PSG INSTITUTE OF TECHNOLOGY AND APPLIED RESEARCH
COIMBATORE – 641 062

(Autonomous Institution Affiliated to Anna University)

2025 Regulations
Courses of Study, Scheme of Assessment and Syllabi

for

B.E. INSTRUMENTATION AND CONTROL ENGINEERING

B.E. INSTRUMENTATION AND CONTROL ENGINEERING

Vision

To impart quality education and research in instrumentation and control engineering that nurture technically competent, innovative, and socially responsible engineers capable of addressing global industrial and societal challenges.

Mission

- To facilitate conceptual and experiential learning in instrumentation, control engineering and emerging technologies.
- To provide opportunities for students to explore their innovative skills in multidisciplinary research and industry engagement.
- To foster ethical values, leadership qualities, entrepreneurship, and a passion for lifelong learning among students.

PROGRAMME EDUCATIONAL OBJECTIVES:

Graduates of the Instrumentation and Control Engineering program will be able to:

PEO1: Apply engineering fundamentals, analytical skills, and modern tools to design, develop, and optimize instrumentation and control systems for industrial and interdisciplinary applications.

PEO2: Engage in research, innovation, and continuous learning to adapt to evolving technologies and solve real-world engineering challenges.

PEO3: Exhibit professionalism, ethical integrity, leadership, effective communication, and entrepreneurial competence to make meaningful contributions to industry and society.

PROGRAM OUTCOMES (POs)

PO1 Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2 Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3 Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4 Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)

PO5 Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6 The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7)

PO7 Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8 Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams

PO9 Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10 Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments

PO11 Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAMME SPECIFIC OUTCOMES:

Graduates of the Instrumentation and Control Engineering program will be able to:

PSO1: Develop and validate industrial instrumentation systems by designing, calibrating, and analysing sensors and their signal conditioning circuits.

PSO2: Apply control engineering principles to model, analyse, and design feedback control systems for industrial process automation.

B.E. INSTRUMENTATION AND CONTROL ENGINEERING
(Minimum No. of credits to be earned: 168)

S. No.	Course Code	Course Title	Hours / Week			C	Maximum Marks			CAT
			L	T	P		CA	ESE	Total	
SEMESTER I										
THEORY										
1	25MA101	Calculus and its Applications	3	1	0	4	40	60	100	BS
2	25PH104	Physics for Instrumentation Engineering	3	0	0	3	40	60	100	BS
3	25IC101	Electric Circuits	3	1	0	4	40	60	100	ES
4	25IC102	Electronic Devices and Circuits	3	0	0	3	40	60	100	ES
5	25HS101	English Language Proficiency	3	1	0	4	40	60	100	HS
6	25HS102	தமிழர் மரபு / Heritage of Tamils	1	0	0	1	40	60	100	HS
PRACTICALS										
7	25GE111	Design Thinking for Innovation	0	0	2	1	100	0	100	ES
8	25GE112	Engineering Graphics	0	0	4	2	60	40	100	ES
9	25IC111	Circuits and Devices Laboratory	0	0	4	2	60	40	100	ES
MANDATORY COURSES										
10	25GEM01	Induction Programme**	-	-	-	-	-	-	-	MC
11	25HSO01/ 25HSO02	Physical Education/ Yoga and Health	0	0	2	Grade	-	-	-	MC
		Total 31 periods	**16**	**3**	**12**	**24**	**460**	**440**	**900**	

S. No.	Course Code	Course Title	Hours / Week			C	Maximum Marks			CAT
			L	T	P		CA	ESE	Total	
SEMESTER II										
THEORY										
1	25MA201	Complex Variables and Transforms	3	1	0	4	40	60	100	BS
2	25CY203	Chemistry for Instrumentation Engineering	3	0	0	3	40	60	100	BS
3	25IC201	Digital Electronics	3	1	0	4	40	60	100	ES
4	25IC202	Linear Integrated Circuits	3	0	0	3	40	60	100	ES
5	25HS201	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	1	0	0	1	40	60	100	HS
PRACTICALS										
6	25HS21_	Language Elective	0	0	4	2	60	40	100	HS
7	25IC211	Analog and Digital Electronics Laboratory	0	0	4	2	60	40	100	ES
8	25BS212	Physics and Chemistry Laboratory	0	0	4	2	60	40	100	BS
9	25IC212	Problem Solving and Python Programming Laboratory	0	0	2	1	60	40	100	ES
10	25EEC01	Workplace Communication Skills	0	0	2	-	100	-	100	EEC
MANDATORY COURSES										
11	25GEM02	Activity Point Programme I*	-	-	-	-	-	-	-	MC
12	25HSO01/ 25HSO02	Physical Education/ Yoga and Health	0	0	2	Grade	-	-	-	MC
		Total 33 periods	**13**	**2**	**18**	**22**	**540**	**460**	**1000**	

****As per AICTE norms;**
*** As per AICTE norms; Grade: Non-Credit Course:**
CAT - Category; BS - Basic Science; HS - Humanities and Social Sciences; ES - Engineering Sciences; PC - Professional Core; PE - Professional Elective; OE - Open Elective; EEC - Employability Enhancement Course; MC – Mandatory Course; CA - Continuous Assessment; ESE - End-Semester Examination
L-Lecture; T-Tutorial; P-Practical; C-Credits

S. No.	Course Code	Course Title	Hours / Week			C	Maximum Marks			CAT
			L	T	P		CA	ESE	Total	
SEMESTER III										
THEORY										
1	25MA302	Linear Algebra	3	1	0	4	40	60	100	BS
2	25IC301	Sensors and Transducers	4	0	0	4	40	60	100	PC
3	25IC302	C Programming	2	0	0	2	40	60	100	ES
4	25IC303	Electrical Machines	4	0	0	4	40	60	100	BS
5	25HS301	Project and Finance Management	3	0	0	3	40	60	100	HS
PRACTICALS										
6	25IC311	Sensors and Transducers Laboratory	0	0	4	2	60	40	100	PC
7	25IC312	C Programming Laboratory	0	0	2	1	60	40	100	ES
8	25EEC02	Foundations of Problem Solving	0	0	2	1	100	0	100	EEC
MANDATORY COURSES										
9	25MC0_ _	Mandatory Course I	2	0	0	Grade	100	0	100	MC
10	25GEM03	Activity Point Programme II*	-	-	-	-	-	-	-	MC
Total 27 periods			**18**	**1**	**8**	**21**	**520**	**380**	**900**	

S. No.	Course Code	Course Title	Hours / Week			C	Maximum Marks			CAT
			L	T	P		CA	ESE	Total	
SEMESTER IV										
THEORY										
1	25MA403	Stochastic Processes and Statistical Analysis	3	1	0	4	40	60	100	BS
2	25IC401	Electrical and Electronic Measurements	3	0	0	3	40	60	100	PC
3	25IC402	Control Systems	3	1	0	4	40	60	100	PC
4	25IC403	Microprocessors and Microcontrollers	4	0	0	4	40	60	100	PC
5	25IC404	Data Structures and Algorithms	2	2	0	4	40	60	100	ES
PRACTICALS										
6	25IC411	Microprocessors and Microcontrollers Laboratory	0	0	4	2	60	40	100	PC
7	25IC412	Measurement and Control Laboratory	0	0	4	2	60	40	100	PC
8	25EEC03	Problem Solving	0	0	2	1	100	0	100	EEC
9	25ICE01	Mini Project I	0	0	2	1	100	0	100	EEC
MANDATORY COURSES										
10	25MC0_ _	Mandatory Course II	2	0	0	Grade	100	0	100	MC
11	25GEM04	Activity Point Programme III*	-	-	-	-	-	-	-	MC
Total 33 periods			**17**	**4**	**12**	**25**	**620**	**380**	**1000**	

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L-Lecture; T-Tutorial; P-Practical; C-Credits

S. No.	Course Code	Course Title	Hours / Week			C	Maximum Marks			CAT
			L	T	P		CA	ESE	Total	
SEMESTER V										
THEORY										
1	25IC501	Industrial Instrumentation	3	0	0	3	40	60	100	PC
2	25IC502	Digital Signal Processing	3	0	0	3	40	60	100	PC
3	25IC503	Digital Control Systems	3	1	0	4	40	60	100	PC
4	25IC504	Embedded System Design	3	0	0	3	40	60	100	PC
5	25ICP_ _	Professional Elective I	3	0	0	3	40	60	100	PE
PRACTICALS										
6	25IC511	Signal Processing and Digital Control Laboratory	0	0	2	1	60	40	100	PC
7	25IC512	Embedded Systems Laboratory	0	0	2	1	60	40	100	PC
8	25IC513	Industrial Instrumentation Laboratory	0	0	4	2	60	40	100	PC
9	25EEC04	Aptitude skills	0	0	2	1	100	0	100	EEC
10	25ICE02/ 25ICE03	Internship I / Community Project	0	0	0	1	100	0	100	EEC
MANDATORY COURSES										
11	25GEM05	Activity Point Programme IV*	-	-	-	-	-	-	-	MC
		Total 26 periods	**15**	**1**	**10**	**22**	**580**	**420**	**1000**	

S. No.	Course Code	Course Title	Hours / Week			C	Maximum Marks			CAT
			L	T	P		CA	ESE	Total	
SEMESTER VI										
THEORY										
1	25IC601	Instrumentation System Design	3	0	0	3	40	60	100	PC
2	25IC602	Industrial Process Control	3	1	0	4	40	60	100	PC
3	25IC603	Artificial Intelligence for Measurement and Control	3	0	0	3	40	60	100	PC
4	25ICP_ _	Professional Elective II	3	0	0	3	40	60	100	PE
5	25_ _O_ _	Open Elective I	3	0	0	3	40	60	100	OE
PRACTICALS										
6	25IC611	Instrumentation System Design Laboratory	0	0	4	2	60	40	100	PC
7	25IC612	Process Control Laboratory	0	0	4	2	60	40	100	PC
8	25IC613	Virtual Instrumentation Laboratory	0	0	2	1	60	40	100	PC
9	25EEC05	Enhancing Problem Solving Ability with Code	0	0	2	1	100	0	100	EEC
10	25ICE04	Mini Project II	0	0	2	1	100	0	100	EEC
MANDATORY COURSES										
11	25GEM06	Activity Point Programme V*	-	-	-	-	-	-	-	MC
		Total 30 periods	**15**	**1**	**14**	**23**	**580**	**420**	**1000**	

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L-Lecture; T-Tutorial; P-Practical; C-Credits

S. No.	Course Code	Course Title	Hours / Week			C	Maximum Marks			CAT
			L	T	P		CA	ESE	Total	
SEMESTER VII										
THEORY										
1	25IC701	Logic and Distributed Control Systems	3	0	0	3	40	60	100	PC
2	25IC702	Industrial Internet of Things	3	0	0	3	40	60	100	PC
3	25ICP_ _	Professional Elective III	3	0	0	3	40	60	100	PE
4	25ICP_ _	Professional Elective IV	3	0	0	3	40	60	100	PE
5	25_ _O_ _	Open Elective II	3	0	0	3	40	60	100	OE
PRACTICALS										
6	25IC711	Industrial Automation Laboratory	0	0	4	2	60	40	100	PC
7	25IC712	Industrial Internet of Things Laboratory	0	0	2	1	60	40	100	PC
8	25ICE05	Project Work I	0	0	4	2	100	0	100	EEC
9	25ICE06	Internship II	0	0	0	1	100	0	100	EEC
Total 25 periods			**15**	**0**	**10**	**21**	**520**	**380**	**900**	

S. No.	Course Code	Course Title	Hours / Week			C	Maximum Marks			CAT
			L	T	P		CA	ESE	Total	
SEMESTER VIII										
THEORY										
1	25ICP_ _	Professional Elective V	3	0	0	3	40	60	100	PE
2	25ICP_ _	Professional Elective VI	3	0	0	3	40	60	100	PE
PRACTICALS										
3	25ICE07	Project Work II	0	0	8	4	60	40	100	EEC
Total 14 periods			**6**	**0**	**8**	**10**	**140**	**160**	**300**	

Summary of Credit Distribution

B.E. INSTRUMENTATION AND CONTROL ENGINEERING										
S. No.	**Course Category**	**Credits Per Semester**								**Total Credits**
		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	
1	HS	5	3	3	0	0	0	0	0	11
2	BS	7	9	8	4	0	0	0	0	28
3	ES	12	10	3	4	0	0	0	0	29
4	PC	0	0	6	15	17	15	9	0	62
5	PE	0	0	0	0	3	3	6	6	18
6	OE	0	0	0	0	0	3	3	0	6
7	EEC	0	0	1	2	2	2	3	4	14
8	MC	-	-	-	-	-	-	-	-	-
TOTAL		**24**	**22**	**21**	**25**	**22**	**23**	**21**	**10**	**168**

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L-Lecture; T-Tutorial; P-Practical; C-Credit

LIST OF PROFESSIONAL ELECTIVE COURSES: VERTICALS

S. No.	Vertical I Industrial Electronics and System Design	Vertical II Applied Instrumentation	Vertical III Advanced Control	Vertical IV Diversified	Vertical V Healthcare Instrumentation
1	25ICP01 Industrial Electric Drives	25ICP09 Instrumentation Standards	25ICP17 Advanced topics in PID control	25EEP07 Digital Image Processing	25ICP28 Biomedical Instrumentation
2	25ICP02 Process Modelling and Simulation	25ICP10 Fiber Optics and Laser Instrumentation	25ICP18 Computer Control of Processes	25ICP23 Micro Electro Mechanical systems	25ICP29 Medical Imaging Equipment
3	25ICP03 System Identification	25ICP11 Nano Science and Instrumentation	25ICP19 Building Automation	25EEP35 VLSI Design Techniques	25ICP30 Diagnostic and Therapeutic Instrumentation
4	25ICP04 Piping and Instrumentation Diagrams	25ICP12 Virtual Instrumentation	25ICP20 Hydraulics and Pneumatics	25ICP24 Real Time Embedded Systems	25ICP31 Bio-Signal Analysis
5	25ICP05 Graphical System Design	25ICP13 Safety Instrumented Systems	25ICP21 Fault Tolerant Control	25EEP34 Data Analytics	25ICP32 Biomedical Image processing
6	25ICP06 Soft Computing Techniques	25ICP14 Thermal Power Plant Instrumentation	25ICP22 Robotics and Automation	25ICP25 Industry 4.0	25ICP33 Physiological Control Systems
7	25ICP07 Fault Detection and Diagnosis	25ICP15 Instrumentation in Oil and Gas Industry	25EEP03 Internet of Things (IoT) and its Applications	25ICP26 Machine Learning and Deep Learning	25ICP34 Biomechanics
8	25ICP08 Automotive Instrumentation and Control	25ICP16 Instrumentation for Nuclear Power plant	25EEP36 Cyber Security	25ICP27 Multi Sensor Data Fusion	25ICP35 Rehabilitation Instrumentation

LIST OF COURSES FOR MINOR DEGREE PROGRAMME IN INDUSTRIAL INSTRUMENTATION

S. No.	Course Code	Course Title
1	25ICM01	Test and Measuring Instruments
2	25ICM02	Transducer Engineering
3	25ICM03	Process Instrumentation
4	25ICM04	Introduction to Process Control
5	25ICM05	Essentials of Control Engineering
6	25ICM06	Fundamentals of Industrial Data Communication
7	25ICM07	Analytical Instrumentation Systems
8	25ICM08	Instrumentation Practices in Industries

LIST OF OPEN ELECTIVES

S. No.	Course Code	Course Title
1	25EEO01	Industrial Automation
2	25EEO02	Embedded system and Internet of Things
3	25EEO03	Energy Technologies
4	25EEO04	Sensors and Actuators
5	25EEO05	Electrical Drives
6	25EEO06	Electric Vehicle Technology
7	25EEO07	Biomedical Instrumentation
8	25EEO08	Electrical safety practices and standards

LIST OF ONE CREDIT COURSES

S. No.	Course Code	Course Title
1	25EE901	PCB Designing
2	25EE902	Modelling and Computational Tools for Electrical Engineers
3	25EE903	VHDL and Verilog Programming
4	25EE904	Electric Vehicle Technology
5	25EE905	Data Science and Analytics for Electrical Engineers

LIST OF LANGUAGE ELECTIVE COURSES

S. No.	Course Code	Course Title
1	25HS211	Communication Skills for Engineers
2	25HS212	Basic German
3	25HS213	Basic Japanese

LIST OF MANDATORY COURSES

S. No.	Course Code	Course Title
1	25MC001	Environmental Science
2	25MC002	Indian Constitution
3	25MC003	Industrial Safety
4	25MC004	Disaster Risk Reduction and Management
5	25MC005	Indian Knowledge System for Sustainable Human Development
6	25MC006	Strategic Data Management and Governance
7	25MC007	Professional Ethics
8	25HSO01	Physical Education
9	25HSO02	Yoga and Health

SEMESTER I
25MA101 CALCULUS AND ITS APPLICATIONS
(Common to CIVIL, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

3 1 0 4

DIFFERENTIAL CALCULUS: Functions of two variables, limits and continuity, partial derivatives, chain rule, extreme values and saddle points, Lagrange multipliers, Taylor's formula for two variables. **(9+3)**

INTEGRAL CALCULUS: Double and iterated integrals over rectangles, double integrals over general regions, Fubini's theorem, area and volume by double integration, reversing the order of integration, double integrals in polar form. **(9+3)**

FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS: Basic concepts, separable differential equations, exact differential equations, integrating factors, linear differential equations, modeling - mixing problems, Newton's law of cooling, decay and growth problems. **(9+3)**

SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS: Homogeneous linear equations of second order, homogeneous linear ODEs with constant coefficients, Euler–Cauchy equations, solution by variation of parameters, free oscillations mass spring systems, electric circuits. **(9+3)**

VECTOR CALCULUS: Gradient and directional derivative of a scalar field, divergence and curl of a vector field. Integration in vector field – line integrals, path independence of line integrals, Green's theorem in the plane, divergence theorem of Gauss and Stokes' theorem. **(9+3)**

Total: L: 45 + T: 15 = 60 periods

TEXT BOOKS:

1. J. Hass, C. Heil, and D. W. Maurice, '*Thomas Calculus*'. Pearson Education, New Delhi, 2018.
2. Erwin Kreyszig, '*Advanced Engineering Mathematics*'. Wiley India, New Delhi, 2018.

REFERENCES:

1. H. Anton, I. Bivens, and S. Davis, '*Calculus*'. John Wiley and Sons, USA, 2016.
2. C. R. Wylie and L.C. Barrett, '*Advanced Engineering Mathematics*'. Tata McGraw-Hill, New Delhi, 2019.
3. D. G. Michael, '*Foundations of Applied Mathematics*'. Dover Publications, New York, 2013.
4. Gilbert Strang, '*Calculus*'. Wellesley Cambridge Press, USA, 2017.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts related to Calculus, Differential Equations and Vector Calculus.	**K2**
CO2	Apply the techniques of Calculus, Differential Equations and Vector Calculus to solve engineering problems.	**K3**
CO3	Analyze the solutions of engineering problems employing Calculus, Differential Equations and Vector Calculus.	**K4**
CO4	Use modern tools to solve engineering problems with the help of Calculus, Differential Equations and Vector Calculus.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		1											
CO4					1								
	3	**1**			**1**								

1 – low, 2 – medium, 3 – high

25PH104 PHYSICS FOR INSTRUMENTATION ENGINEERING

3 0 0 3

MECHANICS: Motion in a straight line, average motion, instantaneous velocity, acceleration and constant acceleration, motion in two and three dimensions, force and motion. Application of Newton's laws. Free body diagram. Work, energy and power. Conservation of energy, conservative and non-conservative forces, conservation of mechanical energy. Gravity. **(9)**

RIGID BODY DYNAMICS AND ROTATIONAL MOTION: systems of particles - centre of mass, momentum. Kinetic energy of a system. Elastic and inelastic collisions. Rotational motion, Rotational vectors: velocity, acceleration, torque, angular moment, moment of inertia. – determination of moment of inertia for rigid bodies, rotational energy and rolling motion. **(9)**

ELECTRIC CHARGE, FORCE &FIELD: Electric charge, Coulomb's law, Electric field intensity, electric dipoles, electric field of a dipole along the axis and equatorial point, Equipotential surfaces. Gauss's law of electrostatics: Application of Gauss's law to line, plane and spherical symmetry. Field at a conductor surface. Applications: Microwave cooking, Liquid Crystals, Shielding and Lightning Safety. **(9)**

ELECTRIC POTENTIAL: Electric potential difference, curved paths and non-uniform fields. Calculating potential difference: potential of a point charge, zero potential, finding potential differences using superposition. Potential difference and Electric field, charged conductors. Electrostatic Energy, Capacitors, Energy in the Electric field. Applications: Corona discharge, pollution control and xerography. **(9)**

ELECTROMAGNETISM: Magnetic force and field, Charged particles in magnetic fields, Magnetic force on a current. Biot-Savart's law, magnetic force between conductors. Magnetic dipoles, Gauss's law of magnetism. Ampere's law, electromagnetic induction. Faraday's law, magnetic circuits, self and mutual induction – magnetic field energy density, Maxwell's equations and propagation of electromagnetic waves in isotropic media. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Richard Wolfson, '*Essential University Physics*'. Pearson, 2020
2. Raymond A Serway and John W. Jewett, '*Physics for Scientists and Engineers with Modern Physics*'. Cengage Publishers, USA, 2019.

REFERENCES:

1. D Halliday, R Resnick and Walker, '*Fundamentals of Physics*'. John Wiley and Sons, 12th edition, 2021
2. R. K. Gaur and S.L. Gupta, 'Engineering Physics'. Dhanpat Rai Publications, 2014
3. Hugh D Young and Roger A Freedman, '*University Physics Addison Wesley*'. 15th edition, 2020

COURSE OUTCOMES

At the end of the course, students will be able to:		Bloom's Level
CO1	Explain the principles of mechanics, rotational motion, electric fields, electric potential, and electromagnetism, focusing on their fundamental concepts and applications in engineering systems.	**K2**
CO2	Apply mathematical techniques to calculate parameters such as velocity, acceleration, electric field intensity, electric potential, and magnetic flux in engineering contexts.	**K3**
CO3	Analyse physical systems involving mechanical motion, electric and magnetic forces, and energy storage using principles of mechanics, electrostatics, and electromagnetism.	**K4**
CO4	Prepare a report or presentation on the practical applications of electric and magnetic fields in modern engineering systems, highlighting case studies on electromagnetic devices and power systems.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		1											
CO4						1			1		1		
	3	**1**				**1**			**1**		**1**		

1 – low, 2 – medium, 3 – high

25IC101 ELECTRIC CIRCUITS

3 1 0 4

BASIC DEFINITIONS AND LAWS: Overview of electrical circuits: currents, voltages, power and energy – Circuit elements: active and passive elements –Independent and dependent sources –Resistive circuits: Ohm’s law and Kirchoff’s laws - Series resistors and voltage division - Parallel resistors and current division –Series voltage source and parallel current source –Y-Δ transformations. **(9+3)**

DC CIRCUIT ANALYSIS AND CIRCUIT THEOREMS: Node voltage analysis – Mesh current analysis – Circuit theorems: Source transformation –Superposition theorem – Thevenin’s theorem –Norton’s theorem – Maximum power transfer theorem. **(9+3)**

COMPLETE RESPONSE ANALYSIS: First order circuits – Source-Free RC Circuits – Source-Free RL Circuits – Step Response of RC Circuits – Step Response of RL Circuits –Second order circuits –Finding Initial and Final Values – Source-Free Series RLC Circuits – Source-Free Parallel RLC Circuits – Step Response of Series RLC Circuits - Step Response of Parallel RLC Circuits. **(9+3)**

AC CIRCUIT ANALYSIS: Single phase circuits – Single phase voltages and currents –Phasor representation – RMS value – Form factor –Energy storage elements: Capacitors and inductors –Phasor relationship for R, L and C – Impedance and admittance – Analysis of Series RLC, Parallel RLC circuits using analytical and phasor methods – Resonance in parallel and series circuits - Bandwidth and Q- factor. **(9+3)**

THREE PHASE CIRCUITS: Three-Phase Voltages and currents –Balanced Y-Y Connection,Y-Δ Connection, Δ-Δ Connection, Δ-Y Connection – Power in Balanced System – Unbalanced Three-Phase Systems –connected source and load - Δ connected source and load – Y to Δcircuit –Power and power factor in three phase. **(9+3)**

Total: L: 45 + T: 15 = 60 periods

TEXT BOOKS:

1. Charles K. Alexander and Mathew N. O. Sadiku. ‘*Fundamentals of Electric Circuits*’. 7th edition, Tata McGraw Hill, 2022.
2. John Bird, ‘*Electrical Circuit Theory and Technology*’. 7th edition, Routledge, 2022.

REFERENCES:

1. Richard C. Dorf and James a Svoboda, ‘*Introduction to Electric Circuits*’. 9th edition, John Wiley and Sons Inc, 2017.
2. K. C. A. Smith and R.E. Alley, ‘*Electrical circuits an Introduction*’. Cambridge University Press, 2017.
3. Allan H. Robbins and Wilhelm C. Miller, ‘*Circuit Analysis: Theory and Practice*’. 5th edition, Cengage publishers, 2013.
4. A. Sudhakar and Shyammohan S. Palli, ‘*Circuits and Network Analysis and Synthesis*’. 6th edition, Tata McGraw Hill, 2025.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Explain the fundamental concepts of DC/AC electric circuits and network theorems	**K2**
CO2	Solve DC/AC electric circuits using network reduction techniques, mesh and nodal methods, and evaluate resonance parameters	**K3**
CO3	Analyse and obtain the response of DC/AC electric circuits under transient as well as steady-state conditions	**K4**
CO4	Analyse and compute electrical parameters of DC/AC circuits under various operating conditions, and validate the results using Multisim software	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		2											2
CO4				1	1			1	1				1
	3	**2**		**1**	**1**			**1**	**1**				**3**

1 – low, 2 – medium, 3 – high

25IC102 ELECTRONIC DEVICES AND CIRCUITS

3 0 0 3

DIODES: Semiconductor materials – N type and P type semiconductor – PN Junction – The Ideal diode – Diode operation – Voltage and current characteristics – Diode models - Diode testing – Zener diode – Zener diode applications –Types of diodes – Diode applications. **(9)**

BIPOLAR JUNCT ION TRANSISTOR: Construction – operation – parameters – characteristics – configuration – biasing – types of biasing – load line **-** DC Operating point – Transistor as a switch, as an amplifier. (**9)**

FIELD EFFECT TRANSISTORS: Junction Field Effect Transistor (JFET) Construction – Principle of operation - Parameters –Characteristics – Biasing – application – Metal Oxide Semiconductor Field Effect Semiconductor (MOSFET) – types – Construction – Principle of operation - Parameters –Characteristics – Biasing – application. **(9)**

AMPLIFIERS: Amplifier concepts – Gain and attenuation –DC and AC analysis - Impedance matching –Small signal amplifiers – BJT amplifier configurations – Introduction to differential amplifier - Power amplifiers –Class A, B, AB and Class C Power amplifiers –Push-Pull amplifiers. **(9)**

OSCILLATORS: Concept of feedback **–** Conditions for oscillations –Oscillators with RC feedback circuits - Phase shift oscillator - Wein Bridge oscillator - Oscillators with LC feedback circuits- Colpitts oscillators- UJT relaxation oscillator. **(9)**

Total L:45 periods

TEXT BOOKS:

1. Albert P. Malvino, David J. Bates and Patrik E. Hoppe, '*Electronic Principles*'. McGraw Hill, 9th edition, 2021.
2. R. L. Boylestad and Nashelsky, '*Electronic Devices and Circuit Theory*'. Pearson Education India, 11th edition, 2015.

