				**8.0**
2.	UEI852	LINEAR INTEGRATED CIRCUITS	PCC	3	0	2	**4.0**
3.	UEI805	ENVIRONMENTAL INSTRUMENTATION	PCC	3	0	0	**3.0**
OR							
1.	UEI898	Start-up Semester	PRJ				15.0
		TOTAL					**15.0**

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Total Credits: 167.5

Total Credit Score for specific Nature of course/s

Nature of the course	CODE	Total Credits	Semester and Course Name
Basic Science Courses	BSC	27	Semester-I, Physics Semester-I, Mathematics-I Semester-II, Chemistry Semester-II, Mathematics-II Semester-III, Mathematics for Signals Semester-III, Optimization Techniques Semester-IV, Mathematics for Data Science
Engineering Science Courses	ESC	28	Semester-I, Engineering Drawing Semester-I, Manufacturing Processes Semester-II, Programming for Problem Solving Semester-II, Electrical & Electronics Engineering Semester-III, Measurement Science and Techniques Semester-IV, Object Oriented Programming Semester-IV, Data Structures and Algorithms
Humanities and Social Science Courses	HSS	11	Semester-I, Professional Communication Semester II, Energy and Environment Semester-III, Employability development skills Semester IV, Evolutionary Psychology Semester-VI, Humanities for Engineers

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Professional Core Courses	PCC	56.5	Semester-III, Digital Electronics Semester-III, Analog Devices and Circuits Semester-III, Network Analysis Semester-IV, Electrical and Electronic Measurement Semester-IV, Control Systems Semester-V, Fundamentals of Microprocessors and Microcontrollers Semester-V, Bio-medical Instrumentation

Nature of the course	CODE	Total Credits	Semester and Course Name
			Semester-V, Industrial Instrumentation Semester-V, Artificial Intelligence and Applications Semester-V, Digital Signal Processing and Applications Semester-VI, Virtual Instrumentation Semester-VI, Data Acquisition and System Design Semester-VI, Process Dynamics and Control Semester-VII, Advanced Process Control
Open Elective Courses	OEC	15	Semester-VI, Elective-I, Semester-VI, Elective-II Semester-VII, Elective-III Semester-VII, Elective-IV Semester-VII, Generic Elective
Project	PRJ	28	Semester-III, Engineering Design Project (BUGGY) Semester-V, Instrument Design Project Semester-VII, Capstone Project Semester-VIII, Project Semester
Others	OTH	2.0	Semester-V, Innovation and Entrepreneurship

Table: Nature of course and code

Nature of the course	CODE**
Basic Science Courses	BSC
Engineering Science Courses	ESC
Humanities and Social Science Courses	HSS
Professional Core Courses	PCC
Open Elective Courses	OEC
Project	PRJ
Others	OTH

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Baskets:

S.No.	**Industrial Automation**	**Biomedical Instrumentation**	**Smart Systems**	**Computer Systems**
1	Robotics	Biometrics	IoT Systems	Data Base Management Systems
2	Advanced Control systems	Prosthetics and rehabilitation	Data Analytics	Computer Networks
3	Power Electronics for Automation	Biomedical devices and signal analysis	Embedded system design	Operating Systems
4	Robust and Real Time Control Systems	Deep Learning in Health Care Applications	Smart Sensor Networks	Deep Learning and Computer Vision

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	UEI615	DATA BASE MANAGEMENT SYSTEM (basket-4)	2	0	2	3.0
7	UEI616	CLOUD COMPUTING	2	0	2	3.0
8	UEI617	NETWORK PROGRAMMING	2	0	2	3.0

Elective-II

S. No.	**COURSE NO.**	**TITLE**	**L**	**T**	**P**	**CR**
1	UEI632	ADVANCED CONTROL SYSTEMS **(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

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6	UCS638	SECURE CODING	2	0	2	3.0
7	UCS537	SOURCE CODE MANAGEMENT (Paid)	2	0	2	3.0

Elective-III

S. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UEI735	POWER ELECTRONICS FOR AUTOMATION	3	0	2	4.0
2	UEI736	BIOMEDICAL DEVICES AND SIGNAL ANALYSIS (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	UEI726	NETWORK SYNTHESIS	3	0	2	4.0
5	UEI711	OPERATING SYSTEMS (basket 4)	3	0	2	4.0
6	UEI712	SOFTWARE ENGINEERING	3	0	2	4.0
7	UEI713	COMPUTER GRAPHICS	3	0	2	4.0

Elective-IV

S. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UEI744	ROBUST AND REAL TIME CONTROL SYSTEMS	3	0	0	3.0
2	UEI745	DEEP LEARNING IN HEALTH CARE APPLICATIONS	3	0	0	3.0
3	UEI742	SMART SENSOR NETWORKS **(basket 3)**	3	0	0	3.0
4	UEI743	BIOSENSORS AND MEMS	3	0	0	3.0
5	UEI727	DEEP LEARNING AND COMPUTER VISION (basket 4)	2	0	2	3.0
6	UEI728	COMPUTER & NETWORK SECURITY	2	0	2	3.0
7	UEI729	BLOCKCHAIN AND ITS APPLICATIONS	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.	UTD004	CAMPUS 2 CORPORATE	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

UPH013: 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.

Syllabus

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

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

Laboratory Work :

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

Micro Project: Students will be given physics-based projects/assignments using computer simu-

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

1. Understand damped and simple harmonic motion, the role of reverberation in designing a hall and generation and detection of ultrasonic waves.
2. Use Maxwel'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.
6. Perform an experiment, collect data, tabulate and report them and interpret the results with error analysis.

Text Books:

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

Reference Books:

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

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

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UES101: Engineering Drawing

L	T	P	Cr
2	4	0	4.0

Course Objectives: This module is dedicated to graphics and includes two sections: 2D drafting and 3D modelling of solid objects. This course is aimed at making the student understand the concepts of projection systems, learn how to create projections of solid objects using first and third angle orthographic projection as well as isometric and auxiliary projection, concept of sectioning, to interpret the meaning and intent of toleranced dimensions and to create/edit drawings using drafting software. In addition, this course shall give an insight on the basic 3D modelling concepts like extrude, revolve, sweep, construction of complex solids.

Syllabus

Engineering Drawing Concepts

1. Introduction to Engineering Drawing
2. Projection systems: First angle and third angle projection system
3. Orthographic Projection: Points, Lines, Solid objects
4. Isometric Projections
5. Auxiliary Projections
6. Development of surfaces
7. Section of solids
8. Limits, fits and tolerances

2D Drafting

1. Management of screen menus commands
2. Creating basic 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

3D Modelling

1. Management of screen menus commands
2. Introduction to basic 3D modelling commands such as extrude, revolve, sweep etc.
3. Creation of 2D drawings from a 3D model

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Micro Projects /Assignments:

1. Completing the views - Identification and drawing of missing lines and views in the projection of objects
2. Projects related to orthographic and isometric projections Using wax blocks/soap bars/any soft material to develop three dimensional object from given orthographic projections
3. a. 3D modelling of complex machine components
   b. Development of production drawings of individual components from the model

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

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

1. Creatively comprehend the geometrical details of common engineering objects
2. Draw dimensioned orthographic and isometric projections of simple engineering objects
3. Interpret the meaning and intent of limits, fits and tolerances in the drawing
4. create/edit the engineering drawings for simple engineering objects using 2D drafting software
5. create/edit 3D models of engineering components using 3D modelling software

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).
6. Mastering AutoCAD 2021 and AutoCAD LT 2021, Brian C. Benton, George Omura, Sybex
   - John Wiley and Sons, Indiana (2021).

Evaluation Scheme

Evaluation Elements	Weightage %
MST (1.5 hours-CAD based) (MST)	20
EST (2 hours-CAD based)** (ESE)	45
AutoCAD tutorials/SolidWorks/Project work*	35

* Students are required to bring their personal computers for the tutorial work.

* Availability of institute server resources for sharing the software licenses with the student community.

**Institute computational resources in collaboration with other academic units / departments for conducting the mid semester and end semester test.

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UHU003: Professional Communication

L	T	P	Cr
2	0	2	3.0

Course Objectives: The course is designed to develop the interpersonal, written, and oral as well as the non- verbal communication skills of the students. The course begins by building up on the theoretical concepts and then practicing on the applicability of the various elements. Since the course has very high applicability content, the students are advised to practice in class as well as off class. A very high level of interaction is expected of the students in the class.

Syllabus

Fundamentals of Communication: Meaning, Types and Characteristics of communication, Applicability of Transactional Analysis and Johari Window for enhancing interpersonal communication skills. Seven Cs of Effective Communication, Barriers to Effective Communication.

Effective Oral Communication: Understanding Principles of Oral communication, Formal and Informal Oral Communication, Oral Communication and Behavioral Patterns, Advantages and Disadvantages of Oral Communication.

Effective Listening: Listening vs Hearing, Active Listening techniques, Barriers to Listening.

Effective non-verbal communication: Meaning and Importance of Non-Verbal Communication, Different Types of Non-verbal Communication, Interpretation of Non-verbal Cues.

Effective written Communication: Characteristics of Good Writing, Choice of Words, Sentence Construction, Paragraph development, Forms of writing.

Business Communication: Technical Report Writing, Designing Resumes and Cover Letters for effective job application, E-mail writing and e-mail etiquette.

Organizational Communication: Directional communication: Downward, Upward and Horizontal Communication, Grapevine.

Reading: The following texts (one from each of the two categories listed below) are required to be read by the students in the semester:

Category 1: Animal Farm by George Orwell, Lord of the Flies by William Golding, Life of Pi by Yann Martel

Category 2: The Namesake by Jhumpa Lahiri, The God of Small Things by Arundhati Roy, Q&A by Vikas Swarup

Laboratory Work :

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

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

1. Apply communication concepts for effective interpersonal communication.
2. Speak assertively and effectively.
3. Interpret non-verbal cues in professional communication.
4. Write objectively, purposefully and effectively.
5. Design effective resumes and reports.

Text Books:

1. Mukherjee H.S..Business Communication: Connecting at Work. Oxford University Press.(2013)
2. Lesikar R.V, and Flately M.E., Basic Business Communication Skills for empowering the internet generation.(2006)
3. Raman, M.,and Singh ,P, Business Communication . Oxford . University Press (2008).