REFERENCES:

1. Thomas L. Floyd, '*Electronic Devices*'. Pearson Education, 10th edition, 2021.
2. D. A. Bell, '*Electronic Devices and Circuits*'. Oxford University Press, 5th edition, 2013.
3. J. Millman, C. Halkias and C. D. Parikh, '*Integrated Electronics*'. Tata McGraw-Hill, 2nd edition, 2017.
4. Donald Neamen, '*Electronic Devices: Analysis and Design*'. McGraw Hill, 3rd Edition, 2006.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the structure, characteristics and operation of PN junction devices (Diodes and FETs).	**K2**
CO2	Compute the performance of various configurations of Diodes and FET based circuits by designing proper biasing schemes in oscillators and amplifiers.	**K3**
CO3	Analyse the behaviour of devices in amplifier and oscillator configurations.	**K4**
CO4	Design electronic circuits using semiconductor devices.	**K5**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3											1	
CO3		3			2							1	2
CO4			3		2							1	2
	3	**3**	**3**		**2**							**1**	**2**

1 – low, 2 – medium, 3 – high

25HS101 ENGLISH LANGUAGE PROFICIENCY
(Common to CIVIL, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

3 1 0 4

VOCABULARY: Etymology-Prefixes and suffixes–Synonyms–Antonyms–Guessing meanings from context–Word formation- Single-word substitutes- Different forms of a word–Phrasal verbs–Collocations. **(9+3)**

LISTENING AND SPEAKING: Understanding listening – Listening techniques - Introducing oneself and others – Seeking and sharing information– Description-Conversation skills– Extempore speaking– Speech practice in varied formal contexts. **(9+3)**

GRAMMAR: Wh-questions – Yes/no questions– Parts of speech – Articles– Prepositions–Gerunds–Conjunctions-Degrees of comparison– Tenses– Modal verbs – Adverbs - Direct and indirect questions. **(9+3)**

READING: Reading strategies: Skimming and scanning, predicting– Reading comprehension: techniques –Practice reading. **(9+3)**

WRITING: Discourse markers – Dialogue writing - Completing sentences – Jumbled sentences – Paragraph writing –Writing compare & contrast paragraphs – Letter writing. **(9+3)**

Total: L: 45 + T: 15 = 60 Periods

TEXTBOOKS:
1. K. N. Shoba and Lourdes Joavani Rayen, ‘*Communicative English*’. Cambridge University press, Cambridge, 2021.
2. Raymond Murphy, ‘*Intermediate English Grammar*’. Cambridge University Press, New Delhi, 2020.
3. Dr M. Sambaiah, ‘*Technical English an integrated text book*’. Wiley India Pvt. Ltd., 2025.

REFERENCES:
1. Raymond Murphy, ‘*English Grammar in Use*’. Cambridge University Press, New Delhi 2020.
2. N. P. Sudharshana and C. Savitha, ‘*English for Engineers*’. Cambridge University Press, New York, 2018.
3. Helen Naylor with Raymond Murphy, ‘*Essential English Grammar*’. Cambridge University Press, New Delhi, 2019.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Demonstrate the ability to recognize and use a wide range of vocabulary and key grammatical structures accurately, while developing inferential reading skills to comprehend, interpret, and analyze written texts across diverse contexts.	**K2**
CO2	Organize their ideas logically in essay writing, develop paragraphs with clear topic sentences and adapt their letter-writing skills to various real-world scenarios.	**K3**
CO3	Develop and demonstrate clear and confident speaking skills in formal and informal contexts.	

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1									3		3		
CO2									3		3		
CO3									1		1		
									3		**3**		

1 – low, 2 – medium, 3 – high

25HS102 *தமிழர் மரபு*
(Common to all B.E./B.Tech./B.Des. Degree Programmes)

1 0 0 1

மொழி மற்றும் இலக்கியம்: *இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் – சங்க இலக்கியத்தின் சமயச்சார் பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க்காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் – பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.* **(3)**

மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக்கலை: *நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள் – பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரி முனையில் திருவள்ளுவர் சிலை – இசைக்கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வியல் கோவில்களின் பங்கு.* **(3)**

நாட்டுப்புறக்கலைகள் மற்றும் வீரவிளையாட்டுகள்: *தெருக்கூத்து, கரகாட்டம், வில்லுப் பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.* **(3)**

தமிழர்களின் திணைக்கோட்பாடுகள்: *தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக்கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்க காலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்க கால நகரங்களும் துறைமுகங்களும் – சங்க காலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி.* **(3)**

இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு: *இந்திய விடுதலைப் போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப் பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப் படிகள் – தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.* **(3)**

Total L: 15 Periods

25HS102 HERITAGE OF TAMILS
(Common to all B.E./B.Tech./B.Des. Degree Programmes)

1 0 0 1

LANGUAGE AND LITERATURE: Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan. **(3)**

HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE: Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils. **(3)**

FOLK AND MARTIAL ARTS: Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamil. **(3)**

THINAI CONCEPT OF TAMILS: Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Chola. **(3)**

CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE: Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books. **(3)**

Total L: 15 Period

TEXT – CUM – REFERENCE BOOKS:

1. கே. கே. பிள்ளை, 'தமிழக வரலாறு - மக்களும் பண்பாடும்'. தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்.
2. முனைவர் இல. சுந்தரம், 'கணினித்தமிழ்'. விகடன் பிரசுரம்
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம், தொல்லியல் துறை வெளியீடு
4. பொருநை - ஆற்றங்கரை நாகரிகம், தொல்லியல் துறை வெளியீடு
5. Dr. K.K. Pillay, '*Social Life of Tamils*'. A joint publication of TNTB, ESC and RMRL
6. Dr. S. Singaravelu, '*Social Life of the Tamils – The Classical Period*'. International Institute of Tamil Studies.
7. Dr. S.V. Subaramanian and Dr. K.D. Thirunavukkarasu, '*Historical Heritage of the Tamils*'. International Institute of Tamil Studies
8. Dr. M. Valarmathi, '*The Contributions of the Tamils to Indian Culture*'. International Institute of Tamil Studies.
9. Keeladi – Sangam '*City Civilization on the banks of river Vaigai*'. Department of Archaeology, Tamilnadu Text Book and Educational Services Corporation, Tamilnadu
10. Dr. K.K. Pillay, Studies in the History of India with Special Reference to Tamilnadu
11. '*Porunai Civilization*'. Department of Archaeology, Tamil Nadu Text Book and Educational Services Corporation, Tamilnadu
12. R. Balakrishnan, '*Journey of Civilization Indus to Vaigai*'. RMRL, Tamilnadu

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the Dravidian language family, outline the features of Tamil classical literature, and explain the development of Tamil art, sculpture, and temple-related traditions in a historical context.	**K2**
CO2	Demonstrate the cultural relevance of Tamil folk and martial arts, apply the concepts of Sangam landscape classification to social contexts, and relate Tamil contributions to India's freedom struggle, cultural legacy, and Siddha medicine.	**K3**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1							3				3		
CO2							3				3		
							3				**3**		

1-Low, 2-Medium, 3-High

25GE111 DESIGN THINKING FOR INNOVATION
(Common to CIVIL, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

0 0 2 1

Foundations of Design Thinking: History & Origins: Roots in Creative Problem Solving: Traces back to mid-20th century practices in architecture, engineering, and psychology. Herbert Simon's 'Sciences of the Artificial' (1969): Introduced design as a way of thinking distinct from scientific inquiry. IDEO and the Rise of Human-Centered Design: Popularized design thinking as a repeatable, user-focused innovation process. Stanford school's Influence: Helped institutionalize design thinking in education and entrepreneurship.

Variations of Design Thinking Phases: IDEO's 3-Phase Model: Inspiration, Ideation, Implementation A flexible, non-linear approach emphasizing creativity and action. Stanford school's 5-Phase Model: Empathize, Define, Ideate, Prototype, Test A structured yet iterative framework centered on user empathy. Double Diamond Model (Design Council UK): Divides the process into Discover, Define, Develop, and Deliver—highlighting divergent and convergent thinking.

Related Concepts & Frameworks: Human-Centered Design (HCD): Focuses on designing solutions that deeply resonate with users' needs and contexts. Systems Thinking: Encourages understanding the broader ecosystem and interdependencies within a problem space. Agile & Lean UX: Integrates design thinking with iterative development and minimal viable experimentation. Service Design: Applies design thinking to orchestrate holistic user experiences across touchpoints. Participatory Design: Involves stakeholders directly in the design process to ensure relevance and inclusivity.

EMPATHIZE: Apply Human-Centric Design Principles: Focus on designing solutions that prioritize user needs, experiences, and values throughout the process. Consult Experts: Engage with subject matter experts to gain foundational knowledge about the problem space. Competitive Analysis: Identify & studying similar products or services to identify gaps and opportunities. Stakeholder Interviews: Engaging with people who influence or are affected by the product or service. Conduct Observations: Observe users in their natural environment to understand behaviors, challenges, and interactions. Engage with Users: Use interviews, conversations, and other methods to connect with users and hear their stories. Immerse Yourself: Step into the users' context to experience their environment and challenges firsthand. Create Empathy Maps: Visualize what users say, think, feel, and do to synthesize insights. Identify User Needs and Pain Points: Extract meaningful patterns and needs from user interactions and observations. Set Aside Assumptions: Approach the research with an open mind, suspending personal biases and preconceptions. Document Insights: Capture quotes, observations, and emotional cues to inform the next stage (Define). **(6)**

DEFINE: Organize Research Findings: Review and structure the data collected during the Empathize stage. Analyze Observations: Identify patterns, themes, and insights from user interactions and behaviors. Craft a Human-Centered Problem Statement: Frame the problem from the user's perspective, focusing on their needs—not business goals. Avoid Business-Centric Framing: Refrain from defining problems based on company objectives alone (e.g., market share). Persona Development: Synthesizing research into user personas to guide design decisions. Use Empathy to Guide Definition: Ensure the problem statement reflects real user challenges and motivations. Develop Point-of-View Statements: Create concise summaries that capture who the user is, what they need, and why. Prepare for Ideation: Formulate 'How Might We' questions to spark creative thinking in the next phase. **(6)**

IDEATE: Review the Problem Statement: Revisit the user-centric problem defined in the previous stage to guide ideation. Explore Multiple Perspectives: Encourage diverse viewpoints to broaden the range of potential solutions. Use Ideation Techniques: Apply methods like Brainstorming, Brain writing, SCAMPER, and Worst Possible Idea to spark creativity. Encourage Free Thinking: Create a judgment-free space to generate as many ideas as possible without filtering. Expand the Problem Space Push boundaries and explore unconventional or extreme ideas to uncover hidden opportunities. Refine and Select Ideas: Use evaluation techniques to identify promising concepts that address user needs effectively. Prepare for Prototyping: Choose ideas that are feasible and impactful to develop into tangible prototypes in the next stage. **(6)**

PROTOTYPE: Build Low-Cost Prototypes: Create simple, scaled-down versions of the product or its features to explore ideas. Experiment with Solutions: Implement different solutions from the Ideate stage into prototypes for testing. Test Internally and Externally: Share prototypes with team members, other departments, or a small group of users. Observe User Interactions: Watch how users engage with the prototypes to uncover usability issues and insights. Evaluate and Iterate: Accept, refine, or discard prototypes based on user feedback and performance. Identify Limitations: Discover constraints and challenges in the proposed solutions through hands-on testing. Gain Deeper User Understanding: Learn how users think, feel, and behave when interacting with the product. **(6)**

TEST: Conduct Rigorous Testing: Evaluate the complete product using the most promising prototypes. Observe Real User Interactions: Study how users behave, think, and feel while using the product. Gather Feedback and Insights: Collect qualitative and quantitative data to assess usability and effectiveness. Identify Remaining Issues: Detect limitations, pain points, and areas for improvement. Refine and Iterate: Use test results to improve the product and revisit earlier stages if needed. Redefine Problems if Necessary: Reframe or adjust problem statements based on new insights. Enhance Understanding of Users: Deepen empathy and knowledge of user needs through real-world testing. **(6)**

Design Thinking & Customer Centricity: A human-centered approach that blends empathy and innovation to create solutions that truly resonate with customer needs. Practical Examples of Customer Challenges: Real-world scenarios where customers face friction, unmet needs, or emotional disconnects in their product or service journey. Use of Design Thinking to Enhance Customer Experience: Applying iterative problem-solving and user insights to craft experiences that are intuitive, delightful, and deeply relevant. Parameters of Product Experience: Key dimensions like usability, accessibility, emotional impact, and consistency that shape how customers perceive and interact with a product. Alignment of Customer Expectations with Product Design: Ensuring that every design decision reflects what customers value, expect, and aspire to achieve through the product.

Total P: 30 periods

TEXT BOOKS:

1. T. Brown, '*Change by Design*'. Harper Business, 2009.
2. J. Liedtka and T. Ogilvie, '*Designing for Growth*'. Columbia Business School Publishing, 2011.

REFERENCES:

1. T. Kelley and D. Kelley, '*Creative Confidence*'. Crown Business, 2013.
2. Stanford d. School resources: https://dschool.stanford.edu/
3. https://apphaus.sap.com/toolkit/methods#design-thinking

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Apply empathy-driven research to understand user needs.	**K3**
CO2	Frame actionable problem statements and generate creative ideas.	**K5**
CO3	Develop and test prototypes to refine innovative solutions to the real-world problems.	**K4**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3					3	3	3	3		3		
CO2		2				2	2	2	2		2		
CO3			1			1	1	1	1		1		
	3	**2**	**1**			**3**	**3**	**3**	**3**		**3**		

1 – low, 2 – medium, 3 – high

25GE112 ENGINEERING GRAPHICS
(Common to EEE, ECE, ICE and EE-VLSI)

0 0 4 2

INTRODUCTION TO ENGINEERING GRAPHICS **(4)**

1. Introduction to Engineering Graphics.
2. Lettering practice as per BIS.
3. Principles of Dimensioning.

ORTHOGRAPHIC PROJECTIONS **(40)**

1. Introduction to Orthographic Projections.
2. Drawing multiple views from pictorial views of objects.
3. Projection of points.
4. Projection of straight lines (only First angle projections) inclined to both the principal planes.
5. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.
6. Projection of simple solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method.

SECTION OF SOLIDS **(8)**

1. Section of simple solids in simple vertical position when the cutting plane is inclined to one of the principal planes and perpendicular to the other and obtaining true shape of section.

ISOMETRIC PROJECTIONS **(8)**

1. Isometric projection of simple solids in simple vertical positions.

Total P: 60 periods

TEXT BOOKS:

1. N. D. Bhatt, ‘*Engineering Drawing*’. Charotar Publishing House Pvt. Ltd., 55th Edition, 2025.
2. K. C. John, ‘*Engineering Graphics for Degree*’. Prentice Hall India Publishers, 2009.
3. K. V. Natarajan, ‘*A Text book of Engineering Graphics*’. Dhanalakshmi Publications, 34th Refined Edition, 2021.

REFERENCES:

1. K. Venugopal and V. Prabhu Raja, ‘*Engineering Graphics*’. New Age International Publishers, 17th Edition, 2024.
2. ‘*Bureau of Indian Standards*’. Engineering Drawing Practices for Schools and Colleges SP 46-2003, BIS, New Delhi, 2003.

COURSE OUTCOMES

At the end of the course, students will be able to:		Bloom’s Level
CO1	Apply projection techniques to create basic shapes, solids, and sectioned objects.	**K3**
CO2	Use the standards and specifications for engineering drawing.	

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3												
CO2	1												
	3												

1 – low, 2 – medium, 3 – high

25IC111 CIRCUITS AND DEVICES LABORATORY

0 0 4 2

LIST OF EXPERIMENTS:

1. Verification of Maximum Power Transfer theorem.
2. Sinusoidal steady state analysis of RLC circuit.
3. Resonance in RLC series circuit.
4. Transient analysis of RC circuit.
5. Characteristics of PN Junction Diode and Zener diode.
6. Design of Half wave rectifier and Bridge rectifier.
7. Characteristics of Bipolar Junction Transistor.
8. Design of single stage amplifier using Bipolar Junction Transistor
9. RC phase shift oscillator using BJT
10. Junction Field Effect transistor as a switch

Total P:60 periods

REFERENCES:

1. David A Bell, '*Electronic Devices and Circuits Lab Manual*'. Oxford University Press, 4th edition, 2006.
2. Department of Instrumentation and Control Systems Engineering, *'Laboratory manual'*. PSG Institute of Technology and Applied Research, Neelambur, Coimbatore-641062, 2025.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand the concepts relating to the circuit elements and their operation in DC and AC Circuits	**K2**
CO2	Design and implement electronic circuits using semiconductor devices.	**K3**
CO3	Analyse the behaviour of electrical and electronic circuits by applying maximum power transfer theorem, examining transient and steady-state responses, and designing rectifier, amplifier, and oscillator circuits.	**K4**
CO4	Evaluate the performance of electrical and electronic circuits by interpreting measurements, comparing theoretical and practical results, and assessing the effectiveness of amplifier and oscillator	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3							2	2			3	2
CO3		3						2	2			3	3
CO4				3	3			2	2			3	3
	3	**3**	**3**	**3**	**3**			**2**	**2**			**3**	**3**

1 – low, 2 – medium, 3 – high

25GEM01 INDUCTION PROGRAMME
(Common to CIVIL, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

All students shall undergo an induction programme at the beginning of the first semester for a duration of three weeks as per the guidelines of All India Council for Technical Education (AICTE). A student completing the induction programme will be awarded a completed grade in the grade sheet, and only the students who complete the induction programme shall be considered as eligible for award of degree subject to satisfying other conditions. A student who does not complete the induction programme in the first semester shall redo the same in the subsequent semester.

SEMESTER II
25MA201 COMPLEX VARIABLES AND TRANSFORMS
(Common to CIVIL, EEE, ECE, ICE, MECH and EE-VLSI)

3 1 0 4

COMPLEX DIFFERENTIATION: Derivative, analytic function, Cauchy-Riemann equations, Laplace's equation, linear fractional transformations. **(9+3)**

COMPLEX INTEGRATION: Cauchy's integral theorem, Cauchy's integral formula, derivatives of analytic functions, Laurent series, singularities and zeros, residue integration method (Residue integration of complex integrals only). **(9+3)**

LAPLACE TRANSFORMS: Laplace transform, linearity, first shifting theorem, transforms of derivatives and integrals, unit step function, second shifting theorem, Dirac's delta function, periodic functions, differentiation and integration of transforms, solving ODEs with constant coefficients and initial value problems. **(9+3)**

FOURIER ANALYSIS: Fourier series – arbitrary period, even and odd functions, half range expansions. Fourier transforms, Fourier cosine and sine transforms. **(9+3)**

PARTIAL DIFFERENTIAL EQUATIONS: Basic concepts of PDEs, wave equation, heat equation, steady state two-dimensional heat problems, solution by Fourier series. **(9+3)**

Total L: 45 + T: 15 = 60 periods

TEXT BOOKS:

1. Erwin Kreyszig, '*Advanced Engineering Mathematics*'. Wiley India, New Delhi, 2018.
2. G. Z. Dennis, '*Advanced Engineering Mathematics*'. Jones and Bartlett Pvt Ltd, New Delhi, 2017.

REFERENCES:

1. G. Z. Dennis and D. S. Patrick, '*A first course in Complex Analysis with Applications*'. Jones and Bartlett Pvt Ltd, New Delhi, 2015.
2. C. R. Wylie and L. C. Barret, '*Advanced Engineering Mathematics*'. Tata McGraw-Hill, New Delhi, 2019.
3. Peter V. O Neil, '*Advanced Engineering Mathematics*'. Cengage, New Delhi, 2018.
4. G. D. Dean, '*Advanced Engineering Mathematics with MATLAB*'. CRC Press, USA, 2017.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts related to Complex Variables, Laplace Transforms, Fourier Analysis and Partial Differential Equations.	**K2**
CO2	Apply the techniques of Complex Variables, Laplace Transforms, Fourier Analysis and Partial Differential Equations to solve engineering problems.	**K3**
CO3	Analyze the solutions of engineering problems employing Complex Variables, Laplace Transforms, Fourier Analysis and Partial Differential Equations.	**K4**
CO4	Use modern tools to solve engineering problems with the help of Complex Variables, Laplace Transforms, Fourier Analysis and Partial Differential Equations.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		1											
CO4					1								
	3	**1**			**1**								

1 – low, 2 – medium, 3 – high

25CY203 CHEMISTRY FOR INSTRUMENTATION ENGINEERING

3 0 0 3

METALS AND ALLOYS: Binary phase diagrams –Cu/Ni, Pb/Ag alloy – interpretation using phase rule, steel – Fe-C phase diagram, heat treatment. Aluminium and titanium alloys. Corrosion – electrode potentials, chemical and electrochemical corrosion – emf series, galvanic series –passivation. Forms of corrosion – galvanic, differential aeration, atmospheric corrosion, stress corrosion cracking, fretting, corrosion fatigue, tribo-corrosion. Corrosion rate – factors influencing corrosion. **(9)**

CORROSION AND WEAR PROTECTION OF METALS: Electropolishing, electroplating – Cu, Ni and Cr, electroless plating – Cu and Ni, anodizing, phosphating, chromating, organic coatings-paints – constituents and functions, powder coating, electrophoretic painting, superhydrophobic and self-healing coatings. Lubricants-classification, properties, mechanism of lubrication- additives, improvers. **(9)**

POLYMERS: Polymerisation - chain and condensation polymerization, polymer topologies – linear, branched and crosslinked, degree of polymerisation, polydispersity, average molecular weight. States of aggregation – amorphous and crystalline states – influence on properties of polymers – thermal properties – phase transitions – Glass transition and melting – thermal analysis, classification based on thermal behaviour – thermoplastics and thermosetting plastics, mechanical properties – stress strain behaviour. Modification of properties of polymers – additives-processing, protective and functional additives, composites – fillers – particulate and fibres – carbon, glass, aramid. **(9)**

INDUSTRIAL AUTOANALYZERS: Performance requirements of analytical instruments. Instrument calibration methods – calibration curve, standard addition, internal standard methods. Automated chemical analysis – segmented flow system and flow injection analysis. Types of analysers – colorimeters and spectrophotometers, ICP-MS, electrochemical analysers- potentiometers, conductivity meters, amperometry. Analysers for water quality monitoring – pH – ion-selective electrode, TDS, conductivity, turbidity determination, Sensors for air quality monitoring –particulate matter, CO, CO_2, VOC., NOx, SOx content determination. Sensors for smart farming– soil nutrient content, pH, humidity. **(9)**

POWER SOURCES FOR IIoT DEVICES: Power requirements for wireless devices. Batteries - characteristics. Primary batteries – construction and working of zinc- carbon cells, lithium cells – $Li\text{-}MnO_2$, $Li\text{-}FeS_2$, $Li\text{-}SOCl_2$.Secondary batteries – lead-acid, lithium-ion batteries. Supercapacitors – EDLC and pseudo capacitors. Flexible solar cells – DSSC and polymer photovoltaics – materials – conducting polymers and fullerenes. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Shashi Chawla, ‘*A Text Book of Engineering Chemistry*’. Dhanpat Rai and Co., New Delhi, 6th Edition, 2022.
2. S. S. Dara and S. S. Umare, ‘*A Textbook of Engineering Chemistry*’. S Chand and Co., 2010.

REFERENCES:

1. Robert W. Messler, Jr, ‘*The Essence of Materials for Engineers*’. Jones and Barlett India Pvt. Ltd., 2011.
2. Derek Pletcher and Frank C. Walsh, ‘*Industrial Electrochemistry*’. Chapman and Hall, 1993.
3. J. M. G. Cowie and Valeria Arrighi, ‘*Polymers: Chemistry and Physics of Modern Materials*’. CRC Press, London, 3rd edition, 2016.
4. R. S. Khandpur, ‘*Handbook of Analytical Instruments*’. McGraw Hill Education (India) Private Limited, 2015.

COURSE OUTCOMES

At the end of the course, students will be able to:		Bloom's Level
CO1	Learn the basic concepts of engineering materials and instrumentation	**K2**
CO2	Utilize metals, alloys, polymers, energy storage devices and analytical instruments for engineering applications	**K3**
CO3	Analyse the features of materials, methods and select suitable materials and methods for engineering applications	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3										3		
CO3								1	1				
	3							**1**	**1**		**3**		

1 – low, 2 – medium, 3 – high

25IC201 DIGITAL ELECTRONICS

3 1 0 4

NUMBER SYSTEMS AND BOOLEAN FUNCTIONS: Review of Number Systems, number complements, Binary arithmetic, Binary codes: weighted and non-weighted codes, alphanumeric codes, Error detection and correction codes, switching functions, Canonical forms, incompletely specified functions, Simplification of logic functions through Boolean Algebra, K –maps and Quine-McClusky method, Implementation of logic functions using basic logic gates and universal gates. **(9+3)**

COMBINATIONAL LOGIC DESIGN: Design of Arithmetic Circuits-Adders / subtractors, carry look-ahead adder, signed number addition and subtraction, BCD adders, IC adders, Magnitude comparator, Decoders, Encoders, Multiplexers and Demultiplexers. Implementation of combinational logic function using multiplexers and demultiplexers - Introduction to HDL. **(9+3)**

SEQUENTIAL LOGIC DESIGN: General model of sequential circuits – Latch, Flip Flops, Design of synchronous sequential circuits–Up-down / Modulus counters, Shift register: Ring counter, Johnson counter, Timing diagram. Mealy / Moore models – Concept of state, State diagram, State table, Design of sequence detector, State reduction procedures using Partitioning and Implication cart. Introduction to Asynchronous Sequential Circuits. **(9+3)**

PROGRAMMABLE LOGIC DEVICES AND HDL: Semicustom design - Introduction to Programmable Logic Devices – Read Only Memory, Programmable Array Logic, Programmable Logic Array, Field Programmable Logic Array, Field Programmable Logic Sequencer, Architecture of Programmable Logic Devices, Implementation of digital functions using HDL. **(9+3)**

DIGITAL LOGIC FAMILIES: Characteristics of digital ICs – Voltage and current ratings, Noise margin, Propagation delay, Power dissipation, Fan-in, Fan-out. TTL logic family–Totem pole, Open collector and tri state outputs. MOS transistor switches – nMOS Inverter /Logic gates, CMOS Inverter / logic gates, ECL logic families, Comparison of performance of various logic families, Interfacing TTL and CMOS devices. **(9+3)**

Total: L: 45 +T: 15 = 60 periods

TEXT BOOKS:

1. M. Morris Mano and Michael D. Cilette, '*Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog*'. 6th edition, Prentice Hall, 2022.
2. Donald P Leach, Albert Paul Malvino and Gautam Saha, '*Digital Principles and Applications*'. 8th edition, Tata McGraw Hill, 2019

REFERENCES:

1. Thomas L Floyd, '*Digital Fundamentals*'. 11th edition, Prentice Hall, 2021.
2. Donald D Givone. '*Digital Principles and Design*'. Tata McGraw Hill, 2019.
3. A. Anand Kumar, '*Fundamentals of Digital Circuits*'. 4th edition, Prentice Hall of India, Pvt Ltd, New Delhi, 2019.
4. R.J. Tocci and N.S. Widmer, '*Digital Systems: Principles and Applications*'. 10th edition, Pearson Education Pvt. Ltd, 2013.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Learn the number systems, Boolean functions, combinational and sequential logic circuits, digital logic families, and their relevance in digital system design	**K2**
CO2	Apply Boolean algebra, K-maps, and logic gates to simplify combinational and sequential circuits.	**K3**
CO3	Analyse and compare various digital logic families and their interfacing techniques in terms of speed, power, and compatibility.	**K4**
CO4	Develop HDL code and programmable logic devices to simulate behaviour of combinational and sequential circuits	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											2	
CO3		3										2	
CO4			3		3			1	1		1	3	
	3	**3**	**3**		**3**			**1**	**1**		**1**	**3**	

1 – low, 2 – medium, 3 – high

25IC202 LINEAR INTEGRATED CIRCUITS

3 0 0 3

OPERATIONAL AMPLIFIER CHARACTERISTICS: Functional Block Diagram - Symbol - Characteristics of an ideal operational amplifier - Circuit schematic of 741 op-amp - Open loop gain - CMRR - DC characteristics - Frequency response characteristics - stability - frequency compensation –slew rate. **(9)**

LINEAR APPLICATIONS OF OPERATIONAL AMPLIFIERS: Inverting and Non-inverting amplifiers - Voltage follower - Summing amplifier - Differential amplifier - Instrumentation amplifier: Design and applications - Integrator and Differentiator - Voltage to Current and Current to Voltage converters - Active filters - low pass, high pass, wide band pass, Band stop and notch filter. **(9)**

NON-LINEAR APPLICATIONS OF OPERATIONAL AMPLIFIERS: Comparator - Regenerative comparator - Zero crossing detector - Window detector - Sample and Hold circuit - Precision diode - Half and Full wave rectifiers - Active peak detector - Clipper and Clamper - Logarithmic and Exponential amplifiers - Square and Triangular wave form generators. **(9)**

VOLTAGE REGULATORS AND SPECIAL FUNCTION ICS: Block diagram of general-purpose voltage regulator - Circuit configurations, Fixed and adjustable three terminal regulators - 555 Timer - Functional block diagram and description - Monostable and Astable Operation, Applications PLL: Functional Block diagram - VCO-Principle of operation-Applications. **(9)**

SIGNAL CONVERTERS: Digital to Analog Converters - Binary weighted and R-2R Ladder types - Analog to digital converters - Continuous, Counter ramp - Successive approximation, Single slope –Dual slope and Parallel types - Performance characteristics. **(9)**

Total L:45 periods

TEXT BOOKS:

1. Roy Choudhury and Shail Jain, '*Linear Integrated Circuits*'. 5th edition, New Age International Limited, 2018.
2. F. R. Coughlin and F.F. Driscoll, '*Operational Amplifiers and Linear Integrated Circuits*'. 6th edition, Pearson Education, Noida, 2016.

REFERENCES:

1. A. R. Gayakwad, '*OP-amps and Linear Integrated Circuits*'. 4th edition, Pearson Education, 2016.
2. Sedra and Smith, '*Microelectronic Circuits*'. 7th edition, Oxford University Press, 2017.
3. David A Bell, '*Operational Amplifiers and Linear ICs*'. 3rd edition, Prentice Hall of India, 2013.
4. Sergio Franco, '*Design with Operational Amplifiers and Analog Integrated Circuits*'. 4th edition, McGraw Hill, 2017

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the DC and AC performance characteristics of Op-amp, and its applications, working of 555 timer, LM565 phase-locked loop, analog multipliers, voltage regulators and A-D / D-A Converters.	**K2**
CO2	Apply the basic circuit laws to obtain circuit parameters and waveform in analog electronic circuits.	**K3**
CO3	Analyse analog electronic circuits that meet desired specifications.	**K4**
CO4	Design analog electronic circuits for the desired specifications, and demonstrate through mini-project.	**K5**
CO5	Conduct investigation on analog electronic circuits using MATLAB/ Multisim/PSpice/Proteus simulation tools.	

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											3	1
CO3		3										1	1
CO4			1	1	1	1		1		1	1	3	1
CO5					3							3	1
	3	**3**	**1**	**3**	**3**	**1**		**1**		**1**	**1**	**3**	**1**

1 – low, 2 – medium, 3 – high

25HS201 தமிழரும் தொழில்நுட்பமும்

1 0 0 1

நெசவு மற்றும் பானைத் தொழில்நுட்பம்: *சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.* **(3)**

வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்: *சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள், சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு – சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் – மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.* **(3)**

உற்பத்தித் தொழில் நுட்பம்: *கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணங்கள் – நாணயங்கள் அச்சடித்தல்- மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத் துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.* **(3)**

வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்: *அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.* **(3)**

அறிவியல் தமிழ் மற்றும் கணினித்தமிழ்: *அறிவியல் தமிழின் வளர்ச்சி – கணினித்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.* **(3)**

Total L: 15 periods

25HS201 TAMILS AND TECHNOLOGY

1 0 0 1

WEAVING AND CERAMIC TECHNOLOGY: Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries. **(3)**

DESIGN AND CONSTRUCTION TECHNOLOGY: Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age–Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)-Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period. **(3)**

MANUFACTURING TECHNOLOGY: Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram. **(3)**

AGRICULTURE AND IRRIGATION TECHNOLOGY: Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conch diving - Ancient Knowledge of Ocean - Knowledge Specific Societ. **(3)**

SCIENTIFIC TAMIL & TAMIL COMPUTING: Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project. **(3)**

Total L: 15 Periods

TEXT – CUM – REFERENCE BOOKS

1. கே. கே. பிள்ளை, தமிழக வரலாறு - மக்களும் பண்பாடும், தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்.
2. முனைவர் இல. சுந்தரம், கணினித்தமிழ், விகடன் பிரசுரம்
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம், தொல்லியல் துறை வெளியீடு
4. பொருநை - ஆற்றங்கரை நாகரிகம், தொல்லியல் துறை வெளியீடு
5. Dr. K.K. Pillay, '*Social Life of Tamils*'. A joint publication of TNTB, ESC and RMRL
6. Dr. S. Singaravelu, '*Social Life of the Tamils – The Classical Period*'. International Institute of Tamil Studies.
7. Dr. S.V. Subaramanian and Dr. K.D. Thirunavukkarasu, '*Historical Heritage of the Tamils*'. International Institute of Tamil Studies
8. Dr. M. Valarmathi, '*The Contributions of the Tamils to Indian Culture*'. International Institute of Tamil Studies.
9. Keeladi – '*Sangam City Civilization on the banks of river Vaigai*'. Department of Archaeology, Tamilnadu Text Book and Educational Services Corporation, Tamilnadu
10. Dr. K.K. Pillay, Studies in the History of India with Special Reference to Tamilnadu
11. '*Porunai Civilization*'. Department of Archaeology, Tamil Nadu Text Book and Educational Services Corporation, Tamilnadu
12. R. Balakrishnan, '*Journey of Civilization Indus to Vaigai*'. RMRL, Tamilnadu

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Identify the significance of ancient Tamil technologies in weaving, pottery, metallurgy, and architecture, with emphasis on traditional design and construction methods across historical periods.	**K2**
CO2	Use insights from traditional Tamil knowledge systems in agriculture, irrigation, and marine sciences, and connect the development of Tamil language to its applications in digital platforms and computing.	**K3**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1						1			1		1		
CO2						1			1		1		
						1			**1**		**1**		

1-Low, 2-Medium, 3-High

25IC211 ANALOG AND DIGITAL ELECTRONICS LABORATORY

0 0 4 2

ANALOG ICS BASED EXPERIMENTS:
1. Implementation of linear applications of operational amplifier
2. Implementation of Nonlinear applications of operational amplifier
3. Design and implementation of active filters
4. Implementation of voltage regulators
5. Realization of a stable multivibrator using 555timer

DIGITAL ICS BASED EXPERIMENTS:
1. Realization of Basic Logic Gates using Universal Gates
2. Design and implementation of combinational circuits
3. Design and implementation of sequential circuits
4. Design and implementation of synchronous sequential circuits
5. Design and Implementation of digital functions using FPGA trainer board.

Total P: 60 periods

REFERENCES:

1. David A Bell, '*Laboratory Manual for Operational Amplifiers and Linear ICs*'. 2nd edition, Prentice Hall of India, New Delhi, 2006.
2. Department of Instrumentation and Control Systems Engineering, *'Laboratory manual'*. PSG Institute of Technology and Applied Research, Neelambur, Coimbatore-641062, 2025.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the various types of combinational and sequential circuits and develop the logical circuit for the given scenario.	**K2**
CO2	Develop the applications of op-amp, voltage regulator circuits and timer IC 555	**K3**
CO3	Analyse the waveform generator circuits using timer IC 555.	**K4**
CO4	Work effectively in teams to perform experiments, analyse the analog and digital circuit, and present findings through well-documented reports and presentations.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2						2			2		
CO4			2					2	2	2	2	2	
	3	**2**	**2**					**2**	**2**	**2**	**2**	**2**	

1 – low, 2 – medium, 3 – high

25BS212 PHYSICS AND CHEMISTRY LABORATORY

0 0 4 2

PHYSICS (ANY EIGHT EXPERIMENTS)

1. Determination of specific resistance of a given wire – Carey foster's bridge.
2. Determination of Young's modulus of the material- Uniform Bending
3. Measurement of Hall coefficient of a semiconductor using Hall effect setup.
4. Determination of electrical resistivity of a given material using four probe setup.
5. Determination of wavelength of laser using diffraction grating - LASER.
6. Determination of Thickness of a thin wire – Air wedge method.
7. Study of I-V characteristics of solar cell and determination of its efficiency
8. Determination of velocity of sound and compressibility of liquid - Ultrasonic Interferometer.
9. Determination of Planck's constant and work function of a metal -Photoelectric Effect
10. Determination of bandgap of a semiconductor – Post office box.
11. Validation of Faraday's law of Induction.
12. Interpreting the working mechanism of spirometer, Co2 sensor, Venturi tube and heart rate sensor

Demonstration:

1. Determination of Numerical Aperture and Acceptance angle - Optical Fiber
2. Study the energy loss of a ferrite magnetic material specimen by B-H curve.

Total P: 30 periods

REFERENCES:

1. Department of Physics, *'Physics laboratory observation'*. PSG Institute of Technology and Applied Research, Neelambur, Coimbatore-641062, 2025.
2. Jerry D Wilson; Cecilia A Hernandez Hall, '*Physics laboratory experiments*'. Boston, MA: Cengage Learning, 2016.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Relate the scientific principles and compare the experimental results with theoretical calculations and apply graphical analysis to visualise the importance of precise measurements.	**K3**
CO2	Analyse the experimental result outcomes using analytical and experimental skills for various engineering materials and applications.	**K4**

CHEMISTRY (Any eight experiments)

1. Determination of total, temporary & permanent hardness of water by EDTA method.
2. Determination of strength of acids in a mixture of acids using conductivity meter.
3. Determination of strength of given hydrochloric acid using pH meter.
4. Estimation of iron content of the given solution using potentiometer.
5. Corrosion experiment-weight loss method.
6. Electroplating of copper and Nickel and determination of coulombic efficiency.
7. Designing a battery and determination of its characteristics.
8. Construction of phase diagram of a simple eutectic system.
9. Determination of kinematic viscosity and acid value of a lubricating oil.
10. Anodizing of aluminium and determination of thickness of anodised film.

Total P: 30 periods

REFERENCES:

1. J Mendham '*Vogel's Textbook of Quantitative Chemical Analysis*'. 6th Ed., Pearsons Education 2009.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO3	Demonstrate the measurement of water quality parameters in the given water sample	**K3**
CO4	Analyze the properties of materials for Engineering applications	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2													
CO3			3						3		3		
CO4				3				3					
			3	**3**				**3**	**3**		**3**		

1 – low, 2 – medium, 3 – high

25IC212 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY

0 0 2 1

EXPERIMENTS

1. Identification and solving of simple real life or scientific or technical problems, and developing algorithm and flow charts for the same.
2. Python programming using simple statements and expressions
3. Scientific problems using Conditionals and Iterative loops.
4. Implementing real-time/technical applications using Lists, Tuples.
5. Implementing real-time/technical applications using Sets, Dictionaries.
6. Implementing programs using Functions.
7. Implementing programs using Strings.
8. Implementing programs using written modules and Python Standard Libraries
9. Implementing real-time/technical applications using File handling.
10. Implementing real-time/technical applications using Exception handling.
11. Exploring Pygame tool and developing a game activity using Pygame.

Total P:30 periods

TEXT BOOKS:

1. Allen B. Downey, '*Think Python: How to Think like a Computer Scientist*'. 2nd edition, O'Reilly Publishers, 2016.
2. Karl Beecher, '*Computational Thinking: A Beginner's Guide to Problem Solving and Programming*'. 1st edition, BCS Learning and Development Limited, 2017.

REFERENCES:

1. Paul Deitel and Harvey Deitel, '*Python for Programmers*'. 1st edition, Pearson Education, 2021.
2. John V Guttag, '*Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data*'. 3rd edition, MIT Press, 2021.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand the basic constructs of Python Programming	K2
CO2	Apply the different data structures like list, tuple, set or dictionary to solve complex problems.	K3
CO3	Implement real-time applications using the modules and packages	K4

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				3							2	1
CO3		3			3							2	1
	3	**3**			**3**							**2**	**1**

1 – low, 2 – medium, 3 – high

25EEC01 WORKPLACE COMMUNICATION SKILLS
(Common to CIVIL, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

0 0 2 0

BUILDING COMMUNICATION SKILLS:

1. Introduction to Workplace Communication
2. Profile Building for Internships
3. English in the Workplace (Grammar & Vocabulary)
4. Professional Communication (Speaking & Writing)
5. Workplace Communication Tools
6. Career Exploration
7. Resume Update

Total P: 30 periods

REFERENCES:

1. P. C. Wren and H. Martin, '*High school English Grammar and Composition*'. S Chand Publishing, New Delhi, 2017.
2. Norman Lewis, '*Word Power Made Easy*'. Goyal Publisher, New Delhi, 2011.

COURSE OUTCOMES

At the end of the course, students will be able to:		Bloom's Level
CO1	Understand the importance of soft skills for employability and fine tune their writing skills – Resume writing	**K3**
CO2	Present with clarity and coherence while speaking in formal contexts.	**K2**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1							3		3				
CO2							3		3				
							3		**3**				

1 – low, 2 – medium, 3 – high

SEMESTER III
25MA302 LINEAR ALGEBRA

3 1 0 4

VECTOR SPACES: General vector spaces - real vector spaces - Euclidean n-space - subspaces – linear independence- coordinates and basis - dimension – change of basis - row space, column space and null space – consistency of linear systems - rank and nullity. **(9+3)**

LINEAR TRANSFORMATIONS: General linear transformation - matrix transformations- geometry of linear operators on R^2- matrices for general linear transformations – similarity. **(9+3)**

INNER PRODUCT SPACES: Inner products - angle and orthogonality in inner product spaces, Gram - Schmidt process: QR decomposition, best approximation: least squares - least squares fitting to data. **(9+3)**

EIGENVALUES AND EIGENVECTORS: Eigenvalues and eigenvectors, diagonalization - orthogonal diagonalization - quadratic forms. **(9+3)**

MATRIX DECOMPOSITION AND OPTIMIZATION: Spectral decomposition - singular value decomposition - reduced singular value decomposition - optimization using quadratic forms. **(9+3)**

Total L: 45 + T: 15 = 60 periods

TEXT BOOKS:

1. Howard Anton, Chris Rorres, Anton Haul '*Elementary Linear Algebra*'. Wiley India, New Delhi, 2019.
2. David C Lay,Judi J McDonald, Steven R. Lay '*Linear Algebra and its Applications*'. Pearson Education, New Delhi, 2021.

REFERENCES:

1. Gareth Williams, '*Linear Algebra with Applications*'. Narosa Publishing House, New Delhi, 2017.
2. Gilbert Strang, '*Linear Algebra and Learning from Data'*. Wellesley-Cambridge Press, USA, 2019.
3. Friedberg, Insel and Spence, *'Linear Algebra'*. Pearson Education, USA, 2015.
4. Steven J Leon, *'Linear Algebra with Applications'*. Pearson Education, USA, 2015

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts related to Vector spaces, Linear transformations, Inner product spaces, Eigenvalues, Eigenvectors and Matrix decomposition.	**K2**
CO2	Apply the techniques of Vector spaces, Linear transformations, Inner product spaces, Eigenvalues, Eigenvectors and Matrix decomposition to solve engineering problems.	**K3**
CO3	Analyse the solutions of engineering problems employing Vector spaces, Linear transformations, Inner product spaces, Eigenvalues, Eigenvectors and Matrix decomposition	**K4**
CO4	Use modern tools to solve engineering problems with the help of Vector spaces, Linear transformations, Inner product spaces, Eigenvalues, Eigenvectors and Matrix decomposition.	

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		1											
CO4					1								
	3	**1**			**1**								

1 – low, 2 – medium, 3 – high

25IC301 SENSORS AND TRANSDUCERS

4 0 0 4

SCIENCE OF MEASUREMENT: Units and Standards, General concept and terminology of measurement systems, General input - output configuration, transducer classification, Static and Dynamic characteristics, Calibration techniques (analog and digital) Statistical analysis of measurement data. **(12)**

RESISTANCE TRANSDUCERS: Principles of operation, construction details, characteristics of resistance transducers, resistance potentiometers, metal and semiconductor strain gauges. Signal conditioning circuits. Applications of strain gauge for measurement of load and torque. **(12)**

INDUCTIVE TRANSDUCERS: Induction potentiometer, variable reluctance transducers, LVDT, eddy current transducers, synchros and resolvers, magneto - strictive transducers, electromagnetic sensors - associated signal conditioning circuits for above transducers, Proximity sensor. **(12)**

OTHER SENSORS: Piezo-electric transducer, Piezo resistive sensor, capacitive transducer, Hall effect transducer, tachogenerator, stroboscope, photoelectric transducers, thermocouples, gyroscope, seismic instruments and accelerometers, digital displacement transducers, fibre optic sensor, IC sensor, LIDAR **(12)**

INTELLIGENT SENSORS: Smart sensors, Cogent sensors, Virtual sensors, Self-adaptive sensors – Adaptation to linearity, Self-validating sensors, Temperature compensating sensors – Selection of sensors. **(12)**

Total L: 60 periods

TEXT BOOKS:

1. Doebelin E O and Dhanesh N Manik, *'Measurement Systems'*. Tata McGraw-Hill, Seventh Edition, 2020.
2. John P. Bentley, *'Principles of Measurement Systems'*. Pearson Education, Fourth Edition, 2020.

REFERENCES:

1. Murty D. V. S, *'Transducers and Instrumentation'*. Prentice-Hall of India Private Limited, New Delhi, Second Edition, 2016.
2. James W.Dally, William F.Rileyand, Kenneth G. McConnell, *'Instrumentation for Engineering Measurements'*. Second Edition, Wiley Publishers, 2012.
3. Manabendra Bhuyan, *'Intelligent Instrumentation: Principles and Applications'*. CRC Press, 2016.
4. Richards S. Figliola and Donald E Beasley, *'Theory and Design for Mechanical Measurements'*. Seventh Edition, Wiley Publishers, 2019.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the principles of measurements, error analysis, characteristics, and operating principles of different types of transducers and sensors.	**K2**
CO2	Apply resistive, inductive, and capacitive transducers for measurement applications, and evaluate measurement errors using statistical methods to assess transducer characteristics.	**K3**
CO3	Analyze the suitability and appropriate transducers and sensors for measuring physical, chemical, and environmental parameters in industrial and real-world applications.	**K4**
CO4	Perform assignments, modelling, and application of transducers and sensors for practical measurement systems.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												2
CO3		3											2
CO4			2		1			1		1	1	2	2
	3	**3**	**2**		**1**			**1**		**1**	**1**	**2**	**2**

1 – low, 2 – medium, 3 – high

25IC302 C PROGRAMMING

2 0 0 2

INTRODUCTION: Analysing and Defining the Problem - Algorithm - Flow Chart -Types of programming language. C: The C character set - Identifiers and keywords - Data types – Constants - Variables - Declarations - input and output functions-pre-processor directives. **(3)**

OPERATORS AND EXPRESSIONS: Arithmetic operators - Unary operators - Relational operators - logical operators - Assignment operators - Conditional operators -bitwise operators- comma operator – size of operator - precedence and associativity- Library functions. Control Statements: simple if, if..else, nested if .. else, else..if ladder , switch case - while -do while - for - nested loops - break – continue. **(9)**

ARRAYS: Defining an array - Processing an array - Multi dimensional arrays -strings. **(6)**

FUNCTIONS: Function prototype - Defining a function – function call - Passing arguments to a function –nested function – recursive function- Storage classes - auto - static - extern and register variables. **(4)**

STRUCTURES: Definitions - Processing a structure – Array and structures – Nested structures - Structures and functions. Pointers: Definition - Pointer Arithmetic – types of pointer - const pointer, pointer to a constant, void pointer, null pointer. **(8)**

Total L: 30 periods

TEXT BOOKS:

1. Paul Deitel and Harvey Deitel, *‘C How to Program: With an Introduction to C++’*. Eighth edition, Pearson Education, 2018.
2. Ajay Mittal, *‘Programming in C - A Practical approach’*. Pearson, New Delhi, 2010

REFERENCES:

1. Gottfried B., *‘Programming with C’*. McGraw Hill Education, New Delhi, 2018.
2. Herbert Schildt, *‘C: The Complete Reference’*. McGraw Hill, New Delhi, 2017.
3. Kernighan B. W. and Ritchie D. M., *‘C Programming Language (ANSI C)’*. Prentice Hall of India, New Delhi, 2013.
4. Reema Thareja, *‘Programming in C’*. Oxford University Press, India, Second edition, 2016

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Understand the basic concepts and syntax of C Programming.	**K2**
CO2	Write C programs involving structures, arrays of structures, nested structures, file I/O operations, and dynamic memory management techniques.	**K3**
CO3	Develop programs that process and manipulate data using arrays, functions, and structures.	**K4**
CO4	Simulate the basic concepts of C programming using the open-source software.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				3								
CO3		2			2								
CO4			1		1			1		1	1		1
	3	**2**	**1**		**3**			**1**		**1**	**1**		**1**

1 – low, 2 – medium, 3 – high

25IC303 ELECTRICAL MACHINES

4 0 0 4

DC MACHINES: Principles of energy conversion - Construction and principle of operation of DC generator - EMF equation - Characteristics of DC generators - Principle of operation of DC motor - Torque equation- Characteristics of DC motors -Starting of DC motors - Speed control of DC motors - Losses and efficiency calculations- Braking- Applications of DC machines. **(12)**

TRANSFORMERS: Construction and principle of operation of single-phase transformer- EMF equation- Equivalent circuit - Testing of transformer – Efficiency and voltage regulation - All day efficiency - Operation of auto transformers - Three phase transformer connections - Applications of single phase and three phase transformers. **(12)**

SYNCHRONOUS MACHINES: Construction and principle of operation of three phase alternators - EMF equation - Determination of regulation - Theory of operation of synchronous motor - Methods of starting- Operating characteristics: Constant excitation with variable load and constant load with variable excitation –Synchronous condenser–Applications. **(12)**

INDUCTION MOTORS: Construction and principle of operation of three phase induction motor - Classification of induction motor –Equivalent circuit - No load and blocked rotor test - Torque production – Torque slip characteristics - Maximum torque - Starting and speed control - Principle of operation of single-phase induction motor - Types of single-phase induction motors and their applications. **(12)**

SPECIAL MACHINES: Stepper motor – Switched reluctance motor - Universal motor - Brushless DC motor - Synchros - Servomotor –Linear induction motor. **(12)**

Total L: 60 periods

TEXT BOOKS:

1. Kothari D P and Nagrath I J, *'Electric Machines'*. Fifth Edition, Tata McGraw Hill, 2017.
2. Bimbhra, *'Electrical Machinery'*. Khanna Publishers, 2021.

REFERENCES:

1. Theodore Wildi *'Electrical Machines, Drives and Power Systems'*. Sixth Edition, Pearson Education, 2013.
2. Murugesh Kumar K, *'DC Machines and Transformers'*. Second Edition, Vikas Publishing House, 2016.
3. Bhattacharya S. K, *'Electrical Machines'*. Fourth Edition, Tata McGraw Hill, 2017.
4. Smarajit Ghosh, *'Control Systems Theory and Applications'*. Second Edition, Pearson Education,2013.

COURSE OUTCOMES

At the end of the course, students will be able to:		Bloom's Level
CO1	Explain the construction, operating principles, and basic characteristics of DC machines, transformers, synchronous machines, induction motors, and special electrical machines.	**K2**
CO2	Compute the performance parameter of AC and DC machines.	**K3**
CO3	Analyse the performance characteristics and speed control methods of DC motors and induction motors under various loading conditions.	**K4**
CO4	Identify suitable speed control technique and starting methods for AC and DC machines.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		3											3
CO4	2												2
	3	**3**											**3**

1 – low, 2 – medium, 3 – high

25HS301 PROJECT AND FINANCE MANAGEMENT
(Common to all B.E. and B.Tech. Programme)

3 0 0 3

INTRODUCTION TO PROJECT MANAGEMENT: Project: Trends in project management, project management versus general management, agile project management, the three goals of a project, life cycle of projects, project selection methods, project portfolio process, case study – friendly assisted living facility. **(9)**

ROLE OF PROJECT MANAGER AND ORGANISATION: Project managers roles and responsibilities, selection of a project manager, project management as a profession, fitting projects into the parent organization, the project team and agile team roles, case study – the company with traditional functional organizational structure setting up teams for the new initiatives. **(9)**

PROJECT ACTIVITIES: The planning process, work-breakdown structure and other aids, risk management, methods of budgeting, cost estimation, scheduling the project with PERT and CPM networks, allocating resources, resource loading and leveling, Goldratt's Critical Chain, application – using Project Libre for project management, case study – success of Chandrayan-3. **(9)**

INTRODUCTION TO FINANCE MANAGEMENT: Overview - finance and related disciplines, scope and objectives of financial management, time value of money, valuation of securities, and risk and return and calculations with spreadsheet, analysis using cash flow statement and financial statements. **(9)**

PERSONAL FINANCE: Compounding, debt, equity and financial markets and investments- debt and bonds. Equity, mutual funds, hedge funds, real estate, and commodities, Personal financial plan to enhance wealth and job marketability, components of a financial plan, tools for planning – financial statements, applying time value concept of money and tax planning. **(9)**

Total L: 45 periods

TEXTBOOKS

1. Jack R. Meredith and Scott M. Shafer, '*Project Management in Practice*'. Wiley, 2021.
2. Khan M. Y. and Jain P. K., '*Basic Financial Management*'. Tata McGraw Hill, 2012.
3. Michael Fisher, '*Saving and Investing*'. Author House, 2005.
4. Jeff Madura, '*Personal Finance*'. Pearson, 2020.

REFERENCES

1. National Finance Olympiad, '*Personal Finance Handbook'*. Pockvue Solutions, 2024
2. Glen Arnold, '*Investing'*. Financial Times Guides, 2020
3. Rachel Siegel and Carol Yacht, '*Personal Finance'*. Open Textbook Library, Saylor Foundation, 2009
4. Google, '*Google Project Management: Professional Certificate'*. Google Project Management: Professional Certificate, Coursera.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts, principles, and practices of project and financial management.	**K2**
CO2	Apply project management tools, scheduling techniques, and financial planning methods to practical problems.	**K3**
CO3	Analyze project performance, risks, resource allocation, and financial decisions to identify appropriate solutions.	**K4**
CO4	Collaborate effectively as a team to plan, execute, and present project solutions using appropriate project management practices.	

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	2
CO2	3									3		3	3
CO3		2								2		2	2
CO4			1		1		1	1	1	1	1	1	1
	3	**2**	**1**		**1**		**1**	**1**	**1**	**3**	**1**	**3**	**3**

1-low, 2-medium, 3-high

25IC311 SENSORS AND TRANSDUCERS LABORATORY

0 0 4 2

LIST OF EXPERIMENTS:

1. Measurement of weight using Strain gauge and Wheatstone bridge circuit.
2. Measurement of linear displacement using LVDT.
3. Temperature measurement using Thermocouple.
4. Temperature measurement using RTD and Thermistor.
5. Design of cold junction compensation for Thermocouples and lead wire compensation schemes for RTD.
6. Measurement of force and pressure using load cell.
7. Measurement of object distance using proximity sensor.
8. Experimental study of loading effect of potentiometer.
9. Implementation of opto-coupler using photoelectric transducers.
10. Characteristics of capacitive measurement systems.
11. Study of Hall effect sensor and digital transducer.
12. Study of vibration measurement using piezoelectric sensor.