Reference Books:

1. Riordan, G.R. Technical Communication. Cengage Learning India Private Ltd. (2012)
2. Butterfield, Jeff., Soft Skills for everyone, Cengage Learning New Delhi, (2013).
3. Robbins, S.P., & Hunsaker, P.L., Training in Interpersonal Skills, Prentice Hall of India, New Delhi, (2008).
4. Orwell, G., Animal Farm, Fingerprint Publishing, New Delhi, (2017).
5. Golding, W, Lord of the Flies, Faber & Faber; Export edition (1999)
6. Martel,Y., Life of Pi, RHC, New Delhi, (2012).
7. Lahiri,J., The Namesake, Harpercollins (2007)
8. Arundhati Roy,A., The God of Small Things, Penguin India, (2002).
9. Swarup,V., Q&A, Black Swan,(2009).

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

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UES102: Manufacturing Processes

L	T	P	Cr
2	0	2	3.0

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

Syllabus

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

Metal Casting: Introduction & Principles of sand casting, Requisites of a sound casting, Permanent mold casting processes, casting defects

Metal Forming: Hot & cold metal working, Forging, Rolling, Sheet Metal operations.

Joining Processes: Method of joining, type of electric arc welding processes, Methods of shield- ing, Power source characteristics, Resistance welding, Soldering, Brazing.

Smart Manufacturing: IoT and ML in manufacturing, Introduction to Additive Manufacturing, Robotics and Automation in manufacturing.

Laboratory Work :

Relevant shop floor exercises involving practices in Sand casting, Machining, Welding, Sheet metal fabrication techniques, CNC turning and milling exercises, Experiments on basic engineering metrology and measurements to include measurements for circularity, ovality, linear dimensions, profiles, radius, angular measurements, measurement of threads, surface roughness.

Basic knowledge and derivations related to above measurements, uncertainties, statistical approaches to estimate uncertainties, Line fitting, static and dynamic characteristics of instruments will be discussed in laboratory classes.

Assignments: Assignments for this course will include the topics: Manufacturing of micro-chips used in IT and electronics industry and use of touch screens. Another assignment will be given to practice numerical exercises on topics listed in the syllabus. Case study related to smart manufacturing.

Micro Project: Fabrication of multi-operational jobs using the above processes as per requirement by teams consisting of 4 -6 members. Quality check should be using the equipment availablein metrology lab.

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

1. identify & analyse various machining processes/operations for manufacturing of industrial components
2. apply the basic principle of bulk and sheet metal forming operations
3. apply the knowledge of metal casting for different requirements.
4. identify and analyse the requirements to for achieving a sound welded joint apply the concept of smart manufacturing

Text Books:

1. Degarmo, E. P., Kohser, Ronald A. and Black, J. T., Materials and Processes in Manufac- turing, Prentice Hall of India (2008) 8th ed.
2. Kalpakjian, S. and Schmid, S. R., Manufacturing Processes for Engineering Materials, Dor- ling Kingsley (2006) 4th ed.

Reference Books:

1. Martin, S.I., Chapman, W.A.J., Workshop Technology, Vol.1 & II, Viva Books (2006) 4th ed.
2. Zimmer, E.W. and Groover, M.P., CAD/CAM - Computer Aided Designing and Manufacturing, Dorling Kingsley (2008).
3. Pandey, P.C. and Shan, H. S., Modern Machining Processes, Tata McGraw Hill (2008).
4. Mishra, P. K., Non-Conventional Machining, Narosa Publications (2006).
5. Campbell, J.S., Principles of Manufacturing, Materials and Processes, Tata McGraw Hill Company (1999).
6. Lindberg, Roy A., Processes and Materials of Manufacture, Prentice Hall of India (2008) 4th ed.

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 2nd meeting of the Academic Council held on December 08, 2025 and revised in the 3rd meeting held on 18th March, 2026

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.

Syllabus

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.

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).

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

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

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

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 Churchill R.V, Complex variables and applications, McGraw Hill, (7th edition)

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

UCB009: Chemistry

L	T	P	Cr
3	0	2	4.0

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

Syllabus

Atomic and Molecular spectroscopy: Introduction to spectroscopy, principles of atomic ab- sorption, flame emission spectrophotometry and ICP-AES (Inductively Coupled Plasma- Atomic Emission Spectroscopy), Quantification by calibration method, Jablonski diagram, fluorescence and phosphorescence, Beer-Lambert's Law, principle and applications of UV-Vis and IR spectroscopy.

Electrochemistry: Background of electrochemistry, Ionic mobility, Conductometric titrations, Modern Batteries: Pb-acid and Li ion battery, Corrosion and its protection.

Water Treatment and Analysis: Physiochemical parameters of water quality, External and internal methods of Softening of water: carbonate, phosphate, calgon and colloidal conditioning, Zeolite process, Ion exchange process, treatment of water for domestic use, Desalination of brackish water: Reverse osmosis & Electrodialysis.

Fuels: Classification of fuels, Calorific value, Cetane and Octane number, alternative fuels: biodiesel, Power alcohol, synthetic petrol, Fuel cells: H2 production and storage, Water splitting, Rocket propellant.

Chemistry of Polymers: Classification of polymers, tacticity of polymers, molecular weight calculations, Polymers in daily life, conducting, inorganic and biodegradable polymers.

Computers in Chemistry: Introduction to SMILES (Simplified Molecular Input Line-Entry System): Methodology and encoding rules, SMILES notation-chemical structure interconversions and its applications.

Laboratory Work : Electrochemical measurements: Experiments involving use of pH meter, conductivity meter, potentiometer, Spectroscopic technique, Volumetric titrations: Determination of mixture of bases, hardness, alkalinity, chloride and iron content, Application of polymers and SMILES Language. conducting currents through a dielectric.

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

1. Recognize principles and applications of atomic and molecular spectroscopy.
2. Explain the concepts of conductometric titrations, modern batteries and corrosion.
3. Apply and execute water quality parameter and treatment methods.
4. Discuss the concept of alternative fuels, application of polymers and SMILES.
5. Execute laboratory techniques like pH metry, potentiometry, spectrophotometry, conduc tometry and volumetry.

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

Text Books:

1. Engineering Chemistry, S. Vairam and S. Ramesh, Wiley India 1st ed, 2014.
2. Engineering Chemistry, K. S. Maheswaramma, and M. Chugh. Pearson, 2016.

Reference Books:

1. Engineering Chemistry, B. Sivasankar, Tata McGraw-Hill Pub. Co. Ltd, New Delhi, 2008.
2. Engineering Chemistry, M.J. Shulz, Cengage Learnings, 2007.
3. J. Chem. Inf. Comput. Sci., D. Weininger, Vol. 28, 1988, 31-36.

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

UES103: PROGRAMMING FOR PROBLEM SOLVING

L	T	P	Cr
3	0	2	4.0

Course Objectives: This course is designed to solve and explore the problems using the art of computer programming with the help of C Language. Students will be able to apply these problem solving concepts in real life applications.

Syllabus

Introduction to Computer Fundamentals: Computer Memory Hierarchy, Types of Software Binary number system, Algorithm, Flowchart, Formulate simple algorithms for logical and arithmetic problems.

Basics of C Programming: Structure and Life cycle of a C Program, Data types, Identifiers, Variables, Keywords, Constants, input/output statements, Operators, Type conversion and type casting. Translate the algorithm s to code snippets.

Decision Making and Iterative Statements: Decision making- if, if-else, Nested if else, Multiple if, else if, switch, Ternary Operator, Loops- (while, do-while, for), Nesting of Loops, break, continue and goto. Implement the switch () to solve the basic functions of scientific calculator.

Functions: Function prototype, Definition and Call, Type of Functions, Scope of variables in (Block, Function, Program, File), Storage classes (Auto, Register, Static and Extern), Recursion (with the introduction of Stack), Implementation of recursion to solve the problem of Tower of Hanoi.

Arrays and Strings: One-dimensional array its operations (Traversal, Linear Search, Insertion, Deletion, Bubble Sort), Two-dimensional and its operations (Addition, Transpose and Multiplication), Passing of array into a function (row and entire array), Input and output of a string, string inbuilt functions, 2-D Character array.

Pointers: Introduction to Pointers, Pointer arithmetic, Passing arguments to a function using pointer (understanding of call by value and call by reference), Accessing arrays using pointers Dynamic memory allocation (malloc(), calloc(), realloc() and free()), Pointer and Functions.

Structures and Union: Structure declaration, Initialization of structures, Structure variables, Accessing structure elements using (.) operator, Array of structure variables, Passing structure variable to a function (individual and entire structure), Structure pointer, Comparison of Structure and Union.

File Handling: Introduction of Files (streams in C), using File (Declaring, Opening and Closing), Operations on File (Reading, Writing and appending), and Random Access of a file, command line argument

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

Laboratory Work

To implement programs for various kinds of real life applications in C Language.

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

1. Comprehend and analyze the concepts of number system, memory, compilation and debugging of the programs in C language.
2. Analyze the control & iterative statements to solve the problems with C language source codes.
3. Design and create programs for problem solving involving arrays, strings and pointers.
4. Evaluate and analyze the programming concepts based on user define data types and file handling using C language.

Text Books:

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

Reference Books:

1. Let Us C, Kanetkar Y., 16th ed., 2017
2. Programming with C, Byron S Gottfried, McGraw Hill Education, Forth edition, 2018

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

UES013:ELECTRICAL AND ELECTRONICS ENGINEERING

L	T	P	Cr
3	1	2	4.5

Course Objectives: To introduce the basic concepts of electrical and electronics engineering.

Syllabus

DC Circuits: Introduction to circuit elements; rms and average values for different wave shapes, independent and dependent current and voltage sources; Kirchhoff's laws; mesh and node analysis; source transformations; network theorems: Superposition theorem, Thevenin's and Norton's theorem, Maximum power transfer theorem; star-delta transformation; steady state and transient response of R-L and R-C and R-L-C circuits.

AC Circuits: Concept of phasor, phasor representation of circuit elements; analysis of series and parallel AC circuits; concept of real, reactive and apparent powers; resonance in RLC series and parallel circuits; balanced three phase circuits: voltage, current and power relations for star and delta arrangement; analysis of balanced and unbalanced circuits; three phase power measurement using two-wattmeter and one-wattmeter methods.

Magnetic circuits: analogy between electric and magnetic circuits; series and parallel magnetic circuits; operating principles of electrical appliances: single-phase transformer and rotating ma- chines; tests and performance of single-phase transformer.