Total P:60 Periods

REFERENCES:

1. John P Bentley, *'Principles of Measurement Systems'*. Third Edition, Pearson Education, 2015
2. Department of Instrumentation and Control Systems Engineering, *'Laboratory Manual'*. PSG Institute of Technology and Applied Research, Neelambur, Coimbatore-641062, 2026

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the working principles and characteristics of various sensors and transducers such as strain gauges, LVDT, and temperature sensors through hands-on experiments	**K2**
CO2	Apply sensor measurement techniques to determine physical parameters like displacement, pressure, and vibration in practical scenarios.	**K3**
CO3	Analyse the performance characteristics and limitations of different sensor systems including capacitive, Hall effect, and piezoelectric sensors.	**K4**
CO4	Design sensor-based measurement setups by interfacing opto-couplers, proximity sensors, and load cells for accurate real-world parameter detection.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				3			3	2			3	2
CO3		3						3	2			3	2
CO4			3		3			3				3	2
	3	**3**	**3**		**3**			**3**	**2**			**3**	**2**

1 – low, 2 – medium, 3 – high

25IC312 C PROGRAMING LABORATORY

0 0 2 1

1. Working with RAPTOR Tool – Flowchart Interpreter
2. Operators
3. Decision making Statements
4. Loops: while, do…While, for
5. One dimensional array
6. Two-dimensional array
7. Strings
8. Functions
9. Recursive functions
10. Structures, array of structures and union.
11. Pointers and double pointers.
12. File handling.

Note: Separate Problem Sheets will be provided during the course

Total P: 30 Periods

REFERENCES:

1. Paul Deitel and Harvey Deitel, *'C How to Program: With an Introduction to C++'*. Eighth edition, Pearson Education, 2018.
2. Ajay Mittal, *'Programming in C - A Practical approach'*. Pearson, New Delhi, 2010.
3. Gottfried B., *'Programming with C'*. McGraw Hill Education, New Delhi, 2018.
4. Herbert Schildt, *'C: The Complete Reference'*. McGraw Hill, New Delhi, 2017.
5. Kernighan B. W. and Ritchie D. M., *'C Programming Language (ANSI C)'*. Prentice Hall of India, New Delhi, 2013

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand the basic concepts of C programming through simple programs.	**K2**
CO2	Write a program that utilizes conditional statements, arrays, functions and structures is used to solve problems.	**K3**
CO3	Create modular programs with function calls, recursive functions, and pointer-based operations to enhance program structure and increase the coding efficiency.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				3								
CO3		2			2								2
	3	**2**			**3**								**2**

1 – low, 2 – medium, 3 – high

25EEC02 FOUNDATIONS OF PROBLEM SOLVING

0 0 2 1

PROBLEM SOLVING:

1. Speed Mathematics (SAW, Oz, Mirror methods)
2. Speed Mathematics (High5, Minion, Butterfly methods)
3. Speed Mathematics (Inception, Golden eye methods)
4. Thinking with Numbers
5. Problem Solving with Visual information
6. Words Puzzles
7. Resume Writing Essentials

Total P: 30 Periods

REFERENCES:

1. R. S. Aggarwal, *‘Quantitative Aptitude for Competitive Examination’*. S Chand Publishing, New Delhi, 2017.

SEMESTER IV

25MA403 STOCHASTIC PROCESSES AND STATISTICAL ANALYSIS

3 1 0 4

PROBABILITY AND DISCRETE RANDOM VARIABLES: Probability, axioms, conditional probability, law of total probability, Bayes' theorem, discrete random variables, probability mass function, cumulative distribution function, binomial, Poisson and geometric random variables, expected values. **(9+3)**

CONTINUOUS RANDOM VARIABLES: Cumulative distribution function, probability density function, uniform, exponential and Gaussian random variables, expected values. **(9+3)**

PAIRS OF RANDOM VARIABLES: Joint cumulative distribution function, joint probability mass function, marginal probability mass function, joint probability density function, marginal probability density function, independent random variables, expected values, covariance, correlation and independence, central limit theorem. **(9+3)**

STOCHASTIC PROCESSES: Types of stochastic processes, Poisson process, discrete time Markov chains, classification of states, limiting state probabilities. **(9+3)**

STATISTICAL INFERENCE: Point estimation, interval estimation. Hypothesis testing: one and two tailed tests, tests concerning mean, proportion, and variance, single and two samples, tests for goodness of fit and independence of attributes. **(9+3)**

Total L: 45 + T: 15 = 60 Periods

TEXT BOOKS:

1. Roy D Yates and David J Goodman, *'Probability and Stochastic Processes'*. Wiley India, New Delhi, 2021.
2. Ronald E. W, Raymond H. M, Sharon L. M and Keying Ye, *'Probability and Statistics for Engineers and Scientists'*. Pearson Education, New Delhi, 2016.

REFERENCES:

1. Saeed Ghahramani, *'Fundamentals of Probability with Stochastic Processes'*. CRC Press, USA, 2018.
2. Dougles C Montgomery and George C Runger, *'Applied Statistics and Probability for Engineers'*. Wiley India, New Delhi, 2018.
3. Athanasios P and Unnikrishna P. S, *'Probability, Random Variables and Stochastic Processes'*. Tata McGraw Hill, New Delhi, 2017.
4. Arnold O. A, *'Probability, Statistics and Queueing theory: with computer science applications'*. Academic press, USA, 2014.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts related to Probability, Random variables, Stochastic processes and Statistical inference.	**K2**
CO2	Apply the techniques of Probability, Random variables, Stochastic processes and Statistical inference to solve engineering problems.	**K3**
CO3	Analyse the solutions of engineering problems using Probability, Random variables, Stochastic processes and Statistical inference.	**K4**
CO4	Use modern tools to solve engineering problems with the help of Matrix Theory and Numerical Methods.	

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		1											
CO4					1								
	3	**1**			**1**								

1 – low, 2 – medium, 3 – high

25IC401 ELECTRICAL AND ELECTRONIC MEASUREMENTS

3 0 0 3

MEASUREMENT ERROR ANALYSIS: Errors in measurement- types of errors - measurement error combinations- probability of errors: normal distribution of errors- probable error- limiting error- propagation of errors- linear and weighted regression- uncertainty analysis. **(9)**

ANALOG INDICATING INSTRUMENTS: Types of ammeters and voltmeters- PMMC Instruments -Moving Iron Instruments -Dynamometer type Instruments. Measurement of power and energy- Dynamometer type wattmeter - Single phase Induction type energy meter, Calibration of meters, Instrument Transformers: Ratio and phase angle errors, Phasor diagram. **(9)**

MEASUREMENT OF R, L and C: Classification of resistances, Measurement of resistances: Ammeter Voltmeter method, Substitution method, Substitution method, Wheatstone bridge, Kelvin's double bridge method, General equation for AC bridge balance – Maxwell's bridge–Wien's bridge–Hay's bridge–Schering bridge – Anderson bridge. **(9)**

TEST AND MEASURING INSTRUMENTS: Evolution of test and measuring instruments, Digital voltmeter of Ramp and Integrating types, Digital multimeter, Digital Storage Oscilloscope, Mixed Signal Oscilloscope, Wave form analysers– Distortion meter –Power analyser - Spectrum Analyzer, Signal generators. **(9)**

ELECTROMAGNETIC COUPLING: Introduction, Interference coupling mechanism, basics of circuit layout and grounding, concepts of interfaces, filtering and shielding - Safety: Introduction, electrical hazards, hazardous areas and classification - Non-hazardous areas, enclosures – NEMA types, fuses and circuit breakers -Protection methods: purging, explosion proofing and intrinsic safety. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Golding E W, Widdis F C, *'Electrical Measurements and Measuring Instruments'*. Third Edition, Reem Publications, New Delhi,2011.
2. David A Bell, *'Electronic Instrumentation and Measurements'*. Oxford Pubilisher,2017.

REFERENCES:

1. Kalsi H S., *'Electronic Instrumentation'*. Third Edition, Tata McGraw-Hill, New Delhi,2017.
2. Sawhney A K, *'A Course in Electrical and Electronic Measurement and Instrumentation'*. Dhanpat Rai and Sons, New Delhi,2017.
3. Albert D, Helfrick, William D Cooper, *'Modern Electronic Instrumentation and Measurement Techniques'*. Pearson Education, NewDelhi,2016.
4. Rangan C S, Sharma G R, Mani V S, *'Instrumentation Devices and Systems'*. McGraw Hill Education, Chennai, 2017.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the types and sources of measurement errors, working principles of analog instruments, and the fundamentals of electromagnetic interference and electrical safety.	**K2**
CO2	Apply suitable instruments and techniques—including analog meters, bridge methods, and digital test equipment—to measure electrical quantities and analyse signals in practical systems.	**K3**
CO3	Analyse the performance and safety aspects of measurement systems considering electromagnetic interference, circuit layout, and protective methods in hazardous and non-hazardous environments.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											3	2
CO3		3			2							3	2
	3	**3**			**2**							**3**	**2**

1 – low, 2 – medium, 3 – high

25IC402 CONTROL SYSTEMS

3 1 0 4

INTRODUCTION AND MODELING OF CONTROL SYSTEMS: Basic Components of Control Systems – Types of Control Systems – Types of Feedback Control Schemes – Modeling of dynamic systems – Mechanical systems, Electrical systems –Analogies - Linearization of Non-linear systems - Block diagram model – Block diagram and transfer function signal flow graph – Application of Mason's gain formula – Conversion between block diagrams to signal flow graphs. **(9+3)**

ANALYSIS AND DESIGN IN TIME DOMAIN: Introduction - Standard test signals - Time response of prototype first order and second order systems – Specification of step response - Analysis of steady state error: static error constants - Concepts of stability: absolute and relative stability – Routh-Hurwitz criterion. Introduction – Root locus analysis – Design using root locus Plots – Control system design—compensators. **(9+3)**

ANALYSIS AND DESIGN IN FREQUENCY DOMAIN: Introduction—Frequency response analysis – Frequency response specifications – Frequency response plots - Bode plot, Gain margin, Phase margin - Nyquist stability criterion - Stability analysis - Relative stability analysis - Control system design by frequency response analysis– Compensators. **(9+3)**

MATHEMATICAL MODELING IN STATE SPACE: State variable representation: State variable concepts, State variable modeling - Modeling of mechanical, Electrical – State diagrams – Transformation of state variables: Similarity Transformation, Invariance property, Conversion of transfer functions to canonical state variable models - Conversion of state variable model to transfer functions. **(9+3)**

ANALYSIS AND DESIGN IN STATE SPACE: Characteristic equation - Eigen values and Eigen vectors - Solution of state equation – State transition matrix - Concepts of controllability and observability - Controllability tests – Observability tests – Controllable and observable companion forms – Duality– Pole placement design – Design of state observers: Full order and reduced order observers. **(9+3)**

Total L: 45 + T: 15 = 60 Periods

TEXT BOOKS:

1. M. Gopal, *'Control Systems: Principles and Design'*. Fourth Edition, Tata McGraw Hill, New Delhi, 2012
2. K Ogata, *'Modern Control Engineering'*. Pearson, Fifth Edition,2018

REFERENCES:

1. William J Palm III, *'System Dynamics'*. Second Edition, Tata McGraw Hill, 2012.
2. Norman S Nise, *'Control Systems Engineering'*. Sixth Edition, John Wiley & Sons, 2011.
3. Farid Galnaraghi & Benjamin C. Kuo, *'Automatic Control System'*. Ninth Edition, John Wiley & Sons, Inc,2010.
4. Anand Natarajan & P Ramesh Babu, *'Control Systems Engineering'*. Second Edition, SciTech, 2010.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Classify the components of control systems and modelling methods for dynamic systems	**K2**
CO2	Employ state variable concepts for arriving at canonical models of systems	**K3**
CO3	Examine the performance of the systems both using time and frequency response principles	**K4**
CO4	Evaluate the state equations using eigenvalue and eigenvectors to select the controllability and observability nature of the systems	**K5**
CO5	Design control systems from frequency response characteristics and state observers both in full and reduced forms	**K6**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3											2	2
CO3		2			1							2	2
CO4			1	1		1						2	2
CO5				2								2	2
	3	**2**	**1**	**2**	**1**	**1**						**2**	**2**

1 – low, 2 – medium, 3 – high

25IC403 MICROPROCESSORS AND MICROCONTROLLERS

4 0 0 4

MICROPROCESSOR: Architecture of 8-bit microprocessor, bus configurations, Instruction set classifications, data format and storage – Overview of 8085 Instruction Set–Programming exercise–Instruction execution time. **(12)**

MEMORY AND I/O INTERFACING: Interface requirements–Address space partitioning Buffering of Buses Memory control signals Typical EPROM, RAM Interfacing. I/O interfacing: Memory mapped I/O scheme–I/O mapped I/O scheme–I/O ports -Programmable peripheral interface. **(12)**

MICROCONTROLLER: Microprocessor versus Microcontroller– 8051 Microcontroller Block diagram – Internal Data RAM – Special Function Registers – Internal register banks and stack–Addressing mode and Instruction Set–8051 Assembler and Intel Hex file format. **(12)**

ON-CHIP PERIPHERALS AND INTERFACING: Input / Output Ports structure - Counter and Timers, Serial Data Input / Output - Interrupts, LCD, LED and Keyboard Interfacing, ADC, DAC and Sensor interfacing, interfacing to external memory. **(12)**

APPLICATIONS AND PROGRAMMING IN C: Stepper and DC moto interfacing, 8051 programming in C: Data types, I/O programming, Logic operation, Accessing code ROM space. **(12)**

Total L: 60 Periods

TEXT BOOKS:

1. Ramesh S Gaonkar, *'Microprocessor Architecture, Programming and Applications with the 8085'*. Sixth Edition, Penram International,2013.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D McKinlay, '*8051 Microcontroller and Embedded Systems'*. Second Edition, Pearson Education,2022.

REFERENCES:

1. Kenneth Ayala, *'The 8051 Microcontroller'*. Third Edition, Thomson Delmar Learning, 2016.
2. Krishna Kant, *'Microprocessors and Microcontrollers: Architecture, Programming and System Design 8085, 8086, 8051,8096'*. Second Edition, PHI Learning Pvt.Ltd.,2016
3. Douglas V Hall, *'Microprocessor and Interfacing: Programming and Hardware'*. Third Edition, McGraw Hill Inc, 2013.
4. Subrata Ghosal, *'8051 Microcontroller: Internals, Instructions, Programming and Interfacing'*. Pearson Education India,2010.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the architecture, instruction set, timing, and interfacing techniques of 8-bit microprocessors and microcontrollers, with emphasis on 8085 and 8051, including memory and I/O interfacing, address space partitioning, bus buffering, and programmable I/O devices.	**K2**
CO2	Demonstrate the use of 8051 on-chip peripherals such as timers, serial communication, and interrupts in basic embedded system design.	**K3**
CO3	Construct embedded applications by interfacing 8051 with external hardware components such as LEDs, sensors, motors, ADCs, and DACs using assembly and C programming.	**K4**
CO4	Design and implement a mini-project or case study using 8051 microcontroller and C programming, involving real-world applications such as stepper motor control or sensor-based automation.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												2
CO3		2											2
CO4			1										3
	3	**2**	**1**										**3**

1 – low, 2 – medium, 3 – high

25IC404 DATA STRUCTURES AND ALGORITHMS

2 2 0 4

ALGORITHM ANALYSIS: Algorithms- properties –-Recursive Algorithms- Analysis of Algorithms-Best case, Average case, Worst case – Asymptotic Notations-Data types – Abstract data types – Types of Data structures **(6+6)**

LINEAR DATA STRUCTURES: Arrays-operations – Memory Representation- Row Major and Column Major – Multi Dimensional Arrays – Sparse Matrix, Dense Matrix. Stack: Array implementation – operations-Applications – Checking of well-formedness of Parenthesis-Infix to Postfix Conversions. **(6+6)**

QUEUES AND LISTS: QUEUES: Queue Operations-Circular Queue - Array Implementation of Queue**,** LINKED LIST: Types-Singly Linked List – Circularly Linked List – Doubly Linked List–List operations-linked stack-linked queue. **(6+6)**

NONLINEAR DATA STRUCTURES: Trees-Terminologies - Binary trees – Representations – Operations – Traversals- In order, Pre-order and Post order- Binary Search Trees – Insertion and deletion. Graph: Terminologies - Breadth First Search algorithm- Depth First Search Algorithm. **(6+6)**

SORTING AND SEARCHING: Bubble Sort – Insertion Sort – Radix Sort- Quick sort- Algorithms and Time Complexity. Linear Search – Binary Search – Hashing: Hash functions – Separate Chaining – Open Addressing – Linear. robing. **(6+6)**

Total L: 30 + T: 30 = 60 Periods

TEXT BOOKS:

1. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, *'Introduction to Algorithms'*. The MIT Press, 2022.
2. Mark Allen Weiss, *'Data Structures and Algorithm Analysis in C++'*. Pearson Education, 2012.

REFERENCES:

1. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, *'Fundamentals of Computer Algorithms'*. Second Universities Press, 2011.
2. Sahni Sartaj, *'Data Structures, Algorithms and Applications in C++'*. Silicon Press, 2009.
3. Aaron M Tanenbaum, Moshe J Augenstein, Yedidyah Langsam, *'Data structures using C and C++'*. PHI Learning, 2009.
4. G A V Vijayalakshmi Pai, *'Data Structures and Algorithms Concepts, Techniques and Allocations'*. New Delhi: McGraw Hill Education (India) Private Limited, 2015.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts of algorithms, their analysis, asymptotic notations, and types of data structures.	**K2**
CO2	Apply appropriate memory representations to implement and manipulate linear data structures such as arrays, stacks, queues, and linked lists (including their variants) to perform efficient insertion, deletion, and traversal operations for various applications.	**K3**
CO3	Analyse the structure and operations of non-linear data structures such as trees and graphs and apply suitable traversal and search algorithms.	**K4**
CO4	Compare different sorting and searching algorithms and evaluate their time complexities to determine their efficiency for given problem scenarios.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				3								
CO3		2			2								
CO4			1		1	1							1
	3	**2**	**1**		**3**	**1**							**1**

1 – low, 2 – medium, 3 – high

25IC411 MICROPROCESSORS AND MICROCONTROLLERS LABORATORY

0 0 4 2

LIST OF EXPERIMENTS:

1. Arithmetic operations using 8085 microprocessor
2. Code conversion using 8085 microprocessor
3. Sorting using 8085
4. Programmable Peripheral Interfacing i) ADC ii) DAC iii) Traffic Light Controller
5. Rolling display using 8085
6. Arithmetic operations using 8051 microcontroller
7. Logical and Bit manipulation using 8051 microcontroller
8. Generation of delay using on-chip timer/counter
9. ADC and DAC interfacing
10. Stepper and DC motor control interface to 8051.

Total P: 60 Periods

REFERENCES:

1. Mukhopadhyay A. K., *'Microprocessor-Based Laboratory Experiments and Projects'*. Third Edition, I K International Publishing House Pvt. Ltd,2010.
2. Department of Instrumentation and Control Systems Engineering, *'Laboratory Manual'*. PSG Institute of Technology and Applied Research, Neelambur, Coimbatore-641062, 2026.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Use 8085 assembly language instructions to perform arithmetic operations, data conversions, and simple data processing tasks.	**K2**
CO2	Develop programs on 8085 and 8051 to implement algorithms such as sorting, searching, and bitwise manipulations.	**K3**
CO3	Implement peripheral device interfacing through timers, counters, and serial communication features of 8051 for real-time operations.	**K4**
CO4	Build embedded control applications by interfacing 8051 with ADCs, DACs, and motors for real-world automation tasks.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												3	
CO2		3										3	
CO3			2									2	
CO4						1		1	1		1	1	
			2			**1**		**1**	**1**		**1**	**3**	

1 – low, 2 – medium, 3 – high

25IC412 MEASUREMENT AND CONTROL LABORATORY

0 0 4 2

LIST OF EXPERIMENTS:

1. Measurement of resistance using Wheatstone bridge and Kelvin's Double bridge
2. Measurement of capacitance and inductance using Schering Bridge and Anderson Bridge
3. Extension of instrument ranges
4. Calibration of analog instruments
5. Calibration of digital instruments
6. Time response of first order system
7. Time response of second order system
8. Study of frequency response analysis of a system
9. Empirical modelling of real time systems
10. Design of compensation networks

Total P:60 Periods

REFERENCES:

1. Golding E W, Widdis FC, *'Electrical Measurements and Measuring Instruments'*. Reem Publications, New Delhi, 2011.
2. K Ogata, *'Modern Control Engineering'*. Pearson, Fifth Edition, 2018
3. Department of Instrumentation and Control Systems Engineering, *'Laboratory manual'*. PSG Institute of Technology and Applied Research, Neelambur, Coimbatore-641062, 2026.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Interpret the system performance and determine the specifications from the time response of first order and second order systems.	**K2**
CO2	Evaluate the value of resistance as well as capacitance and inductance using measuring bridges.	**K3**
CO3	Calibrate both analog and digital instruments by computing the errors.	**K4**
CO4	Design compensation networks by both time and frequency response analysis	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1												2	1
CO2	3				2				1			2	2
CO3		3			3				1	1		2	2
CO4			2	3	3				1			2	2
	3	**3**	**3**	**3**	**3**				**1**	**1**		**2**	**2**

1 – low, 2 – medium, 3 – high

25EEC03 PROBLEM SOLVING

0 0 2 1

1. Algorithmic thinking, branching and repetition problems
2. Logical reasoning - data arrangements and relations
3. Solving problems based on coding and decoding, series, analogy, odd man out and visual reasoning
4. Problems based on ages, logical connectives, syllogisms, data interpretation and data sufficiency
5. Solving problems on clocks calendars, direction sense and cubes
6. Problems based on number system, percentages, simple and compound interest
7. Resume update

Total P: 30 Periods

REFERENCE:

1. R S Aggarwal, *'Quantitative Aptitude for Competitive Examination'*. S Chand Publishing, New Delhi, 2017

25ICE01 MINI PROJECT - I

0 0 2 1

Students should learn project selection methodologies and teamwork skills to design hardware/software products. Create a good technical report and gain motivation to explain project ideas clearly.

Total P: 30 periods

COURSE GUIDELINES:

- Students can choose project based on industry defined problem or user defined problem which must emulate the real-life problems.
- It is desirable that students should work on the project in group of 2 or 3 but not more than three.
- After making the group, students must decide the title of the project and they will present to the department. Also, students will prepare the proposal report of 4-5 pages and submit at the time of presentation.
- At the end, students must submit the final report of the project and the format for the same will be given by the department.
- The plagiarism check for the final report is to be done through the required software suggested by the department and the report must be having similarity less than 25%.
- The students will report to the respective guide/supervisor at every fortnight to discuss their progress.
- The final evaluation of the project will be done based on the demonstration and presentation.

COURSE OUTCOME:

At the end of the course, students will be able to:		Bloom's Level
CO1	Identify and define a problem statement relevant to simple engineering problems in electrical and electronics engineering.	**K2**
CO2	Apply basic electronic components and electric circuit concepts to develop a working project.	**K3**
CO3	Analyze and solve the complex problems to proposed project work	**K4**
CO4	Design and develop a basic electrical or electronic system to solve a real-world problem using appropriate tools and techniques.	**K6**
CO5	Demonstrate teamwork, project and finance planning, time management and communicate technical information effectively through reports and presentations.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				3							3	3
CO3		3			3							3	3
CO4			3	3	3	3						3	3
CO5						3	3	3	3	3	3		
	3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1 – low, 2 – medium, 3 – high

SEMESTER - V
25IC501 INDUSTRIAL INSTRUMENTATION

3 0 0 3

PRESSURE MEASUREMENT: Terminologies – Units - Manometers-Different Types-Bourdon Tube-Bellows-Diaphragms – Electrical Methods: Elastic elements with LVDT and strain gauges- Capacitive type pressure gauge -Piezo resistive pressure sensors-Low pressure measurement: McLeod gauge-Thermal conductivity gauge-Ionization gauge - Dead weight tester. **(9)**

TEMPERATURE MEASUREMENT: Units - Filled-in systems - Bimetallic thermometer – Electrical methods; RTD and compensation techniques – Thermistors and its linearization - Thermocouples: laws, burnout detection, cold junction compensation – Thermopile- IC Temperature sensors – Radiation methods: Pyrometers and its types, Fibre optic temperature measurement. **(9)**

FLOW MEASUREMENT: Units -Variable head type: Orifice plate -Venturi tube- Flow nozzle- Pitot tube– Variable area meter: Rotameter - Positive displacement flow meters: Reciprocating piston, oval gear and helix type flow meters-Turbine flow meter-Mass flow meters: Angular momentum mass flow meter, Coriolis mass flow meter, Thermal mass flow meter- Electromagnetic flow meter-Ultrasonic flow meters-Laser Doppler anemometer system-Vortex shedding flow meters - Target flow meter. **(9)**

LEVEL MEASUREMENT: Sight glass -Float type level indication- Level switches – Air purge system - Differential pressure method – Electrical methods of level measurement using resistance, capacitance, nuclear radiation and ultrasonic sensors. **(9)**

MEASUREMENT OF VISCOSITY, HUMIDITY AND MOISTURE: Viscosity measurement: Say bolt viscometer, Rotameter type viscometer – Humidity terms – dry and wet bulb psychometers-hotwire electrode type hygrometer-dew cell – electrolysis type hygrometer – moisture measurement – different types of moisture measurement – Electronic recorders – Introduction to pneumatic instruments. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Walt Boyes, '*Instrumentation Reference Book'*. Elsevier Science, 2010.
2. Donald P Eckman, '*Industrial Instrumentation'*. CBS Publisher, 2004.

REFERENCES:

1. Liptak B.G, '*Process Measurement and Analysis'. Fourth Edition*'. Chilton Book Company,2003.
2. William C Dunn, '*Fundamentals of Industrial Instrumentation and Process Control*'. McGraw-Hill Education, Second Edition, 2018.
3. B. E. Noltingk, '*Instrument Technology: Mechanical measurements'*. Butterworths, Fourth Edition, 2016.
4. John P Bentley, '*Principles of Measurement Systems*'. Pearson Education, Fourth Edition, 2020.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the principles, construction, and working of instruments used for pressure, temperature, flow, level, viscosity, humidity, and moisture measurement.	**K2**
CO2	Apply measurement techniques to select appropriate instruments for different process conditions and variables.	**K3**
CO3	Analyse the performance, limitations, and accuracy of various industrial sensors and transmitters in real-time measurement systems.	**K4**
CO4	Evaluate industrial measurement scenarios through case studies and propose suitable instrumentation solutions considering accuracy, feasibility, and application needs.	**K5**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO 2**
CO1													
CO2	3				3						3	3	
CO3		2			2								
CO4				2	2	2						2	
	3	**2**		**2**	**3**	**2**					**3**	**3**	

1 – low, 2 – medium, 3 – high

25IC502 DIGITAL SIGNAL PROCESSING

3 0 0 3

DISCRETE TIME SIGNALS AND SYSTEMS: Motivation–Sampling and Quantization of signal-Discrete time (DT) sequences –Different representations of DT sequence-Operations on DT sequence - LTI system - properties – Linear and circular convolution-correlation. **(9)**

TRANSFORMS: Discrete Fourier Transform – Properties – Fast Fourier Transform, Decimation in Time FFT algorithm-Decimation in Frequency FFT algorithm- Frequency response of LTI system. **(9)**

LTI SYSTEMS AS FREQUENCY SELECTIVE FILTERS: Filter Characteristics-Digital resonators – Notch filters – Comb filters – All pass filters – Moving Average filters. **(9)**

FIR FILTERS: Characteristics, symmetry, linear phase and types – Design of FIR filter using windowing technique Frequency sampling technique- introduction to optimal FIR filter design- Realization of FIR filter. **(9)**

IIR FILTERS AND FINITE WORD LENGTH EFFECT: Design of analog prototype filter–Types of IIR filter–Frequency transformation–Impulse Invariant technique–Bilinear transformation technique – Realization of IIR filter-Effect of coefficient quantization-Effect of round-off noise in digital filters-Limit cycle due to round-off and truncation. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. John G Proakis, Dimitris G Manolakis, '*Digital Signal Processing, Principles, Algorithms and Applications*'. Fifth edition, Pearson, 2021.
2. Lonnie C. Ludeman, '*Fundamentals of Digital Signal Processing*'. Wiley, 2009.

REFERENCES:

1. Alan V Oppenhiem, Ronald W Schafer, '*Discrete Time Signal Processing*'. Pearson, 2014.
2. Sanjit K Mitra, '*Digital Signal Processing: A Computer based Approach*'. McGraw Hill Education, 2014.
3. Sophocles Orfanidis, '*Introduction to Signal Processing*'. Prentice Hall, 2009.
4. Boaz Porat, '*A Course in Digital Signal Processing*'. Wiley, 2012.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental concepts of digital signal processing.	**K2**
CO2	Apply the FIR and IIR filter design techniques for signal processing applications.	**K3**
CO3	Analyse discrete-time signals and systems using Fourier Transform, Discrete Fourier Transform (DFT), and Fast Fourier Transform (FFT) techniques and their properties.	**K4**
CO4	Design and realize FIR and IIR Filter techniques for specific applications.	**K6**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3											3	
CO3		3			2							2	
CO4			1		1							1	
	3	**3**	**1**		**2**							**3**	

1 – low, 2 – medium, 3 – high

25IC503 DIGITAL CONTROL SYSTEMS

3 1 0 4

INTRODUCTION TO DIGITAL CONTROL: Industrial and Embedded Control – Digital Computer as a Compensator Device - Advantages of Digital Computers –Implementation Problems in Digital Control – Digital Implementation of Analog Compensators – Sampling rate selection – Limits of Digital Implementation of Analog Compensators - Modeling the Digital Computer, Sampler, Zero-order Hold, Z-Transform, Inverse Z-Transform. **(9+3)**

TRANSFER FUNCTION MODELS AND DYNAMIC RESPONSE: Model of a Plant – Model of Closed Loop Sampled Data System – Dynamic Response – S-plane to Z-plane mapping - Transfer Functions – Block Diagram Reduction - Pulse Transfer function of the Feedback System – Stability on the Z-plane – Bilinear Transformation – Steady State Errors – Design using Root Locus Plots – Design using Frequency Response Plots - Implementation of Digital Compensator. **(9+3)**

STATE SPACE REPRESENTATIONS OF DISCRETE TIME SYSTEMS: Solution of The Time – Invariant Discrete- Time State Equation, State Transition Matrix, Z-Transform Approach to The Solution of State Equation, Discretization of Continuous- Time State- Space Equations, Controllability and Observability of Discrete- Time Systems, Conditions, Principle of Duality. **(9+3)**

DESIGN VIA POLE PLACEMENT: Necessary and Sufficient Condition for Pole Placement, Ackerman's Formula, State Observers – Necessary and Sufficient Condition for State Observation. Full Order State Observer, Error Dynamics of the Full Order State Observer, Design of Prediction Observer. **(9+3)**

DESIGN OF MINIMUM-ORDER OBSERVER: State Feedback Control System with Minimum- Order Observer. Diophantine Equation, Polynomial Equation approach to Control System Design. Design of Model Matching Control Systems. **(9+3)**

Total L: 45 + T: 15 = 60 Periods

TEXT BOOKS:

1. Norman S Nise, '*Control Systems Engineering*'. Sixth Edition, John Wiley and Sons, 2011.
2. B. C. Kuo, 'Digital Control Systems'. Second Edition, Oxford University Press, Inc., 1992.

REFERENCES:

1. F. Franklin, J. D. Powell, and M. L. Workman, '*Digital control of Dynamic Systems'*. Addison - Wesley Longman, Inc., Menlo Park, CA, 1998.
2. Gopal, '*Digital Control and State Variable Methods'*. Tata McGraw-Hill, India, 1997.
3. C. H. Houpis and G. B. Lamont, '*Digital Control Systems'*. McGraw-Hill, 1985.
4. John S. Baey, '*Fundamentals of Linear State Space Systems'*. First edition, McGraw-Hill, 1999.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental concepts of digital control, including the sampling theorem, quantization effects, and the mapping relationships between the S-plane and Z-plane.	**K2**
CO2	Apply state-variable techniques to represent discrete-time systems, perform discretization of continuous equations, and solve for time-invariant state transitions.	**K3**
CO3	Analyze the stability and dynamic performance of sampled-data systems in the Z-domain using bilinear transformation, Root Locus, and frequency response method.	**K4**
CO4	Design and implement digital control algorithms and observers (Full/Minimum-order) using pole placement technique, Ackerman's formula, and the Diophantine equation approach through simulation studies for chosen applications.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3												3
CO2		2			2								2
CO3				1	1			1	1		1		1
CO4	3	2		1	2			1	1		1		3
	3	**2**		**1**	**2**			**1**	**1**		**1**		**3**

1 – low, 2 – medium, 3 – high

25IC504 EMBEDDED SYSTEM DESIGN

3 0 0 3

EMBEDDED SYSTEMS OVERVIEW: Embedded System Design process – Design Challenge: Optimizing Design Metrics – Processor Technology –IC Technology–Design Technology–Trade-offs. **(9)**

ARCHITECTURE AND PROGRAMMING: Hardware architecture – Software architecture – Application Software-Process of Generating executable image – Development/Testing Tools. **(9)**

INTERFACING NETWORKS: Parallel I/O Interface –Serial Communications Interface (SCI) - Device Driver Arbitration, Multi-Level Bus Architecture–Serial Protocols: I2C, CAN, FireWire, USB–Wireless protocols: IrDA, Bluetooth, IEEE 802.11 - Internet Enabled systems -Sensor Networks. **(9)**

RTOS FOR EMBEDDED SYSTEMS: Interrupt driven systems-Need for Real-time Operating System-RTOS Concepts Tasks, Context switching, Interrupt latency, Memory management, Scheduling, Task Synchronization-Introduction to RTOS APIs- Power optimization strategies for processes-Basic design using RTOS-Response time calculation-Comparison of commercial RTOSs. **(9**)

EMBEDDED BASED CONTROL SYSTEM: Introduction to digital control systems – Open-Loop and Closed-Loop control system – General control systems and PID controllers – Software coding of a PID controller – PID Tuning - Practical issues related to computer – control implementations. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Frank Vahid, Tony Givargis, '*Embedded System Design: A unified hardware software introduction*'. John Wiley & Sons, 2018.
2. Wayne Wolf, '*Computers as Components - Principles of Embedded Computer System Design'*. Fourth Edition, Morgan Kaufmann Publisher, 2017.

REFERENCES:

1. K.V.K.K. Prasad, '*Embedded Real-Time Systems: Concepts, Design and Programming'*. Dreamtech Press, 2014.
2. Jonathan W. Valvano, *'Embedded Systems–Real Time Interfacing'*. Fifth Edition, Cengage Learning, 2017.
3. Raj Kamal, '*Embedded Systems: SOC, IOT, AI and Real Time Systems'*. Fifth Edition, Tata McGraw-Hill Education, 2020.
4. K V Shibu, '*Introduction to Embedded Systems'*. Second Edition, McGraw Hill Education India Private Limited, 2020.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain embedded system concepts including design process, architectures, interfacing, communication protocols, RTOS, and control systems.	**K2**
CO2	Apply programming, development tools, interfacing methods, and RTOS concepts to implement embedded system applications.	**K3**
CO3	Analyze system performance, communication interfaces, scheduling, and control strategies in embedded systems.	**K4**
CO4	Design and develop embedded system solutions integrating hardware, software, RTOS, and control techniques.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											2	
CO3		3			1							2	
CO4			2		1			1		1		1	2
	3	3	2		1			1		1		2	2

1 – low, 2 – medium, 3 – high

25IC511 SIGNAL PROCESSING AND DIGITAL CONTROL LABORATORY

0 0 2 1

LIST OF EXPERIMENTS:

SIGNAL PROCESSING BASED EXPERIMENTS:

1. Generation of signals and operation on signals.
2. Sampling and Quantization, discretization of continuous time systems.
3. Transform domain analysis of signals and systems.
4. Design of FIR filter.
5. Design of IIR filter. **(15)**

DIGITAL CONTROL EXPERIMENTS:

1. Implementation of position and velocity form of PID controller.
2. Synthesis and implementation of digital PID controller.
3. Design of PID controller based on graphical analysis method.
4. Design and implementation (Full/ minimum order) observer
5. Design and implementation of pole placement controller. **(15)**

Total P: 30 Periods

REFERENCES:

1. Department of Instrumentation and Control Systems Engineering, '*Laboratory manual*'. PSG Institute of Technology and Applied Research, Neelambur, Coimbatore, 2025.
2. B.C Kuo, '*Digital Control Systems'*. Second Edition, Oxford University Press, Inc., 1995.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain fundamental concepts of signals, systems, digital control, and PID controller.	**K2**
CO2	Apply signal processing techniques such as IIR and FIR filters and digital control methods.	**K3**
CO3	Analyze system response, and controller performance using time and frequency domain techniques.	**K4**
CO4	Evaluate the performance of IIR and FIR filters, PID controllers, and control strategies based on design specifications.	**K5**
CO5	Design and implement signal processing algorithms and digital control systems such as FIR/IIR filters, PID controllers, observers, and pole placement methods.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	2				1			1	1			2	
CO3		2			1			1	1				
CO4			2	1	1			1	1				
CO5			2	1	1			1	1				2
	2	**2**	**2**	**1**	**1**			**1**	**1**			**2**	**2**

1 – low, 2 – medium, 3 - high

25IC512 EMBEDDED SYSTEMS LABORATORY

0 0 2 1

LIST OF EXPERIMENTS:

1. General Purpose Input- Output Programming.
2. Basic I/O Interfacing: Matrix Keypad, 7 segment LED, and LCD Display
3. Polling and interrupt service mechanism using Timer/ Counter Peripheral.
4. Interfacing of stepper motor.
5. Interfacing of Analog Sensor using ADC peripheral.
6. Data Transmission between two different devices using serial communication protocols.
7. Data Transmission between two different devices using wireless protocols.
8. Microcontroller based system design for real time applications.
9. Interfacing of Image Sensors with Single Board Computers.
10. Mini Project

Total P: 30 Periods

REFERENCES:

1. NXP, '*LPC2148 & LPC1768 Datasheets'*.
2. ATMEL, '*ATMEL Datasheet'*.
3. Dragino, '*LoRa Product Datasheets'*.
4. NVIDIA, 'Jetson Product Datasheets'.
5. Department of Instrumentation and Control Systems Engineering, '*Laboratory manual*'. PSG Institute of Technology and Applied Research, Neelambur, Coimbatore, 2025.

COURSE OUTCOMES

At the end of the course, students will be able to:		Bloom's Level
CO1	Explain embedded systems concepts, I/O interfacing, communication protocols, and real-time operations.	**K2**
CO2	Apply embedded programming to interface peripherals, sensors, and communication modules.	**K3**
CO3	Analyze interrupt handling, data communication, and real-time system performance.	**K4**
CO4	Design and develop embedded system solutions using microcontrollers, sensors, and communication technologies through mini projects.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											2	
CO3		3										2	
CO4			2	2	2			1	1	1		2	
	3	**3**	**2**	**2**	**2**			**1**	**1**	**1**		**2**	

1 – low, 2 – medium, 3 – high

25IC513 INDUSTRIAL INSTRUMENTATION LABORATORY

0 0 4 2

LIST OF EXPERIMENTS:

1. Determination of discharge coefficient of orifice plate and venturi meter.
2. Characteristics of P/I and I/P Converters.
3. Measurement of absorbance and transmittance of a solution using UV spectrophotometer.
4. Measurement of pH and conductivity
5. Measurement of level and flow using DP transmitter.
6. Calibration of pressure gauge using dead weight tester.
7. Measurement of temperature using IR thermometer.
8. Determination of transfer function model of thermocouple.
9. Determination of viscosity using say bolts viscometer.
10. Measurement of humidity using a hygrometer.
11. Study of smart transmitter and smart valve positioner.

Total P: 60 Periods

REFERENCES:

1. Patranabis. D, '*Principles of industrial instrumentation*'. Tata McGraw Hill Education, 2008.
2. S K Singh, '*Industrial Instrumentation and Control'*. Tata McGraw, 2010.
3. Department of Instrumentation and Control Systems Engineering, '*Laboratory manual*'. PSG Institute of Technology and Applied Research, Neelambur, Coimbatore, 2025.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Apply principles of industrial instrumentation to perform calibration and measurement of flow, pressure, level, temperature, and viscosity.	**K3**
CO2	Analyze the performance characteristics of measurement systems such as P/I & I/P converters, thermocouples, RTDs, and transmitters	**K4**
CO3	Evaluate accuracy, sensitivity, and error in various measurement instruments including spectrophotometers, hygrometers, IR thermometers, and smart transmitters.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2				2							2	
CO2		3										2	
CO3			2		2								
	2	**3**	**2**		**2**							**2**	

1 – low, 2 – medium, 3 - high

25EEC04 APTITUDE SKILLS

0 0 2 1

1. Reading comprehension
2. Sentence correction, Sentence completion and Para-jumbles
3. Vocabulary, Articles, Prepositions and Interrogatives
4. Critical reasoning
5. Ratio and Proportion, Profit and loss, Partnerships and averages
6. Permutation, Combination and Probability
7. Time, Speed and Distance
8. Resume progress check

Total P: 30 Periods

REFERENCES:

1. Norman Lewis, '*Word Power Made Easy*'. Goyal Publisher, New Delhi, 2011.
2. P C Wren and H Martin, '*High School English Grammar and Composition'*. S Chand Publishing, New Delhi, 2017.
3. R S Aggarwal, '*Quantitative Aptitude for Competitive Examination'*. S Chand Publishing, New Delhi, 2017.

SEMESTER - VI

25IC601 INSTRUMENTATION SYSTEM DESIGN

3 0 0 3

DESIGN OF DATA ACQUISITION SYSTEM: Need for data acquisition - Factors affecting performance of sensors- Signal conditioning - Resolution and Sampling rate considerations for ADC- Sampling techniques - Selection of ADC. **(9)**

LINEARIZATION AND COMPENSATION TECHNIQUES: Analog linearization- Linear interpolation- Piece-wise linearization- Microcontroller-based linearization. Compensation methods: Offset compensation- Error and Drift Compensation- Lead wire compensation- Cold junction compensation. **(9)**

DESIGN OF FLOWMETERS: Orifice sizing –Liquid, gas and steam services – Factors affecting orifice plate sizing- Rotameter design- Pitot tube sizing- Design of venturi meter- Selection of flowmeters. **(9)**

DESIGN OF TRANSMITTERS: Flow transmitter- Level transmitter- RTD and thermos couple-based temperature transmitter -pH transmitter- 2-wire transmitter current loops-4-wire transmitter current loops- Troubleshooting current loops-Smart transmitter. **(9)**

DESIGN OF ACTUATORS: Energy dissipation in a turbulent fluid stream- Importance of control valve sizing- Control valve sizing- Liquid, gas and steam services- Selection criteria for control valve- Variable Frequency Drive- Thyristor power controller. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Manabendra Bhuyan, *'Intelligent Instrumentation: Principles and Applications'.* First Edition, CRC Press, 2017.
2. Subhas Chandra Mukhopadhyay, '*Intelligent Sensing, Instrumentation and Measurements*'. Springer, 2013.

REFERENCES:

1. John P Bentley, '*Principles of Measurement Systems*'. Fourth Edition, Pearson Education, 2020.
2. Gregory K McMillan and Douglas M Considine, *'Process/ Industrial Instruments and Controls Handbook*'. Fifth Edition, Tata McGraw Hill, 2009.
3. Norman A Anderson, '*Instrumentation for Process Measurement and Control*'. Third Edition, CRC Press, 2005.
4. Curtis D. Johnson, *'Process Control Instrumentation Technology*'. Eighth Edition, Pearson Education India, 2015.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the principles and design requirements of data acquisition systems, sensor performance, signal conditioning, linearization techniques, compensation methods, and basic working of flowmeters, transmitters, and actuators.	**K2**
CO2	Apply engineering concepts to design data acquisition systems, implement signal conditioning circuits, select suitable ADCs, and perform basic design calculations for flowmeters, transmitters, and actuators	**K3**
CO3	Analyze the performance of instrumentation systems by evaluating errors, compensation techniques, flow measurement methods, transmitter configurations, and actuator behaviour under different operating conditions.	**K4**
CO4	Evaluate and select appropriate instrumentation systems and propose optimized solutions for industrial applications through case study.	**K5**
CO5	Design and develop complete instrumentation systems including data acquisition, signal conditioning, measurement, and control elements for industrial applications.	**K6**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3				1							3	
CO3		2			1							2	
CO4				2	1							2	
CO5			2		2			1	1		1	1	
	3	**2**	**2**	**2**	**2**			**1**	**1**		**1**	**3**	

1 – low, 2 – medium, 3 – high

25IC602 INDUSTRIAL PROCESS CONTROL

3 1 0 4

PROCESS DYNAMICS : Piping and Instrumentation Diagram : Instrument terms and symbols - Feedback control concepts - Classification of variables - Servo and regulatory Control - Process Characteristics: Degrees of freedom, Self-regulation, Process lag, Dead time, Inverse response - Continuous and batch process - Mathematical model of first order level, pressure, hydraulic and thermal processes - Higher order Process : Interacting and non- interacting systems - Linearization of nonlinear models - Approximation of higher order transfer functions - Development of empirical models from process data: Fitting first and second order models using step tests and PRBS. **(9+3)**

BASIC CONTROL ACTIONS AND CONTROLLERS : Characteristics of on-off, proportional, single-speed floating, integral and derivative control modes - P+I, P+D and P+I+D control modes - Integral windup and prevention - Auto / Manual transfer: Bump less transfer- Electronic controllers to realize various control actions - Response of controllers for test inputs - Effects of P,I and D actions on closed loop response - Selection of controller modes for control of level, pressure, flow and temperature process. **(9+3)**

FINAL CONTROL ELEMENT: Current to pressure converter - Pneumatic and electric actuators - Valve positioner - Pneumatic control valve: parts, classification and mathematical model - Characteristics of control valves: Inherent and Installed characteristics - Commercial valve bodies - Cavitation and flashing - Control valve types: flow control valve, pressure control valve and directional control valve - Motorized Control valve. **(9+3)**

CONTROLLER DESIGN: Model based controller design - Direct synthesis method- Internal Model Controller (IMC) - Evaluation criteria: IAE, ISE, ITAE - ¼ decay ratio criterion - Determination of optimum settings for mathematically described processes using time response and frequency response methods - Online controller tuning: Process reaction curve method, Ziegler Nichols method, Damped oscillation method – Relay autotuning. **(9+3)**

MULTI LOOP & MULTIVARIABLE CONTROL : Feed forward control - Ratio control - Cascade control - Time delay compensation: Smith Predictor Control- Inferential control - Split range control - Selective Control - Introduction to Adaptive Control - Multi Input Multi Output Processes: Process interactions and control loop interactions - Pairing of controlled and manipulated variables – Design of Decoupler- Model Predictive Controller (MPC) - Case studies: Binary distillation column control, boiler drum level control and chemical reactor control. **(9+3)**

Total L: 45 + T: 15 = 60 Periods

TEXT BOOKS:

1. George Stephanopoulos, '*Chemical Process Control: An Introduction to theory and Practice*'. First Edition, Pearson Education India, 2008.
2. Dale. E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp and Francis J. Doyle, *'Process Dynamics and Control'*. Fourth Edition, John Wiley & Sons, 2016.

REFERENCES:

1. Donald P. Eckman, '*Automatic Process Control*'. First Edition, Wiley India Pvt Ltd, 2021.
2. Donald R. Coughanowr and Steven E. LeBlanc, '*Process Systems Analysis and Control*'. Third Edition, McGraw Hill Education, 2017.
3. Bela G. Liptak, '*Instrument Engineers Handbook: Process Measurement and Analysis*'. Fifth Edition, CRC Press, 2016.
4. Curtis D. Johnson, '*Process Control Instrumentation Technology*'. Eighth Edition, Pearson Education India, 2015.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the characteristics of various controllers and classify control elements along with their associated mathematical models.	**K2**
CO2	Apply the concept of process modelling and control action implementation for a mathematically described process.	**K3**
CO3	Examine the choice of the controller in a multiloop, multivariable process through closed loop interactions.	**K4**
CO4	Develop empirical models from the process data to find the optimum controller settings for closed loop operation.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				3								3
CO3				2	2						2		2
CO4				2	2						2		2
	3			**2**	**3**						**2**		**3**

1 – low, 2 – medium, 3 – high

25IC603 ARTIFICIAL INTELLIGENCE FOR MEASUREMENT AND CONTROL

3 0 0 3

FOUNDATIONS OF ARTIFICIAL INTELLIGENCE: Concept and importance of Artificial Intelligence, Machine Learning and Data Science - Human intelligence vs. Machine intelligence - AI Basics: Divide and Conquer, Greedy, Branch and Bound, Gradient Descent - Problem solving methods in AI - Knowledge representation. **(9)**

EXPERT SYSTEMS: Introduction - Expert system architecture- Functions of various parts - Mechanism and role of inference engine - Types of Expert system - Tuning of expert systems - Expert PID Control. **(9)**

DATA ANALYSIS TECHNIQUES: Regression analysis: Simple linear regression, Multiple linear regression, K-nearest neighbours' regression – Multicollinearity in regression analysis - Classification techniques: Clustering, Association rules analysis - Logistic regression in classification. **(9)**

MACHINE LEARNING: Supervised learning - Unsupervised learning - Reinforcement learning. Artificial Neural Network: Architectures- Multi Layer Perceptron - Backpropagation learning algorithm - Activation functions - Types of Loss function - Optimization algorithm: Gradient descent, Stochastic gradient descent - Batch normalization and Dropout - Neural network control - Adaptive control based on neural approximation. **(9)**

SENSORS WITH ARTIFICIAL INTELLIGENCE: Multidimensional intelligent sensors - ANN-based intelligent sensors: Soft sensing, Fault detection - Fuzzy logic–based intelligent sensors - AI for prognostic instrumentation. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Lavika Goel, '*Artificial Intelligence: Concepts and Applications'*. Wiley Publishers, 2021.
2. Ethem Alpaydin, '*Introduction to Machine Learning'*. MIT Press, Fourth Edition, 2020.

REFERENCES:

1. Manabendra Bhuyan, '*Intelligent Instrumentation: Principles and Applications*'. CRC Press, 2017.
2. Jinkun Liu, '*Intelligent Control Design and MATLAB Simulation*'. Springer, 2018.
3. Thomas A. Runkler, '*Data Analytics: Models and Algorithms for Intelligent Data Analysis*'. Springer Verlag, Second Edition, 2016.
4. John D. Kelleher, '*Deep Learning'*. MIT Press, 2019.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the basic concepts of Artificial Intelligence, machine learning, problem-solving methods, and the role of expert systems in control applications.	**K2**
CO2	Apply regression and classification techniques for data analysis relevant to instrumentation and control problems.	**K3**
CO3	Analyse the structure and working of artificial neural networks and their applications in control systems.	**K4**
CO4	Evaluate the role of intelligent sensors using ANN and fuzzy logic for soft sensing and fault detection.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				3							3	3
CO3		3			2							2	2
CO4			2		2								2
	3	**3**	**2**		**3**							**3**	**3**

1 – low, 2 – medium, 3 – high

25IC611 INSTRUMENTATION SYSTEM DESIGN LABORATORY

0 0 4 2

LIST OF EXPERIMENTS:

1. Study of zero elevation and zero suppression in differential pressure transmitters.
2. Implementation of alarm circuits using an annunciator.
3. Linearization of thermistor and cold junction compensation of thermocouple using LabVIEW.
4. Interfacing of smart transmitter with HART communicator and PLC.
5. Analysis of lead wire compensation techniques for RTDs.
6. Implementation of thermistor Linearization using graphical programming.
7. Creation of GUI for temperature data acquisition and alarm interface circuit.
8. Design and implementation of signal conditioning circuit for temperature measurement
9. Calibration of DP Transmitter using loop calibrator
10. Design of control valve sizing for liquid and steam services.

Total P: 60 Periods

REFERENCES:

1. Jovitha Jerome, '*Virtual Instrumentation Using LabVIEW'*. PHI, 2010.
2. Department of Instrumentation and Control Systems Engineering, *'Laboratory manual'*. PSG Institute of Technology and Applied Research, Neelambur, Coimbatore-641062, 2025.

COURSE OUTCOMES

At the end of the course, students will be able to:		Bloom's Level
CO1	Explain the principles, characteristics, calibration methods, and compensation techniques of industrial process measurement instruments and transmitters.	**K2**
CO2	Apply industrial instrumentation tools, communication protocols, calibration techniques, and software platforms for process measurement, monitoring, and control applications.	**K3**
CO3	Analyze measurement system performance and design signal conditioning, compensation, control, and monitoring solutions for industrial process instrumentation systems.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				3							3	
CO3		3			2						2	2	
	3	**3**			**3**						**2**	**3**	

1 – low, 2 – medium, 3 – high

25IC612 PROCESS CONTROL LABORATORY

0 0 4 2

LIST OF EXPERIMENTS:

1. Modeling and validation of interacting and non-interacting systems.
2. Experimental study and analysis of PI and PID controller response on Flow and Level control loops.
3. Experimental study and analysis of PI and PID controller response on Temperature control loops.
4. Experimental study and analysis of PI and PID controller response on Pressure control loops.
5. Experimental study on Inherent and Installed characteristics of control valves
6. Experimental study on characteristics of control valve with and without valve positioner
7. Online controller tuning using open loop and closed loop methods.
8. Design and implementation of Feed forward plus feedback controller.
9. Design and implementation of Cascade control mechanism
10. Design and Implementation of PID controller for MIMO process.

Total P: 60 Periods

REFERENCES:

1. Stephanopoulos G, '*Chemical Process Control: An Introduction to theory and Practice*'. First Edition, Pearson Education India, 2008.
2. Department of Instrumentation and Control Systems Engineering, *'Laboratory manual'*. PSG Institute of Technology and Applied Research, Neelambur, Coimbatore-641062, 2025.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Apply the first principle modeling method to develop and validate mathematical models for interacting and non-interacting process systems.	**K3**
CO2	Analyze PI/PID-based feedback, feedforward, cascade, and multivariable (MIMO) control strategies for flow, level, pressure, and temperature process control systems under different operating conditions.	**K4**
CO3	Design and implement PI and PID controller for a MIMO process.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3				3			2			2		3
CO2		3			3			2			2		3
CO3			2		2			2			2		3
	3	**3**	**2**		**3**			**2**			**2**		**3**

1 – low, 2 – medium, 3 - high

25IC613 VIRTUAL INSTRUMENTATION LABORATORY

0 0 2 1

LIST OF EXPERIMENTS:

1. Develop a LabVIEW program to carry out the arithmetic and Boolean operations.
2. Programming exercises on loops and charts.
3. Develop a LabVIEW program to generate random number and plot it on uniform chart.
4. Develop a LabVIEW program to measure and indicate water level in a tank system
5. Develop a LabVIEW program to interface heating and cooling systems.
6. Develop a LabVIEW program to implement instrumentation amplifier.
7. Programming exercises on different types of signal analysis tools.
8. Build a VI to interface RPS/volt-meter/DMM using DAQ system
9. Build a VI to interface signal generator/DSO using DAQ system.
10. Develop a LabVIEW program to interface switches and LED using DAQ system.
11. Develop a LabVIEW program to interface seven segment LED using DAQ system.