Digital Logic Design: Digital signals, Number systems, Positive and negative representation of numbers, Signed-number representation, Binary arithmetic, Postulates and theorems of Boolean Algebra, Algebraic simplification, Sum of products and product of sums formulations (SOP and POS), Gate primitives, Logic Gates and Universal Gates, Minimization of logic functions, Karnaugh Maps, Logic implementation using Gates, Decoder, MUX, Flip-Flops, Asynchronous up/down counters.

Electronic Devices: p- n junction diode: V-I characteristics of diode, Operation of Bipolar Junction Transistor, CB and CE configuration, Transistor as a switch, Operation of SCR, DIAC and TRIAC.

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

Laboratory Work

Kirchhoff‟s laws, network theorems, ac series and parallel circuit, three phase power measurement, magnetic circuit, tests on transformer, resonance in AC circuit, combinational circuits, flip flops, shift register and binary counters, asynchronous and synchronous up/down counters, BJT characteristics.

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

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

Approved in9th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

1. Apply various networks laws and theorems to solve dc circuits
2. Compute different ac quantities with phasor representation
3. Comprehend the operation in magnetic circuits, single phase transformer and rotating machines.
4. Recognize and apply the number systems and Boolean algebra.
5. Reduce and simplify Boolean expressions and implement them with logic gates.
6. Discuss and explain the working of diode, transistor and operational amplifier, their configurations and applications.

Text Books:

1.Hughes, E., Smith, I.M., Hiley, J. and Brown, K., Electrical and Electronic Technology, Prentice Hall (2008) 10th ed.

2.Nagrath, I.J. and Kothari, D.P., Basic Electrical Engineering, Tata McGraw Hill (2002).

3.Boylestad, R.L. and Nashelsky, L., Electronic Devices & Circuit Theory, Perason (2009).

4.Mano M. M. and Ciletti, M.D., Digital Design, Pearson, Prentice Hall, (2013).

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).
3. David Bell, Electronics Devices and Circuits, Oxford Publications (2009).

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

UEN008: Energy and Environment

L	T	P	Cr
2	0	0	2.0

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 need of sustainability in addressing the current environmental & energy challenges.

Syllabus

Introduction: Concept of sustainability and sustainable use of natural resources, Climate Change & its related aspects.

Air Pollution: Origin, Sources and effects of air pollution; Primary and secondary meteorological parameters; wind roses; Atmospheric stability; Source reduction and Air Pollution Control Devices for particulates and gaseous pollutants in stationary sources.

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

Solid waste management: Introduction to solid waste management, Sources, characteristics of municipal solid waste, Solid waste management methods: Incineration, composting, landfilling.

Energy Resources: Classification of Energy Resources; Non-conventional energy resources- Biomass energy, Thermo-chemical conversion and biochemical conversion route; Solar energy- active and passive solar energy absorption systems; Type of collectors; Thermal and photo con- version applications.

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

1. comprehend the interdisciplinary context of environmental issues with reference to sustainability
2. assess the impact of anthropogenic activities on the various elements of environment and apply suitable techniques to mitigate their impact.
3. demonstrate the application of technology in real time assessment and control of pollutants.
4. correlate environmental concerns with the conventional energy sources associated and assess the uses and limitations of non-conventional energy technologies

Text Books:

1. Moaveni, S., Energy, Environment and Sustainability, Cengage (2018)
2. Rajagopalan, R., Environmental Studies, Oxford University Press (2018)
3. O‟Callagan, P.W., Energy Management, McGraw Hill Book Co. Ltd. (1993).

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

Reference Books:

1. Peavy H.S., Rowe D.S., and Tchobanoglous, G. (2013) Environmental Engineering, McGraw Hill.
2. Rao, M.N. and Rao, H.V.N. (2014) Air Pollution, McGraw Hill.
3. Metcalf and Eddy. (2003) Wastewater Engineering: Treatment and Reuse, Fourth Edition, McGraw Hill.
4. Rai, G.D. (2014) Non-conventional Energy Resources, Khanna Publishers.

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

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.

Syllabus

Ordinary Differential Equations: Review of first order differential equations, Exact differential equations, Second and higher order differential equations, Solution techniques using one known solution, Cauchy - Euler equation, Method of undetermined coefficients, Variation of parameters method, Engineering applications of differential equations.

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

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

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 Diagonalization, Inner product spaces and Gram- Schmidt orthogonalization process.

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

1. solve the differential equations of first and 2nd order and basic application problems de- scribed 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 eigenvalues and eigenvectors.

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

Text Books:

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

Reference Books:

1. Kreyszig Erwin, Advanced Engineering Mathematics, John Wiley (2006), 8th edition.
2. Jain, R.K. and Iyenger, S.R.K., Advanced Engineering Mathematics, Narosa Publishing House (2011), 4th edition.

Evaluation Scheme

Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

SEMESTER-III

UES034: MEASUREMENT SCIENCE AND TECHNIQUES				
	L	T	P	Cr
	3	1	2	4.5

Course Objective: To introduce the basic concepts of instruments, errors, system characteristics, sensors, transducers, and signal conditioning.

Syllabus

Measuring Instruments: Functional elements of an Instrument, Active and Passive transducers, Analog and digital modes of operation, Null and Deflection Methods, Input-Output Configurations of Measuring Instruments and Instrument systems.

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

Static Characteristics: Calibration, Accuracy, Precision. Combination of errors, static sensitivity, Linearity, Threshold, Resolution, Hysteresis and dead space. Span.

Dynamic Characteristics: mathematical model of measurement system, Digital simulation methods for dynamic response analysis. Transfer Function, Zero order Instrument, First order Instrument, Step response, ramp response, frequency response, Impulse response of first and second order instruments. Dead Time elements, Logarithmic plotting of frequency- response curves, Response of general form of instrument to a periodic and transient input.

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

Introduction of Signal Conditioning: Amplification, filtering, converting, range matching, isolation, linearization, attenuator, surge protection, excitation, AC coupling.

Laboratory Work: Experiments based on first order, second order and time parameters, measurement of signal, sensors and transducers.

Course Learning Objectives (CLO)

The students will be able to:

1. Explain the concepts of measurement and its analysis.
2. Exhibit the knowledge of error analysis in measurement.
3. Exhibit the knowledge of static and dynamic characteristics of various types of instruments.
4. Elucidate the working principle of various sensors, transducers and the concept of signal conditioning.

Text Books

1. Measurement systems, Doeblin, E.O., Tata McGraw Hill, 2017.
2. Nakra, B.C. and Chaudhry, K.K., Instrumentation Measurement and Analysis, Tata McGraw−Hill (2009) 3rd ed

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

Reference Books

1. Transducers and Instrumentation, Murthy, D.V.S., Prentice Hall of India, 2nd edition, 2008.
2. A Course in Electrical and Electronic Measurements and Instrumentation, Sawhney, A.K. and Sawhney, P., Dhanpat Rai, 18th edition, 2008.
3. Mastering Internet of Things: Design and create your own IoT applications using Raspberry Pi, Peter Waher, Packit, 2018.

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

UMA302 MATHEMATICS FOR SIGNALS				
	L	T	P	Cr
	3	1	0	3.5

Course Objective: To introduce the basic concepts and processing of analog and digital signals.

Syllabus

Introduction: Signals and Systems, Classification of signals, Continuous time signals and its classifications, Standard continuous time signals, Classification of continuous time systems, Discrete time signals and its classifications, Concept of frequency in discrete time signals, Standard discrete time signals, Discrete time systems, Classification of discretetime 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.

Laboratory Work (if applicable): Not applicable.

Course Learning Objectives (CLO)

The students will be able to:

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

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

Reference Books

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

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

UEI408: Analog Devices & 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.

Syllabus

Bipolar Junction Transistors (BJT): CE configuration as two port network: -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.

Laboratory Work: Transistor circuits using BJT and FET, oscillators, filters.

Course Learning Objectives (CLO)

The students will be able to:

1. Differentiate between different of diodes based on their working principle.
2. Elucidate the working principle of BJT and FET

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3. Analyse 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.

Text Books

1. Electronic Devices and Circuit Theory, Boylestad R. L., Pearson Education (2007) 9th ed.
2. Integrated Electronics, Millman, J. and Halkias, C.C., 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	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

UEI301: DIGITAL ELECTRONICS				
	L	T	P	Cr
	3	1	2	4.5

Course Objective: To familiarize students with the analysis and design of various digital systems.

Syllabus

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 Gate Analysis & 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 Flip Flops 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, sigma-delta 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 Objectives (CLO)

The students will be able to:

1. Analyze binary codes and logic families used in digital systems
2. Design the analyze combinational and asynchronous sequential logic circuits
3. Exhibit the knowledge of different A/D converters and D/A converters
4. Elucidate the concept of counters, sequence generators and memories

Text Books

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

Reference Books

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

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

UTD003: APTITUDE SKILLS BUILDING				
	L	T	P	Cr
	2	0	0	2

Course Objective:

- The course aims to equip students with a comprehensive understanding of quantitative, verbal, and logical reasoning concepts, enhancing their ability to solve numerical problems, interpret written information, and evaluate arguments effectively. It provides exposure to various aptitude test formats, and time-management strategies, and offers practice opportunities with personalized feedback to build confidence and prepare students for aptitude tests, increasing their job market competitiveness and career advancement opportunities.

- **Verbal Ability & Reading Comprehension:** Introduction to Reading Comprehension: Strategies for approaching different types of passages, identifying main ideas, and understanding structure, Advanced reading techniques, dealing with inferences, tone, and author's purpose, Introduction to Verbal Ability: Grammar Fundamentals, sentence structure, common errors, Sentence Correction and Completion, Review and Test-Taking Strategies: Consolidate knowledge from all areas, focusing on test-taking strategies, time management, and practice tests.
- **Quantitative & Logical Reasoning:** Introduction to Quantitative Ability - Arithmetic Basics: arithmetic concepts (numbers, operations, percentages, ratios, averages), Advanced Arithmetic & Introduction to Algebra: more complex arithmetic (interest, partnerships, mixtures, ratios, variation) and basics of algebra (equations, inequalities, speed, time and distance), Algebra Continued & Introduction to Modern Math: quadratic equations, sequences and introduce concepts of modern math set theory, probability, permutations, combinations, and more complex probability problems, Introduction to Data Interpretation: Basics of data interpretation, understanding and interpreting bar charts and pie charts, Data Interpretation - Line Charts and Tables, interpreting trends, and comparing data, practice session with mixed problems from quantitative ability and data interpretation, Introduction to Logical Reasoning: Number Series and Sequences, Family Relationships and Directions.