Total P: 30 Periods

REFERENCES:

1. Jovitha Jerome, '*Virtual Instrumentation using LabVIEW*'. PHI Learning Pvt. Ltd., 2010.
2. Gary W. Johnson and Richard Jennings, '*LabVIEW for Everyone: Graphical Programming Made Easy and Fun*'. 3rd Edition, Prentice Hall, 2006.
3. Department of Instrumentation and Control Systems Engineering, *'Laboratory Manual'*. PSG iTech, 2025.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Apply LabVIEW programming concepts to develop virtual instruments for arithmetic and Boolean operations, loops, charts, random signal generation, filtering, signal analysis, and basic process simulations.	**K3**
CO2	Analyze the performance of LabVIEW-based virtual instruments and DAQ systems by interpreting signal processing, visualization, and hardware interfacing with measurement and control devices.	**K4**
CO3	Design and implement DAQ-based virtual instrumentation systems using LabVIEW for signal acquisition, interfacing of external hardware such as DMM, signal generator, switches, LEDs, and seven-segment displays.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3				3			3				2	
CO2		3			3			3				2	
CO3			2		2			2			2	2	
	3	**3**	**2**		**3**			**3**			**2**	**2**	

1 – low, 2 – medium, 3 - high

25EEC05 ENHANCING PROBLEM SOLVING ABILITY WITH CODE

0 0 2 1

ENHANCING PROBLEM SOLVING ABILITY WITH CODE:

1. Compilation, Namespace, Header file, Data types, Variables, Declaration, Scope of variables
2. Input / Output, Type Conversion, Operators
3. For, While, Do-while, break, continue,
4. Decision Making
5. Problem solving Pattern Programming
6. Arrays
7. Call by value & Call by reference, with and without arguments
8. Functions, Recursion & Strings
9. Structures & Union
10. Command Line Argument
11. Structure using Pointers
12. Handling Stress
13. Handling Peer pressure
14. Resume progress check

Total P: 30 Periods

REFERENCES:

1. Gayle Laakmann McDowell, '*Cracking the Coding Interview: 150 Programming Questions and Solutions'*. 5th Edition, S Chand Publishing, New Delhi, 2015.
2. John Mongan, Noah Kindler and Eric Giguère, *'Programming Interviews Exposed: Secrets to Landing Your Next Job'*. 5th Edition, Wrox, New Delhi, 2018.

25ICE04 MINI PROJECT - II

0 0 2 1

- Students should learn project selection methodologies and teamwork skills to design hardware/software products.
- Create a good technical report and gain motivation to explain project ideas clearly

COURSE GUIDELINES:

- Students can choose project based on industry defined problem or user defined problem which must emulate the real-life problems.
- It is desirable that students should work on the project in group of 3 or 4 but not more than four.
- After making the group, students must decide the title of the project and they will present to the department. Also, students will prepare the proposal report of 4-5 pages and submit at the time of presentation.
- At the end, students must submit the final report of the project and the format for the same will be given by the department.
- The plagiarism check for the final report is to be done through the required software suggested by the department and the report must be having similarity less than 25%.
- The students will report to the respective guide/supervisor at every fortnight to discuss their progress.
- The final evaluation of the project will be done based on the demonstration and presentation.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Identify and define an engineering problem considering practical requirements, constraints, and objectives.	**K2**
CO2	Apply fundamental principles using electric and electronic circuit concepts to develop solution for the identified problem.	**K3**
CO3	Analyze project outcomes, test results, and performance parameters to identify strengths, limitations, and possible ismprovements.	**K5**
CO4	Design and develop a prototype or proof of concept of the electrical or electronic system using appropriate tools and techniques.	**K6**
CO5	Demonstrate teamwork, project and finance planning, time management and communicate technical information effectively through reports and presentations.	**-**

COs-POs & PSOs MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				3								
CO3		2			3								
CO4			2	2	3							3	3
CO5						2	2	2	2	2	2		
	3	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**

1 – low, 2 – medium, 3 - high

SEMESTER – VII

25IC701 LOGIC AND DISTRIBUTED CONTROL SYSTEMS

3 0 0 3

PROGRAMMABLE LOGIC CONTROLLER (PLC): Introduction - Architecture of PLC -PLC Operation - Input/output modules - Sink and source I/O cards - Programming methods - Basic programming instructions: Bit-level logic Instructions, Instruction addressing, Branch instructions and Internal relay instructions – Ladder diagram for Logic gates - Concept of Latching and Unlatching - Timer Instruction-Counter instruction. **(9)**

ADVANCED FUNCTIONS IN PLC: Program control instructions: Master Control Reset, Jump and Subroutines - Data manipulation instructions: Data transfer, Data compare - Math instructions: Addition, Subtraction, Multiplication and Division- Sequencer instructions- PID functions -Networking of PLC - PLC installation, maintenance and trouble shooting. **(9)**

SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM (SCADA): SCADA Architecture: Hardware and Software- Types of SCADA system- Functions of SCADA - Elements of SCADA: Remote terminal unit, Master terminal unit and HMI- Application areas of SCADA. **(9)**

DISTRIBUTED CONTROL SYSTEM (DCS) AND COMMUNICATION FACILITIES: Evolution of DCS -Architecture of DCS-Hardware units of DCS- Programming techniques- Operator interfaces - Engineering interfaces -Remote operation - Redundancy concept -Interoperability and Interchangeability-Integration of PLC with DCS. Communication facilities: HART protocol, Wireless HART, Foundation Fieldbus and Profibus- Case study of any one DCS. **(9)**

RECENT TRENDS IN AUTOMATION: Introduction to Networked Control System - Plant wide control - Cloud based Automation -OPC Vs OPC UA- Safety PLC- Safety Instrumented Function -Safety Integrity Level - Functional safety standards: IEC61508 / IEC61511 standard - HAZOP. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Frank D. Petruzella, *'Programmable Logic Controllers'*. McGraw-Hill Education, Fifth Edition, New York, 2017.
2. Chanchal Dey and Sunit Kumar Sen, *'Industrial Automation Technologies'*. CRC Press, 2020.

REFERENCES:

1. Stuart A. Boyer, '*SCADA: Supervisory Control and Data Acquisition Systems'*. Fourth Edition, ISA Press, 2016.
2. John W Webb and Ronald a Reis, *'Programmable Logic Controllers - Principles and Applications'.* Fifth Edition, Pearson Education, 2015.
3. Michael P Lukas, *'Distributed Control Systems'.* Van Nostrand Reinhold Co., New York, First Edition, 1986.
4. Glisente Landrini, Basilio Abbamonte and Tino Vandecapelle, '*Safety Instrumented Systems'*. Fifth Edition, GM International, 2017.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the architecture, operation, programming methods, and basic instructions of Programmable Logic Controllers used in industrial automation.	**K2**
CO2	Apply ladder logic programming using bit-level instructions, timers, counters, and advanced math/data manipulation functions to automate industrial processes.	**K3**
CO3	Analyze SCADA, DCS architectures, industrial communication protocols, and their roles in monitoring and control of industrial processes.	**K4**
CO4	Design integrated automation and functional safety solutions using modern industrial networks, cloud-based automation platforms, PLC/DCS integration, and international safety standards.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				3						3		3
CO3		2											2
CO4			2		2							2	3
	3	**2**	**2**		**3**						**3**	**2**	**3**

1 - low, 2 - medium, 3 - high

25IC702 INDUSTRIAL INTERNET OF THINGS

3 0 0 3

INTRODUCTION TO INDUSTRIAL IoT (IIoT) SYSTEMS: Industrial Revolutions- Role of Internet of Things (IoT) & Industrial Internet of Things (IIoT) in Industry- Support System for Industry 4.0- Smart Factories- Enabling Technologies of IoT- Industrial IoT Applications. **(9)**

IMPLEMENTATION SYSTEMS FOR IIoT: Sensors and Actuators for Industrial Processes- Sensor networks- Data Acquisitions on IoT Platform- Microcontrollers and Embedded PC roles in IIoT- Wireless Sensor nodes with Bluetooth-WiFi- and LoRa Protocols and IoT Hub systems- Building Wireless connection into existing Modbus, HART & Profibus networks. **(9)**

IIoT PROTOCOLS: MQTT: Publish & subscribe - Architecture details– communication formats; MQTT-SN: Architecture & Topology – Difference between MQTT & MQTT-SN- Choosing a MQTT broker; CoAP: Architecture details- communication formats – usage example. **(9)**

IIoT DATA MONITORING AND CONTROL: IoT Gate way- IoT Edge Systems and its Programming- Cloud computing- Real Time Dashboard for Data Monitoring- Data Analytics and Predictive Maintenance with IIoT technology. **(9)**

IoT SECURITYAND CASE STUDIES OF IIoT SYSTEMS: IoT Security: IoT Security Challenges - Causes of IoT Security Breaches - Industrial Cyber Security IEC 62443 Standard- IoT Security Risks; Case Studies of IIoT Systems: Smart Energy meter - Monitoring environmental conditions in an apparel factory space - Predictive monitoring of CNC machine operation. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Sudan Jha, Usman Tariq, Gyanendra Prasad Joshi, Vijender Kumar Solanki, '*Industrial Internet of Things: Technologies, Design, and Applications*'. CRC Press, 2022.
2. Perry Lea, *'IoT and Edge Computing for Architects: Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security*'. Second Edition, Packt Publishing, 2020.

REFERENCES:

1. Anand Sharma, Sunil Kumar Jangir, Manish Kumar, Dilip K Choubey, Tarun Shrivastava, S. Balamurugan, '*Industrial Internet of Things: Technologies and Research Directions*'. First Edition, CRC Press, 2022.
2. Jean-Marie Flaus, '*Cybersecurity of Industrial Systems*'. John Wiley & Sons, 2019.
3. Sravani Bhattacharjee, '*Practical Industrial Internet of Things Security: A practitioner's guide to securing connected Industries*'. Packet Publishing Ltd, 2018.
4. Ronald L and Krutz, '*Industrial Automation and Control System Security Principles'.* ISA, 2016.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the wireless network protocols, sensors, actuators, and communication systems in IIoT for effective data acquisition and monitoring in industrial environments.	**K2**
CO2	Examine the role of edge computing, IoT gateways, and cloud platforms in real-time monitoring and control of industrial processes.	**K4**
CO3	Develop a functional IIoT prototype or conduct a case study incorporating sensor networks, wireless protocols, and cloud-based data visualization.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3												
CO2		3											
CO3			2		2								
	3	**3**	**2**		**2**							**3**	**3**

1 – low, 2 – medium, 3 – high

25IC711 INDUSTRIAL AUTOMATION LABORATORY

0 0 4 2

LIST OF EXPERIMENTS:

1. Implementation of basic logic operations and interlocks using PLC
2. Implementation of timer operations using PLC
3. Implementation of counter operations using PLC
4. Study of Analog and Digital I/O interfacing in PLC
5. Implementation of actuator control using PLC
6. Implementation of sequential control using PLC sequencer function
7. Implementation of PLC programming for practical applications
8. Study of interfacing smart field devices with DCS
9. Development of control logic using DCS
10. On-line monitoring and control of a process using DC

Total P: 60 Periods

REFERENCES:

1. Frank D. Petruzella, ‘*Programmable Logic Controllers*’. Tata McGraw Hill, Fifth Edition, New York, 2017.
2. Department of Instrumentation and Control Systems Engineering, *‘Laboratory manual’*. PSG Institute of Technology and Applied Research, Neelambur, Coimbatore-641062, 2025.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Apply PLC programming techniques to implement logic operations, timers, counters, and actuator control for industrial automation systems.	**K3**
CO2	Analyze PLC-based systems by implementing sequential control, interlocks, and real-time industrial automation applications**.**	**K4**
CO3	Evaluate the performance and integration of automation systems involving PLC, analog or digital input-output interfacing, and smart field devices.	**K5**
CO4	Develop and implement DCS-based control strategies for process monitoring and control in industrial environments.	**K6**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3				3								3
CO2		3			3						3		3
CO3			2		2								2
CO4				2	2								2
	3	**3**	**2**	**2**	**3**						**3**		**3**

1 – low, 2 – medium, 3 - high

25IC712 INDUSTRIAL INTERNET OF THINGS LABORATORY

0 0 4 2

LIST OF EXPERIMENTS:

1. Study of IoT System and its components.
2. Wireless Sensor Networks using Zigbee.
3. Wireless Sensor Networks using LoRa.
4. Wireless Sensor Networks using Wi-Fi.
5. Communication between IoT devices through cloud using HTTP Protocol.
6. Communication between IoT devices through cloud using MQTT Protocol.
7. Closed loop control of a real - time system using cloud computing
8. Closed loop control of a real - time system using Fog Computing.
9. Closed loop control of a real - time system using Edge Computing.
10. Industrial IoT using PLC.

Total P: 60 Periods

REFERENCES:

1. ESP32-WROOM-32 Datasheet Version 2.5
2. STM 32 (Rev 18) Datasheet July 2020
3. CC3200 Launchpad datasheet revised March 2020
4. Department of Instrumentation and Control Systems Engineering, *'Laboratory Manual'*. 2023.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the working of wireless sensor networks using Zigbee, LoRa, and Wi-Fi, and outline basic communication with cloud platforms using protocols like HTTP and MQTT.	**K2**
CO2	Implement cloud-based computing systems to enable closed-loop control of real-time industrial processes.	**K3**
CO3	Compare the effectiveness of cloud, fog, and edge computing approaches for latency-sensitive industrial applications.	**K4**
CO4	Design and implement an industrial IoT solution by integrating sensors, controllers, communication protocols, and PLCs for real-time monitoring and control.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												2
CO3		3											
CO4			2		2								2
		3	**2**		**3**								**2**

1 – low, 2 – medium, 3 - high

25ICE05 PROJECT WORK I

0 0 4 2

- Define the objectives of the project
- Literature Survey
- Finalization of System Requirements and Specifications
- Development of software / Hardware Model
- Testing/Validating and obtaining Results
- Future Trends/Extension of the project
- Consolidated Report Preparation

Total P: 60 Periods

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand the prevailing engineering solutions and methodology adopted through literature review / field-survey and identify the project objectives and outcomes.	**K2**
CO2	Apply an appropriate design methodology, simulation tools, and experimental techniques for developing a hardware prototype / simulation model of the proposed system.	**K3**
CO3	Analyze the system performance with respect to feasibility of implementation, effectiveness and consistency with initial objectives on comparing with existing solutions.	**K4**
CO4	Justify the appropriateness of the proposed solution through validation, interpret results, and critically assess the outcomes against expected performance metrics and sustainability.	**K5**
CO5	Create the prototype hardware model with provisions for future enhancement and exhibit the project outcomes effectively through well-structured reports and presentations.	**K6**
CO6	Demonstrate teamwork, ethical responsibility, and project management skills in executing the project.	-

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				3								
CO3		3			3								
CO4			3		3								
CO5				3	3				3		3	3	3
CO6						3	3	3	3	3	3		
	3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1 – low, 2 – medium, 3 – high

25ICE06 INTERNSHIP – II

0 0 0 1

OBJECTIVES:

- To expose students to industrial practices and work culture
- To apply classroom concepts in real-time scenarios
- To enhance technical, communication, and teamwork skills
- To understand professional ethics and responsibilities
- To work under the guidance of an industry mentor
- To understand organizational structure and workflow
- To contribute Involvement in assigned tasks/projects
- To consolidated report preparation of the above

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Apply engineering knowledge in real-time industrial environments to perform assigned tasks under guidance, analyze and solve practical problems using appropriate tools, adapt to organizational work culture, demonstrate technical, teamwork, and communication skills, follow professional ethics, and document and present the work effectively while engaging in continuous learning.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3
	3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

SEMESTER – VIII

25ICE07 PROJECT WORK II

0 0 8 4

Students will do the following:

- Identification of project
- Define the objectives of the project
- Literature Survey
- Finalization of System Requirements and Specifications
- Development of software / Hardware Model
- Testing/Validating and obtaining Results
- Future Trends/Extension of the project
- Consolidated Report Preparation

Total P: 120 Periods

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand the prevailing engineering solutions and methodology adopted through literature review / field-survey and identify the project objectives and outcomes.	**K2**
CO2	Apply an appropriate technique or modern tools to design and develop the hardware or software components to solve the complex engineering problem.	**K3**
CO3	Analyze the system performance with respect to feasibility of implementation, effectiveness and consistency with initial objectives on comparing with the existing solutions.	**K4**
CO4	Justify the appropriateness of the proposed solution through validation, interpret results, and critically assess the outcomes against expected performance metrics and sustainability.	**K5**
CO5	Create the prototype hardware model with provisions for future enhancement and exhibit the project outcomes effectively through well-structured reports and presentations.	**K6**
CO6	Demonstrate teamwork, ethical responsibility, and project management skills in executing the project.	-

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				3								
CO3		3			3								
CO4			3		3								
CO5				3	3			3	3		3	3	3
CO6						3	3	3	3	3	3		
	3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1 – low, 2 – medium, 3 – high

PROFESSIONAL ELECTIVES
25ICP01 INDUSTRIAL ELECTRIC DRIVES

3 0 0 3

INTRODUCTION AND DYNAMICS OF ELECTRICAL DRIVES: Components of electric drives, Dynamics of motor-load systems: Torque-speed characteristics, stability of operating points, multi-quadrant operation. Load torque types (fan, hoist, constant power). Load equalization and heating/cooling dynamics. **(9)**

STARTING AND BRAKING METHODS: Starting, Braking, and Selection of three phase induction motor - Starting methods -star-delta, rotor resistance, soft starters-. Braking methods: Rheostatic, regenerative, and plugging. Drive selection factors and energy conservation. **(9)**

DC MOTOR DRIVES: Single-phase and three-phase converter-fed DC drives. Chopper-fed DC drives - speed control, ripple calculation- Closed-loop control structures -speed and current loops. **(9)**

AC MOTOR DRIVES -Induction Motor-Scalar control: Variable voltage, variable frequency (VVVF) control. Stator voltage control, Rotor resistance control. Vector control / Field-Oriented Control (FOC) of induction motor drives. Soft starters and variable frequency drives (VFDs). **(9)**

SYNCHRONOUS MOTOR DRIVES AND INDUSTRIAL APPLICATIONS: Self-controlled synchronous motor drives. Permanent Magnet Synchronous Motor (PMSM) and BLDC drives. Industrial applications: Paper mills, sugar mills, steel rolling mills, cranes, and hoists. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Gopal K. Dubey, '*Power Semiconductor Controlled Drives*'. Prentice Hall of India, 2000.
2. R. Krishnan, '*Electric Motor Drives Modeling Analysis and Control*'. Pearson India, 2025.

REFERENCES:

1. B. K. Bose, '*Modern Power Electronics and AC Drives*'. Pearson, India, 2015.
2. Gopal K. Dubey, '*Fundamentals of Electrical Drives*'. Alpha Science International, 2001.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Summarize working principles and Torque-speed characteristics of various drive systems including DC, induction, and synchronous motor	**K2**
CO2	Implement appropriate starting, braking, and speed control methods for different motor drives and operating conditions.	**K3**
CO3	Examine the performance of DC drives, induction motor drives and synchronous drives for industrial applications.	**K4**
CO4	Evaluate and justify the selection of suitable motor drives for various industrial applications	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				1								3
CO3		3			1								3
CO4			2		2								2
	3	**3**	**2**		**2**								**3**

1 – low, 2 – medium, 3 – high

25ICP02 PROCESS MODELLING AND SIMULATION

3 0 0 3

GENERAL PRINCIPLES OF MODELLING: Introduction to mathematical modeling; Advantages and limitations of models and applications of process models of stand-alone unit operations and unit processes; Classification of models: Linear vs Nonlinear, Lumped parameter vs. Distributed parameter; Static vs. Dynamic, Continuous vs. Discrete; Numerical Methods: Iterative convergence methods, Numerical integration of ODE- IVP and ODEBVP. **(9)**

MODELLING OF DISTRIBUTED PROCESSES: Steady state models giving rise to differential algebraic equation (DAE) systems; Rate based Approaches for staged processes; Modeling of differential contactors – distributed parameter models of packed beds; Packed bed reactors; Modeling of reactive separation processes; Review of solution strategies for Differential Algebraic Equations (DAEs), Partial Differential Equations (PDEs), and available numerical software libraries. **(9)**

INTRODUCTION TO PROCESS MODELLING: Concept of degree of freedom analysis: System and its subsystem, System interaction, Degree of freedom in a system e.g., Heat exchanger, Equilibrium still, Reversal of information flow, Design variable selection algorithm, Information flow through subsystems, Structural effects of design variable selection, Persistent Recycle. **(9)**

MODELLING OF INDUSTRIAL PROCESSES: Simple examples of process models; Models giving rise to nonlinear algebraic equation (NAE) systems, -steady state models of flash vessels, equilibrium staged processes distillation columns, absorbers, strippers, CSTR, heat exchangers, etc.; Review of solution procedures and available numerical software libraries. **(9)**

SIMULATION OF MATHEMATICAL MODELS: Simulation and their approaches, Modular, Sequential, Simultaneous and Equation solving approach, Simulation tools and their applications, Review of solution techniques and available numerical software libraries - Case Studies. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Luyben W. L., '*Process Modeling, Simulation, and Control for Chemical Engineering*'. 6th Edition, McGraw Hill, 2018.
2. Aris R, '*Mathematical Modeling, A Chemical Engineering Perspective (Process System Engineering)*'.1st
3. Edition, Academic Press, 1999.

REFERENCES:

1. K. Jana, '*Chemical Process Modelling and Computer Simulation'*. 3rd edition, PHI, 2018.
2. M. M. Denn, '*Process Modelling'*. Wiley, New York, 2nd Edition, 1986.
3. C. D. Holland, '*Fundamentals and modeling of separation processes: absorption, distillation, evaporation, and extraction'*. Prentice Hall, 1974.
4. Hussain Asghar, '*Chemical Process Simulation'*. Wiley Eastern Ltd., New Delhi, 1st Edition, 1986.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the concepts of mathematical modeling, model classifications, degree of freedom analysis, and numerical methods used in process systems engineering.	**K2**
CO2	Apply principles of mathematical modeling and numerical methods to formulate models of engineering and process systems.	**K3**
CO3	Analyze lumped and distributed parameter systems, and perform degree of freedom analysis to develop models of industrial processes.	**K4**
CO4	Evaluate and implement simulation strategies using appropriate numerical techniques and software tools for solving complex process models	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		2											2
CO4			2		2								1
	3	**2**	**2**		**2**								**3**

1 – low, 2 – medium, 3 – high

25ICP03 SYSTEM IDENTIFICATION

3 0 0 3

INTRODUCTION TO IDENTIFICATION AND MODELS: System Identification Procedure - Identifiability - Signal to Noise ratio - Overfitting - Models: Definition of a model, Classification of models - Models for discrete time linear time invariant Systems - Models for time varying systems and nonlinear systems. **(9)**

GOODNESS OF ESTIMATORS: Types of estimation problems - Fisher information, Bias, Variance, Efficiency, Sufficiency, Cramer Rao's inequality - Asymptotic bias, Mean square error, Consistency. **(9)**

ESTIMATION METHODS: Method of moments estimators - Least squares estimators - Nonlinear least squares - Maximum likelihood estimators - Bayesian estimators. **(9)**

IDENTIFICATION OF NON-PARAMETRIC AND PARAMETRIC INPUT – OUTPUT MODELS: Identification of Non- Parametric Input Output Models: - Impulse response estimation - Step response estimation - Estimation of frequency response function - Identification of Parametric Input Output Models: - Prediction error minimization (PEM) methods - Properties of the PEM estimator. **(9)**

STATISTICAL ELEMENTS OF MODEL BUILDING: Informative Data - Input design for identification – Data pre-processing - Model development. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Arun K Tangirala, *'Principles of System Identification: Theory and Practice'*. CRC Press, Boca Raton, 1st Edition, 2014.
2. Lennart Ljung, *'System Identification: Theory for the User'*. Prentice Hall, Englewood Cliffs, 2nd Edition, 1999.

REFERENCES:

1. Michel Verhaegen and Vincent Verdult, '*Filtering and System Identification: A Least Squares Approach*'. Cambridge University Press, 2007.
2. Johan Schoukens, Rik Pintelon and Yves Rolain, '*Mastering System Identification in 100 Exercises*'. Wiley-IEEE Press, 1st Edition, 2012.
3. Thomas Kailath, Ali H Sayed, Babak Hassibi, '*Linear Estimation*'. Pearson, 1st Edition, 2000.
4. Jer Nan Juang, '*Applied System Identification*'. Pearson, 1994.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the principles of system identification, model classifications, identifiability, signal characteristics, and dynamic system representations.	**K2**
CO2	Apply system identification procedures and model structures to represent discrete-time, time-varying, and nonlinear systems.	**K3**
CO3	Analyze the statistical properties of estimators and apply estimation techniques, such as least squares, maximum likelihood, and Bayesian methods, to identify system parameters.	**K4**
CO4	Develop input–output models using parametric and non-parametric identification methods, including data preprocessing, input design.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		2											3
CO4				2	2						2		1
	3	**2**		**2**	**2**						**2**		**3**

1 – low, 2 – medium, 3 - high

25ICP04 PIPING AND INSTRUMENTATION DIAGRAMS

3 0 0 3

INTRODUCTION TO P&ID AND SYMBOLS: Definition and importance of P&ID – Difference between Process Flow Diagram (PFD) and P&ID – Basic elements of P&ID – Standard symbols for equipment, piping, valves, and instruments – ISA standards – Tag numbering system – Line types and identification – Overview of industrial applications. **(9)**

INSTRUMENTATION AND CONTROL REPRESENTATION: Measurement of process variables – Representation of sensors, transmitters, controllers, and final control elements – Instrument bubbles and tagging – Signal transmission methods (pneumatic, electrical, digital) – Control loops and loop diagrams – Functional identification of instruments. **(9)**

VALVES, ACTUATORS, AND PROCESS EQUIPMENT: Types of valves (control valves, safety valves, relief valves)—Valve symbols and identification - Actuators and positioners – Pumps, compressors, heat exchangers, reactors, and storage tanks in P&ID – Equipment numbering and specification – Interfacing of equipment with instrumentation. **(9)**

DEVELOPMENT AND INTERPRETATION OF P&ID: Steps in developing P&ID: Reading and interpretation of industrial P&IDs– Flow paths and control strategies– Identification of process control loops – Safety systems and interlocks – Case studies of process industries (chemical, oil & gas, power plant). **(9)**

ADVANCED FEATURES AND APPLICATIONS: Computer-aided P&ID tools – Integration with SCADA/DCS systems – Hazard and operability (HAZOP) basics – P&ID for troubleshooting and maintenance – Documentation and revision control – Industrial standards and best practices. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Arun K. Datta, *‘Process Engineering and Design Using Visual Basic’*. Cambridge University Press, 2017.
2. Gavin S. K. Singh, ‘*Industrial Instrumentation and Control’*. McGraw-Hill, 2017.
3. William Bolton, *‘Instrumentation and Control Systems’*. Elsevier, 2021.

REFERENCES:

1. Liptak, B. G., *‘Instrument Engineers' Handbook, Volume I: Process Measurement and Analysis’*. 5th Edition, CRC Press, 2016.
2. Liptak, B. G., ‘*Instrument Engineers' Handbook, Volume II: Process Control and Optimization’*. 5th Edition, CRC Press, 2018.
3. Bausbacher, E. and Hunt, R., ‘*Process Plant Layout and Piping Design’*. 2nd Edition, Pearson Education, 2009.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Describe the fundamentals of Piping and Instrumentation Diagrams for process representation.	**K2**
CO2	Interpret piping and instrumentation diagrams to identify process equipment, instrumentation, control loops, and signal flow in industrial systems.	**K3**
CO3	Analyze the roles of valves, actuators, and control elements in process industries, and relate them to system operation and safety.	**K4**
CO4	Develop and evaluate P&IDs for simple industrial processes using standard practices and computer-aided tools.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		2											2
CO4			2		2						2		2
	3	**2**	**2**		**3**						**2**		**3**

1 – low, 2 – medium, 3 – high

25ICP05 GRAPHICAL SYSTEM DESIGN

3 0 0 3

INTRODUCTION: Graphical System Design (GSD) model, virtual instrumentation (VI) model, virtual instruments and traditional instruments, hardware and software in virtual instrumentation, virtual instrumentation for test, control and design, graphical programming and textual programming. **(9)**

VI PROGRAMMING TECHNIQUES: Software environment, modular programming, repetition and loops, arrays, clusters, structures, plotting data, strings and file I/O. **(9)**

DATA ACQUISITION: DAQ system, Signal conditioning, DAQ hardware configuration- analog I/O, digital I/O, counter/timer, DAQ software architecture, grounding technique. **(9)**

APPLICATION MODULES AND TOOLKITS: Machine vision, motion control, data logging and supervisory control, control design and simulation tools – control design tool, system identification and simulation interface tool. **(9)**

INTERFACE STANDARDS: Serial and Parallel communication, RS232, RS422, RS485, GPIB, Firewire, Communication protocol overview - Industrial Ethernet, CAN. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Jovitha Jerome, *'Virtual Instrumentation using LabVIEW'*. PHI Learning Pvt Ltd, New Delhi, 2010.
2. Steve Mackay, Edwin Wright, John Park, and Deon Reynders, *'Industrial Data Networks'*. Elsevier, Boston, 2004.

REFERENCES:

1. Gary Johnson and Richard Jennings, *'LabVIEW Graphical Programming'*. McGraw Hill Education, New Delhi, 4th Edition, 2013.
2. Sanjay Gupta and Joseph John, *'Virtual Instrumentation using LabVIEW: Principle and Practices of Graphical Programming'*. Tata McGraw-Hill Education, New Delhi, 2nd Edition, 2010.
3. William Buchanan, *'Computer Buses Design and Application'*. CRC Press, Boca Raton, 2000.
4. Clyde F Coombs, *'Electronic Instruments Handbook'*. McGraw Education, 3rd Edition, 1999.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the architecture of virtual instrumentation systems and graphical programming environments.	**K2**
CO2	Apply modular programming techniques to develop basic VI applications using arrays, loops, structures, and file I/O.	**K3**
CO3	Analyze the performance of virtual instrumentation systems, DAQ architectures, and communication protocols used in industrial automation and control applications.	**K4**
CO4	Simulate a simple P, PI and fault control system using control design tools and evaluate performance with different parameters.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				2							3	
CO3		3			2							2	
CO4			2		2							1	
	3	**3**	**2**		**2**							**3**	

1 – low, 2 – medium, 3 - high

25ICP06 SOFT COMPUTING TECHNIQUES

3 0 0 3

INTRODUCTION TO SOFT COMPUTING AND FUZZY LOGIC: Introduction - Fuzzy Logic - Fuzzy Sets, Fuzzy Membership Functions, Operations on Fuzzy Sets, Fuzzy Relations, Operations on Fuzzy Relations, Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems. **(9)**

NEURAL NETWORKS: Supervised Learning Neural Networks – Perceptrons - Backpropagation -Multilayer Perceptrons – Unsupervised Learning Neural Networks – Kohonen Self-Organizing Networks**.** **(9)**

GENETIC ALGORITHMS: Chromosome Encoding Schemes - Population initialization and selection methods - Evaluation function - Genetic operators- Crossover – Mutation - Fitness Function – Maximizing function. **(9)**

NEURO FUZZY MODELING: ANFIS architecture – hybrid learning – ANFIS as universal approximator – Coactive Neuro fuzzy modeling – Framework – Neuron functions for adaptive networks – Neuro fuzzy spectrum - Analysis of Adaptive Learning Capability. **(9)**

APPLICATIONS OF SOFT COMPUTING TECHNIQUES: Modeling a two input sine function - Printed Character Recognition – Fuzzy filtered neural networks – Plasma Spectrum Analysis – Handwritten neural recognition - Soft Computing for Color Recipe Prediction. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Timothy J.Ross, ‘*Fuzzy Logic with Engineering Applications*’. John Wiley & Sons, UK, 2010.
2. Simon Haykin, ‘*Neural Networks and Learning Machines’*. Prentice Hall, US, 2009.
3. Goldberg, D. E, ‘*Genetic algorithm in search, optimization and machine learning’*. Addison-Wesley, Reading Mass, 2002.

REFERENCES:

1. Suran Goonatilake, Sukhdev Khebbal, ‘*Intelligent hybrid systems’*. John Wiley & Sons, New York, 1995.
2. J.M. Zurada, ‘*Introduction to artificial neural systems’*. Jaico Publishing House, India, 2004.
3. H.J. Zimmermann, ‘*Fuzzy set theory and its applications’*. III Edition, Kluwer Academic Publishers, London, 2011.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Explain the principles of fuzzy logic, neural networks, genetic algorithms, and neuro-fuzzy systems used in intelligent computing applications.	**K2**
CO2	Apply soft computing techniques, including fuzzy logic, neural networks, and genetic algorithms to model and solve engineering problems.	**K3**
CO3	Analyze the structure and learning mechanisms of neural networks and neuro-fuzzy systems for pattern recognition and function approximation.	**K4**
CO4	Develop intelligent systems using soft computing approaches for real-world applications such as prediction, classification, and optimization.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				2						2		
CO3		2			2						2		
CO4				2	1						2		
	3	**3**		**2**	**2**						**2**		

1 – low, 2 – medium, 3 - high

25ICP07 FAULT DETECTION AND DIAGNOSIS

3 0 0 3

INTRODUCTION TO FAULT DETECTION AND DIAGNOSIS: Scope of FDD: Types of faults and different tasks of Fault Diagnosis and Implementation - Different approaches to FDD: Model free and Model based approaches. Classification of Fault and Disturbances- Different issues involved in FDD- Typical applications. **(9)**

ANALYTICAL REDUNDANCY CONCEPTS: Introduction- Mathematical representation of Fault and Disturbances: Additive and Multiplicative types – Residual Generation: Detection, Isolation, Computational and stability properties – Design of Residual generator – Residual specification and Implementation. **(9)**

DESIGN OF STRUCTURED RESIDUALS: Introduction- Residual structure of single fault Isolation: Structural and Canonical structures- Residual structure of multiple fault Isolation: Diagonal and Full Row canonical concepts – Introduction to parity equation implementation and alternative representation. **(9)**

DESIGN OF DIRECTIONAL RESIDUALS: Introduction – Directional Specifications: Directional specification with and without disturbances – Parity Equation Implementation – Linearly dependent column. **(9)**

ADVANCED LEVEL ISSUES AND DESIGN INVOLVED IN FDD: Introduction of Residual generation of parametric fault – Robustness Issues –Statistical Testing of Residual generators – Application of Neural and Fuzzy logic schemes in FDD – Case study. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Janos J. Gertler, '*Fault Detection and Diagnosis in Engineering Systems'*. Macel Dekker, 2nd Edition, 1998.
2. Rolf Isermann, '*Fault-Diagnosis Systems: An Introduction from Fault Detection to Fault Tolerance*'. Springer Verlag, 2011.

REFERENCES:

1. Sachin. C. Patwardhan, '*Fault Detection and Diagnosis in Industrial Process – Lecture Notes*'. IIT Bombay, February 2005.
2. Rami S. Mangoubi, '*Robust Estimation and Failure detection*'. Springer-Verlag-London 1998.
3. Steven X. Ding, '*Model based Fault Diagnosis Techniques: Schemes, Algorithms and Tools*'. Springer Publication, 2012.
4. Hassan Noura, Didier Theilliol, Jean-Christophe Ponsart, Abbas Chamseddine, '*Fault Tolerant Control Systems: Design and Practical Applications*'. Springer Publication, 2009.
5. Mogens Blanke, Michel Kinnaert, Jan Lunze, Marcel Staroswiecki., '*Diagnosis and Fault-Tolerant Control*'. Springer, 2016.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe fault detection and diagnosis methodologies, fault classifications, implementation challenges, and industrial applications of FDD systems.	**K2**
CO2	Apply model-based and model-free approaches to detect and classify faults in dynamic systems using analytical redundancy concepts.	**K3**
CO3	Analyze residual generators for fault detection and isolation using structured and directional residual techniques.	**K4**
CO4	Evaluate advanced fault diagnosis methods and intelligent techniques such as neural and fuzzy systems for real-world applications.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2											
CO4			1		1								1
	3	**2**	**1**		**1**								**1**

1 – low, 2 – medium, 3 - high

25ICP08 AUTOMOTIVE INSTRUMENTATION AND CONTROL

3 0 0 3

FUNDAMENTALS OVERVIEW: Diesel Engine, Drive Train - Transmission, Drive Shaft, Differential, Suspension, Brakes, Steering System, Operating principle: Motivation for Electronic Engine Control- Exhaust Emissions, Fuel Economy, Concept of an Electronic Engine control system, Definition of Engine performance terms, Effect of Air/Fuel ratio, spark timing and EGR on performance, Control Strategy, Electronic Fuel control system, Analysis of intake manifold pressure, Electronic Ignition. **(9)**

SENSORS AND ACTUATORS: Automotive Control System applications of Sensors and Actuators - Variables to be measured, Airflow rate sensor, Strain Gauge MAP sensor, Engine Crankshaft Angular Position Sensor, Magnetic Reluctance Position Sensor, Hall effect Position Sensor, Shielded Field Sensor, Optical Crankshaft Position Sensor, Throttle Angle Sensor (TAS), Engine Coolant Temperature (ECT) Sensor, Exhaust Gas Oxygen (02/EGO) Lambda Sensors, Piezoelectric Knock Sensor. Solenoid, Fuel Injector, EGR Actuator, Ignition System. **(9)**

ENGINE AND VEHICLE MOTION CONTROL: Digital Engine control features, Control modes for fuel Control (Seven Modes), EGR Control, Electronic Ignition Control -Closed loop Ignition timing, Spark Advance Correction Scheme, Integrated Engine Control System- Secondary Air Management, Evaporative Emissions Canister Purge, Automatic System Adjustment, System Diagnostics. Typical Cruise Control System, Digital Cruise Control System, Digital Speed Sensor, Throttle Actuator, Digital Cruise Control configuration, Cruise Control Electronics (Digital only), Antilock Brake System (ABS). **(9)**

AUTOMOTIVE NETWORKING: Bus Systems- Classification, Applications in the vehicle, Coupling of networks, Examples of networked vehicles, Buses - CAN Bus, UN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces. **(9)**

FUTURE AUTOMOTIVE ELECTRONIC SYSTEMS: Alternative Fuel Engines, Electric and Hybrid vehicles, Fuel cell powered cars, Collision Avoidance Radar warning Systems, Low tire pressure warning system, Heads Up display, Speech Synthesis, Navigation - Navigation Sensors - Radio Navigation, Signpost navigation, dead reckoning navigation, Voice Recognition Cell Phone dialling, Advanced Cruise Control, Stability Augmentation, Automatic driving Control. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. William B. Ribbens, '*Understanding Automotive Electronics*'. 6th Edition, Elsevier Publishing.
2. Robert Bosch GmbH (Ed.) '*Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive*'. 5th edition, John Wiley & Sons Inc., 2007.

REFERENCES:

1. Seiffert Ulrich W, '*Integrated Automotive Safety Handbook'*. SAE International, 2013.
2. James Halderman, '*Automotive Technology: Principles, Diagnosis, and Service'*. Pearson, 6th edition, 2021.
3. John Lowry, James Larminie, '*Electric Vehicle Technology Explained'*. Wiley, 2nd edition, 2012.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the fundamentals of automotive systems, engine management, electronic control strategies, sensors, actuators, and emission control mechanisms.	**K2**
CO2	Apply principles of electronic engine control systems, including fuel control, ignition, and emission control strategies, to analyze automotive system performance.	**K3**
CO3	Analyze the operation and integration of automotive sensors, actuators, and control systems for engine and vehicle motion control applications.	**K4**
CO4	Evaluate advanced automotive electronic systems including vehicle networking, safety systems, and emerging technologies such as electric and hybrid vehicles.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											2	
CO3		2											2
CO4			1										
	3	**2**	**1**									**2**	**2**

1 – low, 2 – medium, 3 – high

25ICP09 INSTRUMENTATION STANDARDS

3 0 0 3

STANDARDS ORGANIZATION: Standards: Introduction International and National Standards organization: IEC, ISO, NIST, IEEE, ISA, API, BIS, DIN, JISC and ANSI. API: Process Measurement and Instrumentation (APIRP551): recommended practice for installation of the instruments – flow, level, temperature, pressure - Process Instrument and Control (API RP554): performance requirements and considerations for the selection, specification, installation and testing of process instrumentation and control systems. **(9)**

ISA STANDARDS: Documentation of Measurement and Control, Instruments and System (ISA 5): 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7 - General Requirements for Electrical Equipment in Hazardous Location (ISA 12): 12.2, 12.4, 12.24, 12.29 – Instrument Specification Forms (ISA20): – Measurement Transducers (ISA37). **(9)**

ISA STANDARDS - CONTROL VALVE AND ACTUATOR: Control Valve Standards (ISA75): 75.01, 75.04, 75.05, 75.7, 75.11, 75.13, 75.14, 75.23, 75.24, 75.26. Valve Actuator (ISA 96): 96.01, 96.02, 96.03, 96.04. **(9)**

ISA STANDARDS - FOSSIL AND NUCLEAR POWER PLANTS: Fossil Power Plant Standards (ISA 77): 77.14, 77.22, 77.30, 77.41, 77.42, 77.44, 77.60, 77.70. Nuclear Power Plant Standards (ISA67): 67.01, 67.02, 67.03,67.04, 67.06. **(9)**

BS, ISO, IEC, AND ANSI: Measurement of Fluid Flow by means of Orifice Plates (ISO 5167/ BSI042) IEC 61131-3 – Programmable Controller – Programming Languages – Specification for Industrial Platinum Resistance Thermometer Sensors (BSI904) – International Thermocouple Reference Tables (BS4937) – Temperature Measurement Thermocouple (ANSIC96.1). **(9)**

TOTAL L: 45 Periods

TEXT BOOKS:

1. API Recommended Practice 551, *'Process Measurement Instrumentation'*. American Petroleum Institute, Washington, D.C., Second Edition, May 2001.
2. API Recommended Practice 554, *'Process Instrumentation and Control – 3 parts'*. American Petroleum Institute, Washington, D.C., First Edition, October 2008.

REFERENCES:

1. ISA standard 5, *'Documentation of Measurement and Control Instruments and Systems'*. ISA, North Carolina, USA.
2. ISA standard 12, *'Electrical Equipment for Hazardous Locations'*. ISA, North Carolina, USA.
3. ISA standard 20, *'Instrument Specification Forms'*. ISA, North Carolina, USA.
4. ISA standard 37, *'Measurement Transducers'*. ISA, North Carolina, USA.
5. ISA standard 75, *'Control Valve Standards'*. ISA, North Carolina, USA.
6. ISA standard 96, *'Valve Actuator'*. ISA, North Carolina, USA.
7. ISA standard 77, *'Fossil Power Plant Standards'*. ISA, North Carolina, USA.
8. ISA standard 67, *'Nuclear Power Plant Standards'*. ISA, North Carolina, USA.
9. BS EN 60584-1, *'Thermocouples - EMF specifications and tolerances*. British Standard, 2013.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the roles, hierarchies, and functions of international and national standard organizations (ISO, IEC, NIST, ANSI, ISA) and their impact on global industrial interoperability.	**K2**
CO2	Apply the recommended practices of API RP551 and RP554 for the selection, specification, and installation of process instruments (flow, level, pressure, and temperature) in industrial environments.	**K3**
CO3	Analyse technical documentation and instrumentation symbols in accordance with ISA 5, and evaluate electrical equipment requirements for hazardous locations in accordance with ISA 12.	**K4**
CO4	Design instrumentation and control solutions for control valves and actuators by applying ISA 75 and ISA 96 standards to ensure reliable, safe, and efficient process operation.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		2											2
CO4				1	1						1		1
	3	2		1	1						1		3

1 – low, 2 – medium, 3 - high

25ICP10 FIBER OPTICS AND LASER INSTRUMENTATION

3 0 0 3

OPTICAL FIBERS AND THEIR PROPERTIES: Characteristics of optical radiation, luminescence - Fiber materials and their characteristics - Principles of light propagation through a fiber - Types of optical fibers - Properties - Transmission characteristics - Absorption losses - Scattering losses - Dispersion - Fibers splicing, connector and couplers – Optocouplers – Optrodes. **(9)**

OPTICAL SOURCES AND DETECTORS: LED – LED power and efficiency - Structures, planar, dome, ELED, SLED, super luminescent LEDS, characteristics and applications - General characteristics of photodetectors - Photodiode - Junction photodiodes - Heterojunction diode and PIN diode - APD - Special detectors –Schottky barrier diode - Photo-transistor and photo-thyristor -Solar cells. **(9)**

INDUSTRIAL APPLICATION OF OPTICAL FIBERS: Fiber optic sensors - Fiber optic instrumentation system- Application in instrumentation: interferometric method of measurement of length - Moiré fringes - Measurement of pressure, temperature, current, voltage, liquid level and strain - Fiber optic gyroscope - Cavity dumping – Polarization maintaining fibers. **(9)**

LASER FUNDAMENTALS: Characteristics of lasers – Three level and four level lasers – Properties of laser - Laser modes-Resonator configuration –Q switching and mode locking – Cavity dumping – Types of lasers: gas lasers, solid lasers, liquid lasers, semiconductor lasers. **(9)**

INDUSTRIAL APPLICATIONS OF LASER: Laser for measurement of distance, length, velocity, acceleration, current, voltage and atmospheric effect - Material processing: laser heating, welding, melting, scribing, splicing and trimming of materials, removal and vaporization - Hologram: Principle of holography – Methods and holographic components - Holographic interferometry and applications, holography for non-destructive testing - Medical applications of lasers: laser and tissue interaction – Laser instruments for brain surgery, plastic surgery and oncology. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. John M Senior, *‘Optical Fiber Communication: Principles and Practice’*. Prentice Hall, 2010.
2. Khare R P, *‘Fibre Optics and Optoelectronics’*. Oxford Press, 1st Edition, 2004.

REFERENCES:

1. Wilson, Hawkes J F B, *‘Introduction to Opto Electronics’*. Prentice Hall of India, 2001.
2. Nambiar K R, *‘Laser: Principles, Types and Applications’*. New Age International, 2010.
3. S.C. Gupta, *‘Opto Electronic Devices and Systems’*. Prentice Hall of India, 2010.
4. Donald A, Sterling Jr, *‘Technicians Guide to Fiber Optics’*. Vikas Publishing House, 2009.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Describe how light travels in optical fibers, the properties of fiber materials, and how lasers work, including their types, modes, and basic control methods like Q-switching and mode locking	**K2**
CO2	Apply knowledge of optical sources, detectors and laser systems in industrial measurements and material processing applications.	**K3**
CO3	Analyze and evaluate the use of fiber optic and laser-based systems in industrial and medical applications, using case studies and recent developments.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											3	
CO3		2									1	2	
	3	**2**									**1**	**3**	

1 – low, 2 – medium, 3 - high

25ICP11 NANOSCIENCE AND INSTRUMENTATION

3 0 0 3

FUNDAMENTALS OF NANOSCIENCE: Definition and scope of nanoscience and nanotechnology, classification of nanomaterials, quantum dots, nanowires, nanotubes, ultra-thin films, multilayered materials, effect of length scales on mechanical, electrical, thermal, optical and magnetic properties, overview of applications across physics, chemistry, biology, and engineering. **(9)**

SYNTHESIS TECHNIQUES FOR NANOMATERIALS: Top-down and bottom-up approaches, mechanical milling, ultrasonication, co-precipitation, sol-gel methods, colloidal synthesis, self-assembly, vapor phase deposition techniques: MOCVD, sputtering, evaporation, molecular beam epitaxy (MBE), atomic layer epitaxy, metal-organic molecular beam epitaxy (MOMBE). **(9)**

FUNCTIONAL NANOMATERIALS AND THEIR APPLICATIONS: Nanoforms of carbon: fullerenes, graphene, carbon nanotubes (SWCNT, MWCNT) – synthesis and properties, metal oxide nanomaterials: ZnO, TiO_2, MgO, ZrO_2, NiO, CaO, nanoalumina, ferrites, nanoclays – functionalization and applications, quantum dots and quantum wires – synthesis, properties, applications. **(9)**

CHARACTERIZATION TECHNIQUES IN NANOSCIENCE: X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), high-resolution TEM (HRTEM), atomic force microscopy (AFM), scanning tunneling microscopy (STM), scanning near-field optical microscopy (SNOM), surface analysis techniques: SPM, ESCA, SIMS, Nano indentation. **(9)**

NANO INSTRUMENTATION AND APPLICATIONS: Nano instrumentation in medical diagnostics, bioimaging, drug delivery, nanosensors, MEMS and NEMS technologies, nanoelectronics: nanocrystals, molecular switches, nano computers, super chips, applications in photostat, printing, solar cells, batteries, antibacterial coatings, and cosmetic products. **(9)**

TOTAL L: 45 Periods

TEXT BOOKS:

1. A.K. Bandyopadhyay, *'Nanomaterials'*. New Age International Publishers, 2007.
2. T. Pradeep, *'A Textbook of Nanoscience and Nanotechnology'*. Tata McGraw Hill, 2012.

REFERENCES:

1. Charles P. Poole Jr. and Frank J. Owens, *'Introduction to Nanotechnology'*. Wiley India, 2007.
2. M.S. Ramachandra Rao and Shubra Singh, *'Nanoscience and Nanotechnology: Fundamentals to Frontiers'*. Wiley India, 2015.
3. G. Cao and Y. Wang, *'Nanostructures and Nanomaterials: Synthesis, Properties, and Applications'*. 2nd ed., World Scientific, 2011.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental principles of nanoscience, including the classification of nanomaterials and the effect of length scales on mechanical, electrical, and optical properties.	**K2**
CO2	Apply various top-down and bottom-up synthesis techniques, such as vapor phase deposition (MOCVD/MBE) and chemical methods, to produce specific functional nanomaterials.	**K3**
CO3	Analyze the structural and morphological characteristics of nano-dimensional samples using advanced instrumentation like XRD, SEM, TEM, and Atomic Force Microscopy (AFM).	**K4**
CO4	Perform case studies as a team on the evaluation of the performance and suitability of different nano-forms (Carbon nanotubes, Quantum dots, Metal oxides) for specific industrial and medical applications.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											3	
CO3		2										2	
CO4											1	1	
	3	**2**									**1**	**3**	

1 – low, 2 – medium, 3 – high

25ICP12 VIRTUAL INSTRUMENTATION

3 0 0 3

INTRODUCTION: Building front panel and block diagram, tools and palettes, VI and Sub VI, Editing and Debugging VI. **(9)**

LABVIEW PROGRAMMING: Controlling program flow – Loops, structures, shift registers, local and global variables, data types- Numeric, digital, strings, arrays, clusters, waveform, data presentation elements, graphs and charts. **(9)**

ANALYSIS AND FILTERING TOOLS: Time and frequency domain analysis – digital filter - FFT spectrum - Power spectrum - Windowing and filtering tools. **(9)**

CONCEPT OF DATA ACQUISITION: Generation of signals, analog I/O and digital I/O signal acquisition-different types of data acquisition system – study of DAQ card. **(9)**

DAQ INTERFACING: Interfacing of DAQ system with LabVIEW, Building VIs for analog read and write, digital read and write. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Jovitha Jerome, *'Virtual Instrumentation using LabVIEW'*. PHI Learning Pvt Ltd, New Delhi, 2010.
2. Steve Mackay, Edwin Wright, John Park, and Deon Reynders, *'Industrial Data Networks'*. Elsevier, Boston, 2004.

REFERENCES:

1. Wells Lisa K and Travis Jeffrey, *'LabVIEW for everyone'*. Prentice Hall (1997).
2. Gupta S and Gupta J P, *'PC Interfacing for data acquisition of process control'*. Instrument Society of America (1994).
3. Wells LK, *'LabVIEW for everyone – Graphical Programming made even easier'*. Prentice Hall, 2011.
4. Gupta S and Joseph J, *'Virtual Instrumentation using LabVIEW'*. Tata McGraw Hill, 2005.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the fundamentals of LabVIEW programming, including front panel, block diagram, tools, palettes, Virtual Instruments (VI), SubVIs, and debugging techniques.	**K2**
CO2	Apply time and frequency domain analysis tools such as FFT, power spectrum, digital filters, and windowing techniques using LabVIEW for signal analysis.	**K3**
CO3	Analyse and develop LabVIEW-based applications by interfacing DAQ systems for real-time analog and digital input/output operations and evaluate system performance.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				2								3
CO3		3			2								3
	3	**3**			**2**								**3**

1 – low, 2 – medium, 3 - high

25ICP13 SAFETY INSTRUMENTED SYSTEMS

3 0 0 3

INSTRUMENTATION STANDARDS: Significance of codes and standards – Overview of various types of codes and standards - Introduction of various instrumentation standards – review, interpretation and significance of specific standards - Examples: Usage of standards on specific applications. **(9)**

INTRODUCTION TO SAFETY INSTRUMENTATION: Hazards and Risk – Process Hazards Analysis (PHA) – Safety Life Cycle - Allocation of safety functions to protective layers - SIS design and engineering. **(9)**

PROTECTION LAYERS: Process plant design- Process control system-Alarm Systems-Physical protection. Mitigation layers: - Containment system - Scrubbers and flares - Fire and gas systems - Evacuation procedure. **(9)**

SAFETY INTEGRITY LEVEL: SIL determination methods - ALARP - Risk matrix - Risk graph - LOPA - Examples for design of SIL. **(9)**

SELECTION OF TECHNOLOGY: Relay systems - Solid-state systems - Microprocessor-based systems - PLC-based systems - Safety PLCs - Safety system complexity - Communication with other systems. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Paul Gruhn, Harry Cheddie, *'Safety Instrumented Systems: Design, Analysis, and Justification'*. ISA, 2nd Edition, 2006.
2. Glisente Landrini, Basilio Abbamonte, Tino Vandecapelle, *'Safety Instrumented System'*. GM International, 5th Edition, 2017.

REFERENCES:

1. W.M.Goble, Harry Cheddie, *'Safety Instrumented Systems Verification: Practical Probabilistic Calculations'*. ISA, 2005.
2. Lawrence D.Goettsche , *'Maintenance of Instruments and Systems'*. ISA, 2nd Edition, 2005.
3. Swapan Basu, *'Safety Instrumentation Systems'*. Academic Press, 2017.
4. Bela G. Liptak, *'Instrument Engineers' Handbook'*. CRC Press, 4th Edition, 2003.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental concepts of the safety lifecycle, risk reduction, and the regulatory standards (IEC 61511) governing industrial safety.	**K2**
CO2	Apply mathematical techniques and logic configurations to determine the Probability of Failure on Demand for diverse SIS architectures.	**K3**
CO3	Analyze process hazards and existing protection layers to identify potential safety gaps using techniques like HAZOP and LOPA.	**K4**
CO4	Design Safety Instrumented Systems by selecting suitable hardware, safety PLCs, communication interfaces, and protection strategies to ensure safe and reliable process operation.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											3	3
CO3		1											
CO4			1								1		
	3	**1**	**1**								**1**	**3**	**3**

1 – low, 2 – medium, 3 - high

25ICP14 THERMAL POWER PLANT INSTRUMENTATION

3 0 0 3

ENERGY RESOURCES AND GENERATION TECHNIQUES: Brief survey of methods of power generation: hydro, thermal, nuclear, solar and wind power-Importance of instrumentation in power generation – thermal power plants: building blocks, details of boiler processes, P&I diagram of boiler – cogeneration. **(9)**

ELECTRICAL MEASUREMENTS: Current, voltage, power, frequency, and power factor – non-electrical parameters: flow of feed water, fuel, air, and steam pressure and steam temperature – smoke density measurement – Flue gas oxygen analyzer – pollution monitoring instruments. **(9)**

FURNACE CONTROL: Coal handling: Pulverizers - Furnace Draught: natural draught, forced draught, induced draught, power requirements for draught systems - Combustion control: Fuel/Air ratio, combustion efficiency, excess air, parallel and cross limited combustion control- soot-blowing operation. **(9)**

BOILER CONTROL: Boiler metal temperature measurement, pressure measuring devices – Boiler feed water processing and control - drum level measurement methods - steam temperature control: main steam and reheat steam temperature control, superheater control, deaerator control – distributed control system in power plants – interlocks in boiler operation. **(9)**

TURBINE CONTROL: Speed measurement, rotor and casing movement- vibration - shell temperature monitoring and control - steam pressure control - lubricant oil temperature - cooling system. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. S. G. Dukelow, '*The Control of Boilers*'. 2nd ed. Research Triangle Park, NC, USA: ISA, 2006.
2. R. K. Rajput, '*Power Plant Instrumentation and Control Engineering*'. New Delhi, India: S. Chand, 2009.