Course Learning Outcome

CLO 1: Ability to identify and provide solutions for complex problems and apply the basics of mathematics

CLO 2: Able to analyze and interpret data from various sources to identify trends and make data-driven comparisons.

CLO 3: Able to evaluate logical reasoning scenarios to identify patterns, solve sequences, and make accurate inferences.

CLO 4: Able to improve communication skills, including correcting errors, refining structure, and enhancing verbal proficiency.

CLO 5: Able to analyze various types of information to identify key points, infer meaning, and understand underlying tones and purposes.

Text Books

1. *Aggarwal, R.S., Quantitative Aptitude for Competitive Examinations; S Chand (2017)*

2. *Agarwal, A., An expert guide to problem-solving: with practical examples; CreateSpace Independent Publishing Platform (2016)*
3. *Other supplemental materials: Instructor prepared material disseminated through social media tools & apps*
4. *M. Tyra, Magical Book on Quicker Maths, Fifth Edition, BSC Publishing Co Pvt Ltd, 2018*
5. *K Kundan, Advanced Verbal Reasoning, Tyrasons Publications, 2021*
6. *Wren and Martin, English Grammar Book, S. Chand Publication, 2024*

Evaluation Scheme

Sr. No.	Evaluation elements	Weightage (%)
1	EST	50
2	Sessional	40
3	Assignment	10

UTA030: Engineering Design Project (Buggy)				
	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 coordinated 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 microcontroller
- Programming Concepts: Understanding and Using Variables, If-Else Statement, Comparison Operators and Conditions, For Loop Iteration, Arrays, Switch Case Statement and Using a Keyboard for Data Collection, While Statement, Using Buttons, Reading Analog and Digital Pins, Serial Port Communication, Introduction programming of different type of sensors and communication modules, DC Motors controlling.

Basics of C#:

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

Laboratory Work:

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

Bronze Challenge: Single buggy around track twice in clockwise direction, under full

supervisory control. Able to detect an obstacle. Parks safely. Able to communicate state of the track and buggy at each gantry stop to the console.

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

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

Course Learning Outcomes (CLO)

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

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

Text Books

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

Reference Books

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

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

UEI306: NETWORK ANALYSIS				
	L	T	P	Cr
	2	1	0	2.5

Course Objective: To make the students understand the concepts of graph theory, two port networks, filter design, attenuators, oscillator and 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 for nodal voltage, Duality.

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

Two Port Networks: Two port network description in terms of open circuits impedance, Short circuit admittance, Hybrid and inverse hybrid, ABCD and inverse ABCD parameters, 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 pointand transfer function.

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

Filters and Attenuators: Classification of filters, Analysis of a prototype low pass, High pass, Band pass, Band
asymmetrical.

Active Filters: Introduction to Active filters, first and second order low pass Butterworth filter, First and second order high pass Butterworth filter, Band pass filter.

Course Learning Objectives (CLO)

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

1. Apply various laws and theorems to solve electric networks.
2. Analyse the behaviour of two port networks.
3. Apply graph theory concept to solve electrical networks
4. Realise one-port network parameters
5. Design different filter and attenuator configurations.

Text Books:

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

Reference Books:

1. Circuit Theory, Chakarbarti,A., Dhanpat Rai and Co. (P) Ltd. (2006).
2. Networks and Systems, Roy Chowdhuary, D., New Age International (P) Limited, Publishers (2007).

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

SEMESTER-IV

UEE410 : Data Structures and Algorithms				
	L	T	P	Cr
	3	0	2	4.0

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

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

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

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

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

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

Course Learning Outcomes (CLO)

After 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	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

UMA028: Mathematics for Data Science				
	L	T	P	Cr
	3	0	2	4.0

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

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

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

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

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

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

Hypothesis: Introduction to Sampling Distribution (standard normal, chi-square, T& F distributions), Critical regions, Neyman-Pearson lemma (without proofs).

Parametric & Non-parametric tests: Tests for Goodness of fit: Based on Chi-square Test, one sample and paired sample tests; Sign Test, Signed-rank Test, Kolmogorov Smirnov Test.

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

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

Course Learning Outcomes (CLO)

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

1. compute probabilities of composite events along with an understanding of random
2. variables and distribution functions.
3. understand the convergence of sequence in probabilities
4. analyse the correlated data and fit the linear regression models

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

5. make statistical inferences using principles of hypothesis tests.

Text Books

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

Reference Books

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

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

UEI403: ELECTRICAL AND ELECTRONIC MEASUREMENTS

L	T	P	Cr
3	1	2	4.5

Course Objective: 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.

Syllabus

Electrical Standards: Types of 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, Anderson'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, Deflection sensitivity, Frequency measurement using Lissajous figures, Storage type digital oscilloscopes.

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 Objectives (CLO)

The students will be able to:

1. Exhibit the knowledge of working of different electromechanical indicating instruments.
2. Measure power and energy with the help of wattmeter and energy meter.
3. Exhibit the knowledge of working and applications of instrument transformers and magnetic measurements.
4. Elucidate the working and application of several AC bridges for inductance and capacitance.

5. Exhibit the knowledge of working principle and applications of various electronic instruments.

Text Books

1 Electrical Measurements and Measuring Instruments, Golding, E.W., and Widdis, F.C., Pitman (2003).

2 Modern Electronic Instrumentation and Measurement Techniques, Helfrick, A.D., and Cooper, W.D., Prentice Hall of India (2007).

Reference Books

1. Electronic Instrumentation, Kalsi, H.S., Tata McGrawHill (2007).
2. Instrumentation Measurement and Analysis, Nakra, B.C., Chaudhry, K.K., Tata McGrawHill (2003).

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

UEI501: CONTROL SYSTEMS				
	L	T	P	Cr
	3	1	2	4.5

Course Objective: 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.

Syllabus

Basic Concepts: Historical review, Definitions, Classification, Relative merits and demerits of open and closed loop systems, Linear and non-linear systems, Transfer function, Mathematical modelling of physical systems, 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 Work: Linear system simulator, Compensation design, D.C. position control and speed control, Synchro characteristics, Servo demonstration, Stepper motor, Potentiometer error detector, Rate control system, Series control system, Temperature control system.

Course Learning Objectives (CLO)

The students will be able to:

1. Develop the transfer function of the physical systems.
2. Analyse the response of the closed and open loop systems.
3. Analyse the stability of the closed and open loop systems.
4. Design the various kinds of compensator.
5. Develop and analyse state space models.

Text Books

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

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Reference Books

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

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

UTA018: Object Oriented Programming				
	L	T	P	Cr
	3	0	2	4.0

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

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

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

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

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

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

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

Course Learning Outcomes (CLO)

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

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

Text Books

1. Balagurusamy, E., Object-Oriented Programming with C++, Mc Graw Hill, 8th Eds. (2020).
2. Lafore, R., Object Oriented Programming C++, Pearson, 4th Eds. (2008).

Reference Books

1. Rajaram, R., Object Oriented Programming and C++, New Age International Publishers, 2nd Eds. (2007).
2. Sahay, S., Object Oriented Programming in C++, Oxford University Press, 2nd Eds.

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(2012).

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

UMA035 : OPTIMIZATION TECHNIQUES				
	L	T	P	Cr
	3	0	2	4.0

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

Syllabus

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 multi-objective 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 Objectives (CLO)

The students will 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 multi-objective linear programming problems.
5. Solve nonlinear programming problems.

Text Books

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

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

Reference Books

1. Introduction to optimization: Operations Research, Pant J. C., Jain Brothers(2004)
2. Linear Programming and Network flows, Bazaarra Mokhtar S., Jarvis John J. and ShiraliHanif D., John Wiley and Sons(1990)
3. Operations Research, Swarup, K., Gupta, P. K., Mammohan, , Sultan Chand & Sons, (2010).
4. Introductory Operations research, H.S. Kasana and K.D. Kumar, Springer publication, (2004).
5. Operations Research - Principles and Practice, Ravindran, D. T., Phillips and James J. Solberg, John Wiley & Sons, Second edn.(2005)

Evaluation Scheme	
Evaluation Elements	**Weightage %**
Mid Semester Test (MST)	**25-30**
End Semester Examination (ESE)	**40-45**
Sessional (may include Assignment, Sessional (Includes Regular Lab assessment) and Quizzes Project (Including report, presentation etc.)	**30**

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SEMESTER V

UEIXXX: FUNDAMENTALS OF MICROPROCESSORS AND MICROCONTROLLERS

L	T	P	Cr
3	1	2	4.5

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, Reduced Instruction Set Computer (RISC) and Complex Instruction Set Computer (CISC) architectures, Advantages of RISC architecture, Architecture of 8085 and 8086 microprocessors.

ARM Processor Fundamentals and Architecture: Architecture, ARM General purpose Register set, Architectural inheritance, ARM programmer's model, Current program status register, Advanced Microcontroller Bus Architecture (AMBA), Special Function Registers, GPIO's, Timers and counters, Exception and Interrupt handling, Analog to digital converters, serial communication, direct memory access.

Introduction to pipeline, ARM 3, 5 and 7 stage pipeline, Pipeline hazards.

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, Conditional execution, Programming applications, Thumb state, Thumb Programmers model, Thumb programming Applications.

Hardware and sensor interfacing: ARM Development Environment, Interfacing of ARM processors with LEDs, LCD, Relays, and sensors, Programming of processors using C/C++.

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

Course Learning Outcome (CLO):

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

1. Analyze and explain the architecture and functionality of various types of processors, including their design components and operational mechanisms.
2. Develop and debug programs for ARM processors to perform computational tasks and control functions.
3. Create applications utilizing timers, GPIO, ADC modules, and communication interfaces to address real-world system requirements.
4. Design functional applications using ARM processors and integrate peripherals for embedded system solutions.

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

Text Books:

1. Sloss, Andrew, Dominic Symes, and Chris Wright. *ARM system developer's guide: designing and optimizing system software*. Elsevier, 2004.
2. Zhu, Yifeng. *Embedded Systems with ARM Cortex-M Microcontrollers in Assembly*. E-Man Press Llc, 2023.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessional (May include Assignments/ Tutorials/ Quizzes/ Lab Evaluations)	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

UEI608: BIO-MEDICAL INSTRUMENTATION

L	T	P	Cr
3	0	2	4.0

Course Objectives: The objective of this course is to introduce students 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, Retinal Scanner, Disorders Related to the Respiratory and Neuromuscular Systems, Interconnection Between the Respiratory and Neuromuscular Systems.

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, Radiation Safety in Medical Imaging Future Trends in Non-invasive Diagnostic Instrumentation.

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, Study of Retinal Scanner

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

1. Distinguish and analyze the biomedical signal sources.
2. Analyze cardiovascular system and its measurement techniques.
3. Analyze the working principle and applications of respiratory and neuromuscular systems.
4. Evaluate the parameters non-invasive diagnostic instruments.
5. Study the electrical safety related to biomedical Instruments

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

Text Books:

1. *Cromwell, L. and Weibell, F.J. and Pfeiffer, E.A., Biomedical Instrumentation and Measurement, Dorling Kingsley (2026) 3rd ed.*
2. *Carr, J.J. and Brown, J.M., Introduction to Biomedical Equipment Technology, Prentice Hall (2001) 4th ed.*

Reference Books:

1. *Khandpur, R.S., Handbook of Biomedical Instrumentation, McGraw Hill (2024) 3rd ed.*
2. *Webster, J.G., Medical Instrumentation Application and Design, John Wiley (2020) 5th ed.*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1	MST+EST	70
2	Sessional (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

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.

Pressure Measurement: Moderate pressure measurement, Bourdon tube, Bellows and diaphragms, High pressure measurement: Piezoelectric, Electric resistance, Low pressure measurement: Mcleod gauge, Pirani Gauge, Thermal conductivity, Ionization gauge, Dead weight gauges, MEMS-based pressure sensors, Wireless pressure sensors

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

Temperature Measurement: Resistance Temperature Detector, 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, Gauge blocks, Density measurement, laser and sonar distance measurement, Tachometer for speed measurement. Advanced Sensors and Transducers, Smart Sensors, Biosensors, Wearable Sensors

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

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

1. Analyze the construction & working of various industrial devices used to measure pressure and flow
2. Distinguish the different methods for level and viscosity measurement.
3. Elucidate different methods for temperature measurement.
4. Explicate the construction and working of advanced sensors and transducers

Text Books:

1 *Doeblin, E.O., Measurement systems, Applications and Design, McGraw Hill, 6th Edition (2011).*
2 *Nakra, B. C. and Chaudhry, K. K., Instrumentation Measurement and Analysis, McGraw Hill (2016)*

Reference Books:

1 *Murthy, D.V.S., Transducers and Instrumentation, Prentice Hall of India Private Limited (2008).*

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

2 *Sawhney, A.K., A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai and Co. (P) Ltd. (2020).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessional (May include Assignments//Quizzes/Lab Evaluations/Project)	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

UEIXXX: ARTIFICIAL INTELLIGENCE AND APPLICATIONS

L	T	P	Cr
2	0	2	2.0

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

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

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

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

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

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

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

Fuzzy Systems: Fuzzy sets, Operation on fuzzy sets, Fuzzy relations, Membership functions, fuzzy to crisp conversions, Fuzzy reasoning, Fuzzy Inference Systems, Design of Fuzzy logic controller, Advantages of fuzzy logic controller over a conventional PID controller

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

Optimization with Genetic Algorithms:

Evolutionary algorithms, Genetic Algorithms, Genetic Fuzzy Systems, Genetic Neural Systems

Course Learning Outcomes (CLO): At the end of the course, the student should be able to:

1. Analyze appropriate AI methods to solve a given problem that are amenable to solution by AI.
2. Formalize a given problem in the language/framework of different AI methods.
3. Implement Fuzzy theory for engineering applications.

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4. Implement neural network as learning machine for engineering applications.

Text Books:

1. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)", Mc Graw Hill- 2008. (Units- I,II,VI & V).

2. Dan W. Patterson, "Introduction to AI and ES", Pearson Education, 2007. (Unit-III).

3. Ross, J. T., Fuzzy Logic with Engineering Applications, Fourth Edition, John Wiley & Sons (2016).

4. S. Haykin, Neural Network: A Comprehensive Foundation, Pearson Education (2009).

References Books

1. S.N. Sivanandam, S.N. Deepa "Soft Computing", 3rd Edition, Wiley India, 2018.

2. Stuart Russel and Peter Norvig "AI – A Modern Approach", 2nd Edition, Pearson Education 2021.

3. Deepak Khemani "Artificial Intelligence", Tata Mc Graw Hill Education 2016.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessional (May include Assignments//Quizzes/Lab Evaluations/Project)	30

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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 modelling, Lumped and distributed parameters, Analogies, Thermal, Electrical and chemical systems, Modeling of Continuous Stirred Tank Reactor (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 behaviour of feedback controlled processes for different control modes, Control system quality, Integral absolute error (IAE), Integral Squared Error (ISE), Integral Time weighted Absolute Error (ITAE) criterion, Tuning of controllers using Ziegler-Nichols, Process Reaction Curve method, Direct synthesis method

Realization of Control Modes: Realization of different control modes like P, I, D, and composite modes in Electronic, Pneumatic controllers.

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

Advanced Controls: Introduction to advanced control schemes like Cascade, Feedforward, Ratio, Selective, Override, Split Range and Auctioneering Control.

Laboratory Work: Study of I-to-P and P-to-I converters, control valve characteristics, experimental analysis of temperature, level, and flow control using hardware setups, and MATLAB experiments for PID controller tuning.

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

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

Text Books:

1. *Johnson, C.D., Process Control Instrumentation Technology, Prentice Hall of India Private Limited*

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

(2015).
2. *Stephanopoulos, G., Chemical Process Control, Prentice Hall of India Private Limited (2015).*

Reference Books:

1. *Liptak, B.G., Instrument Engineers Handbook, Butterworth, Heinemann (2016).*
2. *Seborg, D.E. and Edgar, T., Process Dynamics and Control, John Wiley and Sons (2011).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessional (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

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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. Analyze 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.*

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

2. *Blank, Steve (2020), The Startup Owner's Manual: The Step by Step Guide for Building a Great Company, K&S Ranch.*
3. *S. Carter and D. Jones-Evans, Enterprise and small business- Principal Practice and Policy, Pearson Education (2006)*

Reference Books:

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

Evaluation scheme:

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

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SEMESTER VI

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, Overview of System Buses

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.

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. Elucidate the design/working of virtual instruments
2. Exhibit the knowledge of the various types of structures used in LabVIEW
3. Analyze and design different types of programs based on data acquisition
4. Analyze and develop signal and image processing solutions using LabVIEW

Text Books:

1. *Robert H. Bishop, Learning with LabVIEW, 2nd Edition, Pearson (2020)*
2. *Johnson, G., LabVIEW Graphical Programming, McGraw Hill (2006).*
3. *Sokoloft, L., Basic Concepts of LabVIEW 4, Prentice Hall Inc. (2004).*
4. *Wells, L.K. and Travis, J., LabVIEW for Everyone, Prentice Hall Inc. (2006).*

Reference Book:

1. *Gupta, S. and Gupta, J.P., PC Interfacing for Data Acquisition and Process Control, Instrument Society of America (1997).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessional (May include Assignments//Quizzes/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 and systems: Analog and digital data acquisition, Sensor/Transducer interfacing, Sample and hold circuits, Interference, Grounding and Shielding. Single channel and multichannel data acquisition system, Design of Data Acquisition System, PC-Based data acquisition system, Role of IoT in Data acquisition system

Data Acquisition with Op-Amps: Operational Amplifiers, CMRR, Slew Rate, Gain, Bandwidth. Op amp with negative feedback, Frequency response of Op Amp

Op Amp Circuits: Zero crossing detector, Peak detector, Window detector. Difference Amplifier, Instrumentation Amplifier AD 620, Interfacing of IA with sensors and transducer, 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. Graphical Interface (GUI) Software for DAS, RTU.

Laboratory Work: Op-amp as a comparator and its application, Integrator and differentiator, Active filters, Simulation of the above applications using different software, 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. Compare the elements of data acquisition techniques and differentiate in between single channel and multi-channel
2. Design and simulate signal conditioning circuits
3. Analyze various data transfer techniques used in data acquisition systems
4. Design the data acquisition systems

Text Books:

1. *Coughlin, R.F., Operational Amplifiers and Linear Integrated Circuits, Pearson Education (2009).*
2. *Kalsi, H.S., Electronic Instrumentation, Tata McGraw Hill (2012).*
3. *Gayakwad, R.A., Op-Amp and Linear Integrated Circuits, Pearson Education (2021).*
4. *Mathivanan, N., Microprocessor PC Hardware and Interfacing, Prentice Hall of India Private Limited (2008).*

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 (2010).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST+EST	70
2	Sessional	30

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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 signals in both the time and frequency domains to extract relevant information.
2. Apply transformation tools, such as Fourier and Z-transforms, to signals and systems
3. Design and implement structures for different types of digital.
4. Design and analyze various digital filters, focusing on their frequency responses to optimize performance
5. Evaluate the impact of finite word-length effects on digital signal processing

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. *Antoniou, A., Digital Filters: Analysis, Design and Signal Processing Applications, McGraw-Hill, 2018*
2. *Oppenheim, A. V. & Schafer, R. W., Discrete-Time Signal Processing, 3rd Edition, Pearson / Prentice Hall India, 2014*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessional	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. The idea is to provide an opportunity to the students to apply what they have learned throughout the course of graduate program by undertaking a specific problem.

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

Course Learning Outcomes:

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

SEMESTER VII

UEI801 ADVANCED PROCESS CONTROL

FL	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: 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, Piping and instrumentation (PI) diagrams.

Artificial Intelligence Applications in Process Control: Tuning of PID controllers using intelligent methods such as Fuzzy Logic, Artificial Neural Networks and Genetic Algorithms.

Programmable Logic Controllers (PLC): Comparison with hard-wired relay and semiconductor logic, Hardware, Components of PLC, input-output modules of PLC, PLC memory design, PLC operation and communication, PLC troubleshooting and logic, switches, counters and timers, Ladder diagram programming, working logic of PLC by example, Case studies, Introduction to Simple Programmable Logic Device (**SPLD),** Complex Programmable Logic Device (**CPLD),** Field Programmable Gate Array **(FPGA),** logic cell, FPGA design and programming, netlist and Register Transfer Level (RTL), scan chains**.**

Instrumentation in Hazardous Areas: Introduction, hazardous area classification, protective concepts, enclosure classification designations, ingress protection rating, National Electrical Manufacturer Association (NEMA) types, equipment design and construction, intrinsically safe design, determining safe energy levels, intrinsic safety circuit design, installing intrinsically safe systems, transformer isolation barriers, relevant Indian standards.

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, Ringing in digital controllers.

Course Learning Outcomes (CLO): After the completion of the course, the 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
5. Elucidate the concepts of instrumentation in hazardous area

Text Books:

1. *Stephanopoulos, G., Chemical Process Control, Prentice Hall of India Private Limited (2015).*
2. *Liptak, B.G., Instrument Engineers Handbook, Chilton Book Company (2016).*

Reference Books:

1. *Deb, S.R., Robotics Technology and Flexible Automation, Tata McGraw Hill (2017).*
2. *Johnson, C.D., Process Control Instrumentation Technology, Prentice Hall of India Private Limited (2005).*
3. *Zaidi, A., SPC Concepts, Methodologies and Tools, Prentice Hall of India Private Limited (1995).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessional (May include Assignments//Quizzes/Lab Evaluations)	30

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SEMESTER VIII

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. Analyze linear and non-linear applications of op-amps
3. Analyze applications using analog multiplier and PLL
4. Design ADC and DAC using OP – AMPS
5. Generate different waveforms using op-amp circuits

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, 2021.
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, 2009.
5. William D.Stanley, "Operational Amplifiers with Linear Integrated Circuits", Pearson Education,2004.
6. S.Salivahanan & V.S. Kanchana Bhaskaran, "Linear Integrated Circuits", TMH, 2017.

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Evaluation Scheme:

S.No.	Evaluation Elements	Weightage(%)
1.	MST+EST	70
2.	Sessional (may include assignments/quizzes)	30

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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, Calorimetric, 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. Identify and analyze the sources and effects of air and water pollutants.
2. Describe air pollution sampling and measurement techniques.
3. Explain water sampling and analysis techniques.
4. Analyze solid waste management practices and noise level measurement techniques.

Reference Books:

1. *Bhatia, H.S., A Text Book in Environmental Pollution and control, Galgotia Publication (2003).*
2. *Dhameja, S.K., Environmental Engineering and Management, S.K Kataria (2012).*
3. *Rao, M.N. and Rao, H.V., Air Pollution, Tata McGraw Hill (2010).*
4. *Rao. C.S., Environmental Pollution Control, New Age International (P) Limited,Publishers (2018) 2nd ed.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage(%)
1.	MST+EST	70
2.	Sessionals(may include assignments/quizzes)	30

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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 organization twice.

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

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

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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, Denavit Hartenberg 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, John Wiley & Sons / Wiley India, 2020*
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).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST+EST	70
2	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. Analyze different error measures used in biometric identification and verification
3. Apply various biometrics for identification
4. Exhibit the knowledge of multi-model 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.*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST+EST	70
2	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 Arduino board.
3. Deployment of an embedded system on IoT cloud using USB serial and /or Wi-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.*
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+EST	70
2	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. Elucidate the various analog and digital pulse modulation schemes
4. Elucidate digital modulation techniques and their comparison in communication system

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

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

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Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessional (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

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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. Demonstrate the knowledge of concept of spectrometry and optical techniques.
2. Elucidate the working of chromatography, elemental analyzer.
3. llustrate 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)*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

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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

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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:

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

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UCS531: CLOUD COMPUTING

L	T	P	Cr
2	0	2	3.0

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

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

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

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

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

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

Self-learning Content:

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

Laboratory work:

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

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

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

1. Comprehend the basic concepts and architecture of Cloud computing.
2. Implement Cloud Services through AWS offerings and Restful web services.
3. Apply the knowledge of virtualization through different virtualization technologies.
4. Perform operations on data sets using Map Reduce framework, SQL and NO SQL databases.

Text Books:

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

Reference Books:

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

Evaluation Scheme

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

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UCS413: NETWORK PROGRAMMING

L T P Cr
2 0 2 3.0

Course Objectives: The course introduces programming applications that use computer networks. The focus is on problem solving with emphasis on network programming. The operation and characteristics of major computer networks are studied because of their strong influence on programming interfaces (APIs) and application design.

OSI Model Introduction: OSI Model Layers Functions, TCP IP Stack real World Analogy, Data Encapsulation and Decapsulation – Introduction, Data Encapsulation, Data Decapsulation, Data Encapsulation and Decapsulation on Forwarding nodes, Multi Node Topology, Local and Remote Subnets, L3 Routing Information L3 Routes

Subnetting: Data Delivery, Mac and IP Address, Network ID, Broadcast Addresses, Max Value and Control Bits, IP Address Configuration, Point to Point Links Mask, Broadcast Addresses In detail

Layer 2 and Layer 3 Routing: Routing Introduction: Basics, Ethernet Header format, Layer 2 Routing, ARP Goals, ARP Standard Message Format, Address Resolution Protocol, Address Resolution Protocol Demonstration, Layer 2 Switch Concept and Functioning, Need of L3 Routes, Semantics of Layer 3 Routes, Routing table Look up, L3 Routing Topology, Layer 3 Operations, Loopback interfaces – Introduction, properties, Routing using Loopback IP Address as Destination Address

Broadcast Domain and Collision Domain: Introduction, Collision Domain reduction by L2 Switches, Broadcast Domain reduction by L3 router, Application Layer: Introduction, HTTP Server Design and Implementation from Scratch, HTTP Server Demonstration, HTTP Server Code Walk

LANs and VLANs: LANs and Use Cases, LANs Problems: Immobility and Security Issues, Introduction to VLANs: Access and Trunk Ports of L2 Switch, 802.1Q VLAN Header, VLAN Tagging Rules, VLAN L2 Routing Example, VLAN Benefits such as Segmentation, Resolve Thrashing, Reduced Broadcast Domain, Mobility

Router - VLAN Routing: Introduction and Problem Statement, Concept of SVIs, L3 Router Configuration for VLAN forwarding Router to VLAN Forwarding – Example, Inter VLAN Routing Basics and Routing methodology, Ping, Linux TCP dump utility: Capture packets, TCP Dump and ping assignment

Transport Layer: Introduction, Header Stacking, Transport Layer Port Numbers, System Call Interface

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Socket Programming: Introduction to Socket Programming, Server Designing, Accept system call, Select System Call Implementing Multiplexing with Accept & Select System Calls , TCP Server Example, TCP Server Design Observation, TCP Client Design and Implementation, TCP Server Client Demonstration, TCP Server With Multiplexing: High Level Design, Implementation and Demonstration

Domain Name Server (DNS): Introduction, DNS Architecture and Geographical Distribution, A Hierarchical and Decentralized System, Hosting your Own website, Website Domain Name and FQDN, Top Level Domain Servers Classification, DNS Resolver, DNS Query types: Recursive, Iterative and Reverse DNS Query

Packet Encapsulation: IP in IP Encapsulation – Introduction, Heterogeneous Networks, IPv6-in-IP Encapsulation Problem Statement and Solution, IP Encapsulation Problem Statement and Solution, IP Encapsulation Applications

Type Length Value: Introduction, Need of TLVs, Understanding TLVs, TLV Addressing the problem of Heterogeneity, TLV Addressing the problem of Software Upgrade, Data Structure – STREAMS, TLV De-Serialization using STREAMS

Self - Learning Content: Application Layer Protocols: Telnet, FTP, HTTP, SSL, IPFS, SMTP, POP3, IMAP, Client Server architecture, P2P architecture, Secure Socket Layer (SSL).

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

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

1. Analyse the requirements of a networked programming environment and identify the issues to be solved;
2. Create conceptual solutions to those issues and implement a programming solution;
3. Understand the key protocols that support the Internet;
4. Apply several common programming interfaces to network communication;
5. Apply advanced programming techniques such as Broadcasting, Multicasting

Text Books:

1. Harold E. R., Java Network Programming (2013), 4th ed. O'Reilly.
2. James F. K., Keith W. R., Computer Networking: A Top-Down Approach (2009) 6th Ed.

Reference Book:

1. Stevens W. R., Fenner B., Rudoff A.M., Unix Network Programming The Socket Networking API (2004) 3rd Ed, Pearson Education.

Evaluation Scheme

S.No.	Evaluation Elements	Weightage (%)

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

1.	MST+EST	70
2.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

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Elective II

UEI632: ADVANCED CONTROL SYSTEMS

L	T	P	Cr
3	0	0	3.0

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

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessional (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

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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 (SDG 3)
2. Establish the understanding of working principle and applications of seating mechanics and wheel chair designs (SDG 11)
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+EST	70
2	Sessional (May include Assignments//Quizzes/Lab Evaluations)	30

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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+EST	70
2	Sessional (May include Assignments//Quizzes/Lab Evaluations)	30

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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 applicationrefractometer, 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+EST	70
2.	Sessional (May include Assignments//Quizzes)	30

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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 performance and Transmission Impairments. Networking Devices, OSI and 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 congestion control, 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.

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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 flow control.
3. Demonstrate the operation of various routing protocols, subnetting and their performance analysis.
4. Illustrate design and implementation of datalink, transport and network layer protocols within a simulated/real networking environment.

Text Books:

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

Reference Books:

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

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessional (May include Assignments//Quizzes)	30

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UCS638: SECURE CODING

L T P Cr
2 0 2 3.0

Course Objectives: This course aims to provide an understanding of the various security attacks and knowledge to recognize and remove common coding errors that lead to vulnerabilities. It gives an outline of the techniques for developing a secure application.

Introduction: Security, CIA Triad, Viruses, Trojans, and Worms, Security Concepts- exploit, threat, vulnerability, risk, attack, Rootkits, Trapdoors, Botnets, Key loggers, Honeypots. Active and Passive Security Attacks.

Need for secure systems: Proactive Security development process, Secure Software Development Cycle (SSDLC), Security issues while writing SRS, Design phase security, Development Phase, Test Phase, Maintenance Phase, Writing Secure Code – Best Practices SD3 (Secure by design, default and deployment), Security principles and Secure Product Development Timeline.

Threat modelling process and its benefits: Identifying the Threats by Using Attack Trees and rating threats using DREAD, Risk Mitigation Techniques and Security Best Practices. Security techniques, authentication, authorization. Defense in Depth and Principle of Least Privilege.

Software & Web Security: Return-to-libc attack, format string vulnerability. Race condition vulnerability, Dirty COW, PE Code injection. Cross site request forgery: CSRF attacks on HTTP GET and POST services & countermeasures. XSS attack: self-propagating XSS worm, preventing XSS attacks, SQL injection attack & countermeasures. Client-side attacks

Laboratory Work:

In this Lab, student shall learn to recognize and remove common coding errors that lead to vulnerabilities. This lab also gives an outline of the techniques for developing a secure application code, implementing different types of attacks and protection schemes for both software and web security. Evaluation will be mainly based on projects and assignments.

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

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

1. Demonstrate skills needed to deal with common programming errors and develop secure applications.
2. Implement PE Code injection and demonstrate control hijacking via EIP manipulation
3. Demonstrate client-side attacks and identify nature of threats to software and incorporate secure coding practices throughout the planning and development of software product.
4. Demonstrate SQL injection, XSS attack and suggest countermeasures for the same.

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Text Books:

1. Howard, M. and LeBlanc, D., Writing Secure Code, Howard, Microsoft Press (2002) 2nd Edition.
2. Deckard, J., Buffer Overflow Attacks: Detect, Exploit, Syngress (2005) 1st Edition.
3. Wenliang Du, Computer Security: A hands-on approach, CreateSpace (2017).

Reference Books:

1. Swiderski, F. and Snyder, W., Threat Modeling, Microsoft Professional, (2004) 1st Edition.
2. Salt, C., J., SQL Injection Attacks and Defence, Elsevier (2012), 2nd Edition.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessional (May include Assignments//Quizzes)	30

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UCS537: SOURCE CODE MANAGEMENT

L	T	P	Cr
2	0	2	3.0

Course Objectives: The objective of the course is to teach techniques to combine software development and IT operations using DevOps. It helps to understand faster software development practices with higher quality.

Traditional Software Development: The Advent of Software Engineering, Waterfall method, Developers vs IT Operations conflict.

Rise of Agile methodologies: Agile Vs Waterfall Method, Iterative Agile Software Development, Individual and team interactions over processes and tools, working software over comprehensive documentation, Customer collaboration over contract negotiation, responding to change over following a plan

Definition and Purpose of DevOps: Introduction to DevOps, DevOps and Agile, Minimum Viable Product, Application Deployment, Continuous Integration, Continuous Delivery **CAMS** (Culture, Automation, Measurement and Sharing): CAMS – Culture, Automation, Measurement, Sharing, Test-Driven Development, Configuration Management, Infrastructure Automation, Root Cause Analysis, Blamelessness, Organizational Learning.

Typical Toolkit for DevOps: Introduction to continuous integration and deployment, Version control system

Source Code Management History and Overview: Examples - SVN, Mercury and Git, History - Linux and Git by Linus Torvalds,

Version Control System: Version control system vs Distributed version control system: Local repository, Advantages of distributed version control system, The Multiple Repositories Models, completely resetting local environment, Revert - cancelling out changes.

Laboratory work:

Basic structure and Implementation of various distributed version control systems for source code management.

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

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

1. Identify the need for migrating from traditional software development to Agile model and then to DevOps.
2. Define and understand the basic principles and need of DevOps and Continuous Delivery.
3. Understand the history and overview of Source Code Management, along with real-time examples.
4. Differentiate between centralized and distributed version control systems and basic operations in version control systems and demonstrate the use of various version control systems.

Text Books:

1. The DevOps Handbook - Book by Gene Kim, Jez Humble, Patrick Debois, and Willis Willis.
2. Pro Git – Book by Scott Chacon and Ben Straub (available at https://git- scm.com/book/).

Reference Books:

1. What is DevOps? - by Mike Loukides.

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Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessional (May include Assignments//Quizzes)	30

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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 understanding on 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,*

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

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+EST	70
2	Sessional (May include Assignments/Projects/Tutorials/ Quizzes/Lab Evaluations)	30

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Elective III

UEI735: POWER ELECTRONICS FOR AUTOMATION

L	T	P	Cr.
3	0	2	4.0

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, IGBT, 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 for industrial applications.

Inverters: Single phase voltage source bridge inverters, single-phase PWM inverters, current source inverters, types of inverters and their applications, Three phase bridge inverters with 180^o and 120^o modes.

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

DC Motor Drives: Principle of chopper operation, step-up and step-down choppers, EMF and torque production of DC motor, four quadrant operation, thyristor and chopper fed dc motor drives and its industrial applications.

Induction Motor Drives: Principles of operation, single phase to single phase step-up and step-down cycloconverters, Torque-speed and torque-slip characteristics, methods of starting of squirrel cage motors, generating and braking modes, variable frequency operation and its applications.

Laboratory Work: V-I characteristics of SCR, IGBT, DIAC and TRIAC, Gate firing circuit, DC -DC chopper, Semi converter and Full converter with R, RL and RLE type of loads, DC shunt motor speed control, Simulation of power electronics converters.

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
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+EST	70
2.	Sessionals (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

UEI736 Biomedical Devices and Signal Analysis

L T P Cr 2 0 2 3.0

Overview: The objective of the course is to provide basic understanding the diagnosticcharacteristics biomedical signals, images and basic medical equipment.

Diagnostic characteristics of medical equipment and signals: Objectives of Biomedical signalanalysis, Difficulties in Biomedical signal analysis, Noise interferences and artifacts of ECG, EEG,EMG, PCG, EOG, EGG, ENG, ERPs, PCG, Speech signals, Endoscope, Oximetry, Ventilator, Biotelemetry. Audiometer, Ophthalmoscope

Filtering of biomedical signals: Random noise, structured noise and physiological interference-noise and artifacts in biomedical signals. Time domain filters, Frequency domain Filters. Adaptivenoise canceller.

Analysis of Biomedical Signals: Time-frequency analysis, Discrete wavelet transform. Detection of RR interval, QRS and ST segment in ECG, Analysis of Heart Rate variability EEG rhythms- Correlation and coherence analysis of EEG channels, Detection of EEG spike and wavecharacteristics and analysis, Analysis of EMG signal

Medical Imaging Devices: Image interpretation of ultrasound, X-ray, CT – Scan and MRI, Mammography, Echocardiography, Optical Coherence Tomography, positron emission tomography.

Medical Image Processing: Image formation- Image reconstruction- Fourier methods-image reconstruction in: X - ray CT, Nuclear Emission Computed Tomography - SPECT and PET, Magnetic resonance imaging and ultrasound imaging. Image Segmentation, Feature extraction and representation, statistical, shape, texture, feature and image classification.

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

1. Demonstrate the diagnostic characteristics of biomedical signals and the working principleof monitoring equipment. (SDG 3)
2. Illustrate and apply different filtering processes in various biomedical signals.
3. Demonstrate and analyze the various biomedical signals based on application. (SDG 3)
4. Analyze the principle and working of different medical imaging system and their medicalinterpretation. (SDG 3)
5. Comprehend and apply the basic principles of image segmentation and representation.

Text book

- J. Carr and J. Brown, Introduction to Biomedical Equipment and Technology, 4th edition. [ISBN10: 0130104922 | ISBN-13: 978-0130104922]
- R. Aston, Principles of Biomedical Instrumentation and Measurement, 1st edition.[ISBN-10: 0675209439 | ISBN13: 978-0675209434]

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

- Reddy D.C, “Biomedical Signal Processing: Principles and Techniques”, Tata McGraw-Hill, New Delhi,2nd edition ,2005.
- 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

- Sanjit.K, Mitra “Digital Signal Processing”, A Computer Based Approach”, Tata McGraw-Hill, New Delhi, fourth edition 2011.
- Geoff Dougherty, “Digital Image Processing for Medical Applications”, CambridgeUniversity Press, India 2009.
- Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, BioMedical Instrumentation andMeasurements, 2nd edition, Pearson Education. [ISBN-10: 0130764485 | ISBN- 13: 978-0130764485]
- 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	25
2	EST	45
3	Sessional	30

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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 M4, Architecture, Power architecture, Low power modes, Registers, Memory organization and system, Input & Output port, ARM Cortex Microcontroller Software Interface Standard (CMSIS), CMSIS library for DSP operations, CMSIS for artificial intelligence, Exceptions and Interrupts / NVIC / EXTI & Inter-Module Signaling, Communications protocols: SPI, RS232, I2C, Built-in ADC and DAC.
EMBEDDED PROGRAMMING: C/C++ language programming concepts, Declarations and Expressions, Arrays, Decision and Control Statements, interrupts and exception programming, Interfacing with ADC/DAC and LCD/Touchscreen programming. Development tools and Programming: Compiler, Assembler and Debugger, Hardware and Software development tools, Code warrior-IDE or STM32CubeMX IDE/ KEIL/Mbed etc., General-Purpose Input Output (GPIO) and the STM Hardware Abstraction Layer (HAL).
Real-time Operating Systems (RTOS) : Basic concepts of RTOS and its types, Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, scheduling, Concurrency, Introduction to open source RTOS like FreeRTOS/MQX.

IoT in an embedded system: Introduction to WiFI, BLE and Zigbee wireless technologies, IoT protocols, Creating a mini internet of things (IoT) system, IoT clouds like Azure/ AWS etc.

Laboratory Work:

Programming of microcontroller with Integrated development environment (IDE), Interfacing with switches, sensor modules, with their Programming, LCD/ Touch screen interfacing, Interfacing of Temperature Sensors with I2C/SPI bus, Interfacing to Motors, relays and other actuators, Making the embedded system compatible with IoT.

The students can implement the experiments on STEM32 or FRDM-KL25 boards
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/C++ language for embedded applications
3. Elucidate the knowledge of interfacing of sensors and actuators.
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+EST	70
2	Sessional (May include Assignments//Quizzes/Lab Evaluations)	30

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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. Apply the knowledge of fundamentals of digital image processing
2. Apply image enhancement techniques in spatial and frequency domain
3. Analyze and evaluate the mathematical modelling of image restoration and compression
4. Develop image segmentation techniques
5. Apply object detection and recognition techniques to digital images

Text Books:

1. Digital Image Processing, Rafael C.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, Rafeal C. Gonzalez, Richard E.Woods, Steven L. Eddins, Pearson Education.*

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Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessional (May include Assignments//Quizzes/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.

Syllabus:

Introduction and System Structures: Computer-System Organization, Computer-System Architecture, Operating-System Structure, Operating-System Operations Overview, Computing Environments, User and Operating-System Interface, System Calls, Types of System Calls, System Programs, 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

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

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, Page Replacement, Allocation of Frames, Thrashing

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.

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

Course Learning Outcomes (CLO)

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

1. Comprehend the basics of an operating system including the kernel, system calls, system operations and computing environments.
2. Evaluate the effectiveness and trade-offs of different models of multithreading and CPU scheduling algorithms.
3. Comprehend the concurrent computer environment and handle the situations leading to deadlock.
4. Analyze various memory management strategies and virtual memory.
5. Evaluate the effectiveness of different disk management strategies and criticize the design and implementation of file system.

Text Books

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

Reference Books

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

Evaluation Scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST + EST	70
2.	Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	30

UEI712: SOFTWARE ENGINEERING

L	T	P	Cr
3	0	2	4.0

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

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

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

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

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

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

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

Laboratory work:

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

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

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

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

Text Books:

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

Reference Books:

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

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UCS505: COMPUTER GRAPHICS

L	T	P	Cr
3	0	2	4.0

Course Objectives: This course provides an introduction to the principles of computer graphics. It covers detailed study of computer graphics fundamentals, 2-D & 3-D geometric transformations, curve design, visible surface detection and illumination models.

Fundamentals of Computer Graphics: Applications of computer Graphics in various fields, Evolution of computer Graphics, Graphical Input-Output Devices, Random scan displays, Raster scan displays.

Graphics Primitives: Algorithms for drawing various output primitives - Line, circle, ellipse, arcs & sectors, Boundary Fill & Flood Fill algorithm, Color Tables.

2-D & 3-D Geometrical Transformations: Translation, Rotation, Scaling, Shear, Reflection, Homogenous coordinate system, Composite transformations.

Viewing & Clipping in 2-D: Window to View port transformation, Cohen Sutherland, Liang Barsky, Nicholl-Lee-Nicholl Line clipping algorithms, Sutherland Hodgeman, Weiler Atherton Polygon clipping algorithm.

Three Dimensional Viewing & Clipping: 3-D Viewing, Projections, Parallel and Perspective projections, Clipping in 3-D.

Curves & Surfaces: Curved Lines & surfaces, Interpolation & Approximation splines, Parametric & Geometric Continuity conditions, Bezier Curves & surfaces, B-spline curves & surfaces.

Visible Surface Detection Methods: Classification of visible surface detection algorithms, Depth buffer method, Scan-line method, Depth-Sorting method, Subdivision Algorithm.

Illumination Models & Surface Rendering: Light sources, Illumination models, Surface Rendering methods, Basic Ray tracing algorithm.

Laboratory work:

Laboratory work should be done in OpenGL (version 3+). Covers all the basic drawing, filling, 2D & 3D transformations, clipping, and curve generation.

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

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

1. Comprehend the concepts related to basics of computer graphics and its applications in various fields.

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2. Apply algorithms to scan convert various output primitives and alters the coordinate descriptions of objects using 2-D & 3-D geometric transformations.
3. Understand and apply various concepts of viewing & clipping in 2-D & 3-D.
4. Comprehend the concepts related to curve design and identify visible surfaces in three dimensional scene using visible surface detection methods.
5. Apply OpenGL to create various primitives of computer graphics.

Text Books:

1. Donald D Hearn, M. Pauline Baker, "Computer Graphics, C version", 2nd Edition, Pearson Education (1997).
2. James D. Foley, Andries van Dam, Steven K. Feiner, John F. Hughes, "Computer Graphics: Principles & Practice in C", 2nd Edition, Addison Wesley Longman (1995).

Reference Books:

1. Donald Hearn and M Pauline Baker, "Computer Graphics with OpenGL", Pearson education, 2004.
2. Zhigang Xiang, Roy A Plastock, "Computer Graphics", Schaums Outline, TMH (2007).
3. Dave Shreiner, Mason Woo, Jackie Neider, Tom Davis, "OpenGL Programming Guide: The Official Guide to Learning OpenGL" (2013).

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessional (May include Assignments//Quizzes)	30

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 to write test bench for the complex VLSI design.

Introduction: Role of testing in VLSI design, Issues in test and verification of complex chips, VLSI test 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 test benches 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

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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 AcademicPublishers, 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.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessional (May include Assignments//Quizzes)	30

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Elective IV

UEI744 ROBUST AND 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 and 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-pawedness; Internal stability; Coprime factorization and stabilizing controllers, uncertainty representations; Uncertain polynomials; Boundary crossing theorem; Kharitonov's result; Edge theorem; Stability of polytope of polynomials; Sensitivity and complementary sensitivity; Linear fractional transformation (LFT), Robust stability.

H2 optimal control: LQ controllers, Kalman filter, LQG controllers, characterization of H2 optimal controllers.

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. Static and Dynamic allocation Algorithms: First cum first serve, shortest job first, Allocation with priority.

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 H2 Optimal Control problem
4. Demonstrate the knowledge of Implementation Techniques of real-time systems

Text Books:
1. Jeffrey B. Burl, Linear optimal control, H2 and H∞ 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.

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4. D.W. Gu, P. Hr. Petkov and M.M. Konstantinov, Robust Control Design with MATLAB. Springer 2005.
5. Tian Seng Ng , Real Time Control Engineering: Systems And Automation; Springer, 2016

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.
3. Peng Zhang, Industrial Control Technology: A Handbook for Engineers and Researchers; William Andrel, 2007.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessional (May include Assignments//Quizzes)	30

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UEI745 Deep Learning in Health Care Applications

L T P Cr

2 0 2 3.0

Course Objective: This course aims to not only cover the fundamentals of deep learning, butalso give a grasp of contemporary research related to healthcare.

Introduction: Overview of machine learning and deep learning, linear classifiers, lossfunctions, Importance of machine and deep learning techniques in medical applications **Optimization:** Stochastic gradient descent and contemporary variants, back-propagation.

Feedforward networks and training: Activation functions, initialization, regularization,batch normalization, model selection, ensembles.

Convolutional neural networks: Fundamentals, architectures, pooling, visualization,Arrythmia detection using CNN

Recurrent neural networks: Recurrent neural networks (RNN), long-short term memory (LSTM), Deep learning for Health Informatics, Application in Medical image and signal classification

Transfer Learning: Overview of transfer learning**,** Application of transfer learning in medicalimage recognition, signal classification

Deep Learning in Medical Application: Differential diagnosis, Learning a Health KnowledgeGraph from Electronic Medical Records Machine learning for cardiology: Fully Automated Echocardiogram Interpretation in Clinical Practice

Course Learning Outcomes (CLO): On successful completion of this module, the studentshould be able to:

1. Analyze and evaluate the concepts of machine learning
2. Develop convolutional neural network for the medical image analysis
3. Develop recurrent neural network for medical images and signal classification
4. Develop different transfer learning models for healthcare application

Text Books:

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville (2016). *Deep Learning,* MIT Press
2. K. P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
3. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006

Evaluation Scheme

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Sr..No	Evaluation Elements	Weightage (%)
1	MST+EST	70
3	Sessional (Lab, Quiz,Assignment)	30

List of Experiments

1. Implement Support Vector Machine classifier for signal classification
2. Implementation of Neural Network in Medical Image classification.
3. Design CNN model for Arrythmia detection
4. Implementation of RNN in medical signal classification
5. Implementation of LSTM model in medical image classification
6. Application of transfer learning in seizure detection
7. Implementation of CNN-LSTM model in medical image captioning
8. Implementation of Pre-trained model (VGG16, Alexnet, Googlenet) forfeature extraction from signal
9. Application of VGG16 in EMG signal classification
10. Compare the accuracy achieved by deep learning model and transfer learningmodel in seizure detection

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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. Apply 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.*

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

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+EST	70
2	Sessional (May include Assignments//Quizzes/Lab Evaluations)	30

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 – Micromachined fiber 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. Demonstrate the knowledge of bioinstrumentation and bioelectronics devices.
5. Implement different types of MEMS for biomedical applications

Text books:

1. *Gardner, J.W., Microsensors, Principles and Applications, John Wiley and Sons (1994).*
2. *Kovacs, G.T.A., Micromachined Transducer Sourcebook, McGraw Hill (2001).*
3. *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)*

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessional (May include Assignments/Projects/ Tutorials/ Quizzes)	

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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.

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+EST	70
2.	Sessional (May include Assignments/Projects/ Tutorials/ Quizzes)	25

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UCS534: COMPUTER & NETWORK SECURITY

L	T	P	Cr
2	0	2	3.0

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

Introduction: Security Attacks, Security Services, Security Mechanisms and Principles, Security goals, Malicious software, Worms, Viruses, Trojans, Spyware, Botnets, Life cycle of a vulnerability: CAN and CVE.

Computer Security: Set-UID programs, privileged programs, environment variables: hidden inputs, capability leaking, invoking other programs, principle of least privileges. Environment variables and attacks, attacks via dynamic linker, external program and library. Shellshock attack, exploiting shellshock vulnerability. Buffer overflow attacks: program memory layout, stack and function invocation. Writing a shell code, injecting code into buffer, address space layout randomization, Stack Guard.

Network Security: Packet sniffing and spoofing, Attacks on TCP protocol, SYN flood, TCP reset attack, session hijacking attack, Firewalls: Packet filter, Stateful firewall, Application firewall. IP tables, DNS poisoning, Authoritative replies, ARP poisoning, Heartbleed Bug and Attack, Public key infrastructure and Transport Layer Security.

Laboratory work:

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

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

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

1. Identify software vulnerabilities and apply various security mechanisms to protect against security attacks.
2. Demonstrate shellshock attack and its countermeasure.
3. Demonstrate buffer-overflow attack, locate and fix security leaks in a computer software.
4. Implement firewall and its variants.
5. Implement PKI and TLS.

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th and 114th meeting of the Senate held on March 11, 2024 and March 7, 2025 respectively.

Text Books:

1. Stallings, W., Network Security Essentials, Prentice Hall (2017) 6th Edition.
2. Cheswick, R., W., Bellovin, M., S., and Rubin, D., A., Firewalls and Internet Security, Addison-Wesley Professional (2003) 2nd Edition.
3. Wenliang Du, Computer Security: A hands-on approach, CreateSpace (2017).

Reference Books:

1. Graves, K., Certified Ethical Hacking Study Guide,Sybex (2010) 1st Edition.
2. Stallings, W., Cryptography and Network Security, Prentice Hall (2013), 6th Edition.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessional (May include Assignments//Quizzes)	30

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UCS754: BLOCKCHAIN TECHNOLOGY AND APPLICATIONS

L	T	P	Cr
2	0	2	3.0

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

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

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

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

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

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

Laboratory Work:

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

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

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

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

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Text Book:

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

Reference books:

1. Bellaj Badr, Rcihcard Horrocks and Xun Brian Wu, “Blokchain by example”, Packt Publications.
2. Fatima Castiglione Maldonado, “Introduction to Blockchain and Ethereum”, Packt Publications.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST+EST	70
2.	Sessional (May include Assignments//Quizzes)	30

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