REFERENCES:

1. K. Krishnaswamy and M. P. Bala, '*Power Plant Instrumentation*'. New Delhi, India: PHI Learning, 2011.
2. C. R. Jones, '*Instrument Engineers'. Handbook, Vol. 1: Process Measurement and Analysis*, 4th ed. Boca Raton, FL, USA: CRC Press, 2003.
3. B. G. Lipták, '*Process Control and Optimization'*. 4th ed. Boca Raton, FL, USA: CRC Press, 2006.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain various methods of power generation and describe the role of instrumentation in thermal power plants, including key subsystems like boilers and turbines.	**K2**
CO2	Apply appropriate measurement techniques for electrical and non-electrical parameters used in power plant operations and pollution monitoring.	**K3**
CO3	Analyze control systems used in furnace operation, combustion, boiler regulation, and turbine monitoring for safe and efficient power generation.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3										2	2	
CO3		3									1		3
	3	**3**									**2**	**2**	**3**

1 – low, 2 – medium, 3 - high

25ICP15 INSTRUMENTATION IN OIL AND GAS INDUSTRY

3 0 0 3

INTRODUCTION TO OIL AND GAS INSTRUMENTATION: Basics of process control in oil and gas production, overview of instrumentation systems, industrial applications and regulatory environment. **(9)**

INSTRUMENTATION DEVICES AND SIGNAL PROCESSING: Sensors and transducers specific to oil and gas, signal conditioning and data acquisition systems, analytical instruments and techniques. **(9)**

CONTROL AND AUTOMATION SYSTEMS IN OIL AND GAS: PID control and advanced control strategies, distributed control systems (DCS) in oil and gas, programmable logic controllers (PLC) in oil and gas applications. **(9)**

CALIBRATION, MAINTENANCE, AND SAFETY STANDARDS: Calibration procedures and techniques, preventive maintenance and troubleshooting, best practices for instrumentation maintenance, safety instrumented systems (SIS), compliance with industry standards, hazard and risk analysis. **(9)**

EMERGING TRENDS IN OIL AND GAS INSTRUMENTATION: Digital transformation in oil and gas, Industrial Internet of Things (IIoT), advances in analytical instrumentation. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. W. C. Lyons and Gary J. Plisga, *'Standard Handbook of Petroleum and Natural Gas Engineering'*. 3rd ed., Gulf Professional Publishing, 2011.
2. Bela G. Liptak, *'Instrument Engineers Handbook: Process Measurement and Analysis'*. 4th ed., CRC Press, 2003.

REFERENCES:

1. Kim Faith, *'Process Control for the Oil & Gas Industry'*. PennWell Corp., 2014.
2. Idaho National Laboratory, *'Instrumentation and Control for the Chemical, Oil, and Gas Industries'*. INL Report, 2015.
3. John G. Webster and Halit Eren, *'Measurement, Instrumentation, and Sensors Handbook'*. 2nd ed., CRC Press, 2014.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamentals of process control and the role of instrumentation in oil and gas production, identify recent technological trends like IIoT and digital transformation impacting oil and gas instrumentation.	**K2**
CO2	Select and use appropriate sensors, signal conditioning methods, and analytical instruments used in oil and gas facilities.	**K3**
CO3	Analyze the operation and integration of PLC, DCS, and control strategies for automation in oil and gas systems.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3										2	3	
CO3		3											3
	3	**3**									**2**	**3**	**3**

1 – low, 2 – medium, 3 - high

25ICP16 INSTRUMENTATION FOR NUCLEAR POWER PLANT

3 0 0 3

NUCLEAR POWER PLANT OVERVIEW AND INSTRUMENTATION NEEDS: Basics of nuclear energy, types of nuclear reactors, reactor components and layout, role of instrumentation in nuclear power plants, reactor coolant system overview, sensor requirements in nuclear environments. **(9)**

THERMAL AND FLUID MEASUREMENTS IN NUCLEAR SYSTEM: Temperature measurement in reactor cores and steam systems, pressure measurement under high-radiation conditions, flow measurement of coolant and feedwater, level sensors in pressurizers and steam generators, instrumentation for Rankine and Brayton cycle analysis. **(9)**

RADIATION MONITORING AND SAFETY INSTRUMENTATION: Types of radiation and detection principles, radiation detectors (GM counters, ionization chambers, scintillation detectors), area and personnel monitoring systems, containment pressurization instrumentation, reactor protection system instrumentation. **(9)**

CONTROL SYSTEMS IN NUCLEAR POWER PLANTS: Reactor control instrumentation, control rod positioning systems, power output monitoring and control, automated control loops for steam generation, instrumentation in pressurizer and heat exchangers, distributed control systems (DCS) in nuclear applications. **(9)**

ELECTRICAL INSTRUMENTATION, GRID INTERFACE AND STANDARDS: Instrumentation forelectrical load, power, frequency, and power factor monitoring, electrical protection systems, grid synchronization instrumentation, standards and guidelines from IAEA and national regulatory bodies, instrumentation reliability and calibration in nuclear systems. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. N. E. Todreas and M. S. Kazimi, *'Nuclear Systems Vol. I: Thermal Hydraulic Fundamentals'*. 2nd ed. CRC Press, 2012.
2. R. L. Murray and K. E. Holbert, *'Nuclear Energy'*. 7th ed., Elsevier, 2015.

REFERENCES:

1. J. R. Lamarsh and A. J. Baratta, '*Introduction to Nuclear Engineering*'. 3rd ed., Pearson, 2014.
2. C. E. Brennen, *'An Introduction to Nuclear Power Generation*'. Dankat Publishing, 2013.
3. International Atomic Energy Agency, '*Technical Reports on I&C Systems for NPPs*'. IAEA, Vienna.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the layout, types of reactors, and the role of instrumentation in various systems of a nuclear power plant.	**K2**
CO2	Select suitable instruments to measure temperature, pressure, flow, and level in high-radiation thermal and fluid systems of nuclear plants, and implement control strategies in nuclear power plants for reactor operation, steam generation, and automation using DCS.	**K3**
CO3	Examine radiation detection systems and assess safety instrumentation used for reactor protection and containment monitoring.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											3	
CO3		3											3
	3	**3**										**3**	**3**

1 – low, 2 – medium, 3 - high

25ICP17 ADVANCED TOPICS IN PID CONTROL

3 0 0 3

INTRODUCTION: Evolution of PID controller – PID Controller Structures – PID Implementation Issues – Tuning of PID Controller using Classical Approaches. **(9)**

PID CONTROLLER DESIGN: PID Controller Design Techniques: Pole placement, Lamda Tuning, Direct Synthesis, Gain Margin & Phase Margin and Optimization methods - Auto-Tuning. **(9)**

PID STABILIZATION: Stabilization of Linear Time-invariant Plants using P/PI/ PID controllers – Optimal Design using PID Controllers – Robust and Non-fragile PID Controller Design. **(9)**

ADAPTIVE/NON-LINEAR PID CONTROL SCHEMES: Gain Scheduled PID Controller - Self-tuning PI/PID Controller – PID Types Fuzzy Logic Controller – Predictive PID Control. **(9)**

INTRODUCTION TO FRACTIONAL ORDER SYSTEM AND FRACTIONAL ORDER PID CONTROLLER: Fractional-order Calculus and Its Computations – Frequency and Time Domain Analysis of Fractional-Order Systems – Filter Approximations to Fractional-Order Differentiations -Model reduction Techniques for Fractional Order Systems – Fractional Order PI/PID Controller Design. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Karl J. Astrom and Tore Haggland, *'Advanced PID Control'*. ISA Publications, 2005.
2. Aniruddha Datta, Ming-Tzu Ho, and Shankar P. Bhattacharyya, *'Structure and Synthesis of PID Controllers'*. Advances in Industrial Control, Springer Verlag London, 2000.

REFERENCES:

1. Antonio Visioli, *'Practical PID Control'*. Springer- Verlag London, 2006
2. Aidan O' Dwyer, *'Handbook of PI and PID Controller Tuning Rules'*. Imperial College Press, 2009
3. Xue, D., Chen, Y.Q., and Atherton, D.P., *'Linear Feedback Control Analysis and Design with MATLAB, Advances in Design and Control'*. Society for Industrial and Applied Mathematics, 2008.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the fundamental principles and historical development of PID controllers, including their structures, implementation issues, and classical tuning methods.	**K2**
CO2	Apply advanced PID controller design techniques like pole placement, lambda tuning, and optimization to design, stabilize, and optimize linear time-invariant process control systems using robust and non-fragile PID methods	**K3**
CO3	Analyze the fractional-order PID controllers using fractional-order calculus, frequency/time domain analysis, and model reduction techniques to improve control performance in advanced systems.	**K4**
CO4	Design and implement adaptive and nonlinear PID control schemes, including gain-scheduled, self-tuning, fuzzy logic-based, and predictive PID control systems.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		2											2
CO4			2		2								2
	3	**2**	**2**		**2**								**3**

1 – low, 2 – medium, 3 - high

25ICP18 COMPUTER CONTROL OF PROCESSES

3 0 0 3

DISCRETE STATE-VARIABLE TECHNIQUE: State equation of discrete time system with sample and hold – State transition equation – Methods of computing the state transition matrix – Decomposition of discrete time transfer functions – State diagram representations of Discrete time systems - Controllability and observability of linear time invariant discrete time system – Stability tests of discrete time system – State Observer. **(9)**

System identification: Non-Parametric methods: Transient analysis – Frequency analysis – correlation analysis – Spectral analysis – Parametric methods: Least square method – Recursive least square method – Neural network-based identification. **(9)**

Digital controller design: Review of z-transform – Modified of z-transform – Pulse transfer function – Digital PID controller – Dead-beat controller, Dahlin's controller and Kalman's approach – Smith Predictor – Digital Feed-forward controller – Internal Model Controller. **(9)**

Multi-loop regulatory control: Multi-loop Control - Introduction – Process Interaction – Pairing of Inputs and Outputs - The Relative Gain Array (RGA) – Properties and Application of RGA - Multi-loop PID Controller – Biggest Log Modulus Tuning Method - Decoupling Control. **(9)**

Multi-variable regulatory control: Introduction to Multivariable control – Multivariable PID Controller – Multivariable Internal Model Controller – Multivariable Dynamic Matrix Controller – Generalized Predictive Controller. Case Studies: - Computer control of a thermal process. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Gopal, M., *'Digital Control and State Variable Methods'*. Tata McGraw-Hill, 2003.
2. Deshpande P.B. & Ash R.H, *'Computer Process Control'*. ISA publication, USA 1995.

REFERENCES:

1. Dale E. Seborg, Duncan A. Mellichamp, Thomas F. Edgar, *'Process Dynamics and Control'*. Wiley John and Sons, 3rd Edition, 2010.
2. Sigurd Skogestad, Ian Postlethwaite, '*Multivariable Feedback Control: Analysis and Design*'. John Wiley and Sons, 2005.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts of discrete-time state space modeling, system identification methods, digital controllers, and multivariable control systems.	**K2**
CO2	Apply system identification and digital control techniques for the analysis and design of discrete-time and multivariable process control systems.	**K3**
CO3	Analyze the stability, controllability, observability, and performance of digital, multi-loop, and multivariable control systems using advanced control strategies.	**K4**
CO4	Design and implementation of digital PID, feed-forward, internal model, and multivariable controllers for process control applications.	**K5**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												3
CO3		3											3
CO4			2		2								2
	3	**3**	**2**		**2**								**3**

1 – low, 2 – medium, 3 - high

25ICP19 BUILDING AUTOMATION

3 0 0 3

INTRODUCTION TO BUILDING AUTOMATION SYSTEMS: Concept of Building Automation System (BAS) – Role of instrumentation and control – Architecture of BAS – Centralized and distributed control – Comparison with industrial automation – Overview of HVAC, lighting and safety systems – Basic components of BAS. **(9)**

INSTRUMENTATION IN BUILDING SYSTEMS: Measurement of temperature, humidity, pressure, flow and occupancy – Sensor selection and characteristics – Signal conditioning and transmitters – Actuators: control valves, dampers, VFDs – Instrumentation in HVAC and lighting systems. **(9)**

CONTROL SYSTEMS IN BUILDINGS: Control objectives – ON/OFF and PID control – Direct Digital Control (DDC) – Control of HVAC systems (temperature and airflow control) – Lighting control strategies– Basic optimization techniques. **(9)**

COMMUNICATION AND INTEGRATION: Introduction to building communication systems – BACnet, Modbus (concept only) – Basics of fieldbus – Integration with SCADA systems – Data acquisition and monitoring – Overview of IoT in building automation. **(9)**

ENERGY MANAGEMENT AND SAFETY SYSTEMS: Energy management systems (EMS) – Energy efficiency and auditing (basic concepts) – Fire alarm systems – Access control and surveillance – Introduction to green buildings and sustainability – Case studies (brief). **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Shengwei Wang, '*Intelligent Buildings and Building Automation*'. Routledge, 1st Edition.
2. William C. Dunn, '*Fundamentals of Industrial Instrumentation and Process Control*'. McGraw-Hill, 2nd Edition.

REFERENCES:

1. James Sinopoli, '*Smart Building Systems for Architects, Owners and Builders*'. Butterworth-Heinemann.
2. H. Michael Newman, '*BACnet: The Global Standard for Building Automation and Control Networks*'. Momentum Press.
3. ASHRAE, '*Guidelines on HVAC and Building Control Systems*'. ASHRAE Publications

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the architecture and components of building automation systems, including instrumentation and control elements	**K2**
CO2	Apply knowledge of sensors, actuators, and signal conditioning techniques for measurement and control in building automation systems.	**K3**
CO3	Analyze control strategies for efficient operation of HVAC and building systems.	**K4**
CO4	Develop and evaluate building automation solutions using communication protocols, SCADA integration, and energy management concepts.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		2											2
CO4			2		2	1					2		2
	3	**2**	**2**		**2**	**1**					**2**		**3**

1 – low, 2 – medium, 3 - high

25ICP20 HYDRAULICS AND PNEUMATICS

3 0 0 3

INTRODUCTION TO FLUID POWER SYSTEM: Need for automation- Advantages and applications of automation-Basics of hydraulic and pneumatic systems- General types of fluids – Applications of Pascals Law-Properties of air Kinetic theory of gases – Boyle's Law - Laminar and Turbulent flow- Comparison between hydraulic and pneumatic systems-Fluid power transmission principles. **(9)**

HYDRAULIC AND PNEUMATIC ELEMENTS: Hydraulic pumps and motor gears, vane, piston pumps-motors-selection and specification- pump performance – Variable displacement pumps. Drive characteristics – Compressors – Filter, Regulator, Lubricator Unit – Air control valves -Linear actuator – Single acting, Double acting special cylinders like tanden, Rodless, Telescopic, Cushioning mechanism, Construction of double acting cylinder, Limited rotation motor, mounting details, power packs – construction. Reservoir, accumulators – standard circuit symbols. **(9)**

CONTROL AND REGULATING ELEMENTS: Direction flow and pressure control valves- Directional control valve – 3/2-way valve – 4/2-way valve – 5/2-way valve. Shuttle valve – check valve. Pressure control valve – Simple and compound relief valve, pressure reducing valve, sequence valve, counter balance valve. Flow control valve Fixed and adjustable- Methods of actuation, electro hydraulic servo valves. **(9)**

CONTROL CIRCUITS: Speed control circuits, synchronizing circuit, Penumo hydraulic circuit, fail safe circuit, Sequential circuit design for simple applications using cascade method, step counter method. Electrical control of pneumatic and hydraulic circuits-use of relays, timers, counters, Ladder diagram. Programmable logic control of Hydraulics Pneumatics circuits, PLC wiring diagram for various circuits. **(9)**

INDUSTRIAL APPLICATIONS: Role of PLC in Industry 4.0 application, Application of PLC based Industrial automation, Application of Pneumatic, Hydraulic circuits in Industrial automation. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Anthony Esposito, *'Fluid Power with Applications'*. Prentice-Hall, 2009.
2. Parr, A., '*Hydraulics and Pneumatics: A Technician's and Engineer's Guide*'. 3rd Edition, Elsevier/Butterworth-Heinemann, 2011.

REFERENCES:

1. W. Bolton, Mechatronics, *'Electronic control systems in Mechanical and Electrical Engineering'*. Pearson Education, 2011.
2. James L. Johnson, *'Introduction to Fluid Power*'. Delmar Thomson Learning Publishers 2003.

COURSE OUTCOMES

At the end of the course, students will be able to:		Bloom's Level
CO1	Explain the construction, working and control strategies of different industrial drives and valves.	**K2**
CO2	Apply the principles of hydraulic and pneumatic components for the selection, operation, and control of fluid power systems in automation applications.	**K3**
CO3	Analyze fluid power control circuits, electro-hydraulic systems, and PLC-based control strategies for industrial process automation	**K4**
CO4	Design hydraulic, pneumatic, and PLC-integrated automation systems for industrial applications, incorporating modern Industry 4.0 concepts and technologies.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		2											2
CO4			1		1						1		1
	3	**2**	**1**		**1**						**1**		**3**

1 – low, 2 – medium, 3 - high

25ICP21 FAULT TOLERANT CONTROL

3 0 0 3

INTRODUCTION AND ANALYTICAL REDUNDANCY CONCEPTS: Introduction – Types of faults and different tasks of Fault Diagnosis and Implementation – Different approaches to FDD: Model free and Model based approaches– Introduction- Mathematical representation of Faults and Disturbances: Additive and Multiplicative types– Residual Generation: Detection, Isolation, Computational and stability properties – Design of Residual generator – Residual specification and Implementation. **(9)**

DESIGN OF STRUCTURED RESIDUALS & DIRECTIONAL STRUCTURED RESIDUALS: Introduction – Residual structure of single fault Isolation: Structural and Canonical structures – Residual structure of multiple fault Isolation: Diagonal and Full Row canonical concepts – Introduction to parity equation implementation and alternative representation –Directional Specifications: Directional specification with and without disturbances–Parity Equation Implementation. **(9)**

FAULT DIAGNOSIS USING STATE ESTIMATORS: Introduction – State Observer – State Estimators – Norms based residual evaluation and threshold computation – Statistical methods based residual evaluation and threshold settings: Generalized Likelihood Ratio Approach – Marginalized Likelihood Ratio Approach. **(9)**

FAULT TOLERANT CONTROL: Introduction – Passive Fault-tolerant Control- Active Fault tolerant Control – Actuator and Sensor Fault tolerance Principles – Compensation for actuator – Sensor Fault-tolerant Control Design – Fault-tolerant Control Architecture – Fault-tolerant Control design against major actuator failures. **(9)**

CASE STUDIES: Fault tolerant Control of Three-tank System – Diagnosis and Fault-tolerant control of chemical process – supervision of steam generator – Different types of faults in Control valves – Automatic detection, quantification and compensation of valve stiction. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Rolf Isermann, '*Fault-Diagnosis Systems an Introduction from Fault Detection to Fault Tolerance*'. Springer Verlag, 2006.
2. Ding, S. X., '*Model-Based Fault Diagnosis Techniques: Design Schemes, Algorithms and Tools*'. 2nd Edition, Springer, London, 2013.
3. Hassan Noura, Didier Theilliol, Jean-Christophe Ponsart, Abbas Chamseddine, *'Fault- Tolerant Control Systems: Design and Practical Applications*'. Springer Publication, 2009.

REFERENCES:

1. Janos J. Gertler, *'Fault Detection and Diagnosis in Engineering Systems'*. 2nd Edition, Marcel Dekker, 1998.
2. Mogens Blanke, *'Diagnosis and Fault-Tolerant Control'*. Springer, 2006.
3. Ali Ahammad Shoukat Choudhury, Sirish L. Shah, Nina F. Thornhill, *'Diagnosis of Process Nonlinearities and Valve Stiction: Data Driven Approaches'*. Springer, 2008.Tools, Springer Publication, 2012.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe and classify faults in dynamic systems, and understand the role of fault diagnosis in maintaining system reliability.	**K2**
CO2	Apply structured and directional residual design techniques for fault detection and isolation in engineering processes.	**K3**
CO3	Analyze observer-based and statistical fault diagnosis methods to evaluate system health and identify faults in dynamic systems.	**K4**
CO4	Design fault-tolerant control architectures with fault accommodation and compensation mechanisms to maintain system performance and safety under fault conditions.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		2											2
CO4			2								1		1
	3	**2**	**2**								**1**		**3**

1 – low, 2 – medium, 3 – high

25ICP22 ROBOTICS AND AUTOMATION

3 0 0 3

INTRODUCTION TO ROBOTICS AND AUTOMATION: Automation - need-types, basic elements of an automated system, levels of automation computer process control, forms of computer process control Definition of robot -Types of robots -Robot anatomy- Degrees of freedom (DOF)-Robot joints and links-Robot configurations. **(9)**

ROBOTIC KINEMATICS: Representation of position and orientation of body-transformation of rigid body-homogenous transformation- the manipulator kinematics- d-h parameters, 2r and 3r mechanism d-h analysis-forward and inverse kinematics. **(9)**

ACTUATORS AND FEEDBACK SYSTEM: Actuators- pneumatic-hydraulic actuators, electric & stepper motors, comparison, position sensors – potentiometers- resolvers- encoders – velocity sensors-tactile sensors proximity sensors, robot applications in manufacturing. **(9)**

AUTOMATION AND CONTROL: Industrial Automation Architecture – Motion Control Systems – PID Control – CNC Automation – Flexible Manufacturing Systems (FMS) – Industrial Communication Networks – Robot Control Techniques – Trajectory Planning – Smart Manufacturing Applications. **(9)**

ROBOTICS AND AUTOMATION APPLICATIONS: AI-enabled robots -Robotics in Industry 4.0, Robot Process Automation in Manufacturing system-PLC based Industrial Application. **(9)**

Total: L: 45 Periods

TEXT BOOKS:

1. Robotics: Control Sensing, K. S. Fu., R. C. Gonzalez, C.S.G. Lee, *'Vision and Intelligence Indian Edition'.*
2. McGraw Hill Book Co., 2008.
3. Coiffet, P., & Chirouze, M., '*An introduction to robot technology'*. Springer Science & Business Media. 2012.

REFERENCES:

1. Ashitava Ghosal, '*Robotics: Fundamental Concepts and Analysis'*. Oxford University Press India, 2006.
2. John J. Craig, '*Introduction to Robotics: Mechanics and Control'*. Pearson Education, 2018.
3. Ghosal, A, '*Mikell Robotics: fundamental concepts and analysis'*. Oxford University Press, 2006.
4. https://nptel.ac.in/courses/108105063.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the principles of automation, robot structures, configurations, degrees of freedom, and kinematic concepts used in robotic systems.	**K2**
CO2	Apply kinematic modeling, actuator technologies, and sensor systems for the analysis and operation of robotic manipulators.	**K3**
CO3	Analyze robot control techniques, motion control systems, industrial communication networks, and automation architectures for manufacturing applications.	**K4**
CO4	Design intelligent robotic and automation solutions incorporating Industry 4.0 technologies, AI-enabled robots, and smart manufacturing concepts.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2											
CO4			1										
	3	**2**	**1**										

1 – low, 2 – medium, 3 – high

25EEP03 INTERNET OF THINGS (IoT) AND ITS APPLICATIONS
(Common to EEE and ICE)

3 0 0 3

INTRODUCTION TO INTERNET OF THINGS: Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT Models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT. **(9)**

COMPONENTS IN INTERNET OF THINGS: Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee, Wifi, GPS, GSM Modules). **(9)**

PROTOCOLS AND TECHNOLOGIES BEHIND IoT: IoT Protocols - IPv6, 6LoWPAN, MQTT, CoAP - RFID, Wireless Sensor Networks, Big Data Analytics, Cloud Computing, Embedded Systems. **(9)**

OPEN PLATFORMS AND PROGRAMMING: IoT deployment for Raspberry Pi /Arduino platform-Architecture – Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud. **(9)**

IoT APPLICATIONS: Business models for the internet of things, Smart city, Smart mobility and transport, Industrial IoT, Smart health, Environment monitoring and surveillance – Home Automation – Smart Agriculture.

(9)

Total: L: 45 Periods

TEXT BOOKS:

1. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, '*IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things*'. CISCO Press, 2017
2. Samuel Greengard, '*The Internet of Things*'. The MIT Press, 2015

REFERENCES:

1. Perry Lea, '*Internet of Things for Architects*'. Packt, 2018
2. Olivier Hersent, David Boswarthick, Omar Elloumi, '*The Internet of Things – Key applications and Protocols*'. Wiley, 2012
3. David Etter, '*IOT (Internet of Things) Programming: A Simple and Fast Way of Learning*'. IOT Kindle Edition. 2016.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the operation of sensors, actuators, communication modules, and IoT communication protocols.	**K2**
CO2	Apply various protocols, device discovery and cloud services in resource constraint network for IoT applications.	**K3**
CO3	Analyse the various IoT architectural components in real-time application.	**K4**
CO4	Develop IoT solutions for smart city, healthcare, industrial, environmental monitoring, home automation, and agricultural applications.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		3											3
CO4			2		2	2	2	1	1		2		1
	3	**3**	**2**		**2**	**2**	**2**	**1**	**1**		**2**		**3**

1 – low, 2 – medium, 3 – high

25EEP36 CYBER SECURITY

3 0 0 3

FUNDAMENTALS OF CYBER SECURITY: Introduction to Cyber Security – Importance and Challenges – CIA Triad (Confidentiality, Integrity, Availability) – Threats, Vulnerabilities and Attacks – Types of Attackers – Risk Assessment and Management – Cyber Security in Critical Infrastructure – Overview of Security Policies and Standards – Cyber Hygiene Practices. **(9)**

CRYPTOGRAPHY AND SECURE COMMUNICATION: Basics of Cryptography – Symmetric and Asymmetric Encryption – Public Key Infrastructure (PKI) – Hash Functions and Digital Signatures – Key Management Techniques – Secure Communication Protocols – SSL/TLS Basics – Authentication and Authorization Methods. **(9)**

NETWORK SECURITY AND INDUSTRIAL SYSTEMS: Network Fundamentals – Network Vulnerabilities – Types of Attacks (DoS, MITM, Spoofing) – Firewalls – Intrusion Detection and Prevention Systems (IDS/IPS) – Wireless Network Security – Industrial Communication Protocols – SCADA Systems – Security Issues in Industrial Control Systems (ICS). **(9)**

EMBEDDED SYSTEMS AND HARDWARE SECURITY: CMOS circuit families- Static CMOS -Ratioed circuits-Pseudo nMOS - Cascode voltage switch Logic-Dynamic circuits; Domino Introduction to Embedded System Security – Hardware Vulnerabilities – Side Channel Attacks – Secure Boot Techniques – Trusted Hardware – IoT Security Fundamentals – Firmware Security – Device Authentication and Access Control. **(9)**

ETHICAL HACKING, FORENSICS AND CYBER LAWS: Ethical Hacking Concepts – Penetration Testing – Malware (Virus, Worms, Trojans) – Digital Forensics – Incident Response and Recovery – Cyber Laws and Regulations – IT Act – Ethical and Legal Issues in Cyber Security – Risk Management Strategies. **(9)**

Total: L: 45 Periods

TEXT BOOKS:

1. William Stallings, Lawrie Brown, ‘*Computer Security: Principles and Practice’*. *Pearson*, 2023.
2. Charles P. Pfleeger, Shari Lawrence P fleeger, Jonathan Margulies, ‘*Security in Computing’*. *Pearson*, 2022.
3. Behrouz A. Forouzan, Debdeep Mukhopadhyay, ‘*Cryptography and Network Security’*. *McGraw-Hill*, 2021.
4. Anurag K. Srivastava, ‘*Cyber Infrastructure for the Smart Electric Grid’*. Springer, 2016.

REFERENCES:

1. Bruce Schneier, ‘*Applied Cryptography: Protocols, Algorithms, and Source Code in C’*. *Wiley*, 2015.
2. Nina Godbole, Sunit Belapure, ‘*Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives*’. *Wiley India*, 2019.
3. William Stallings, ‘*Cryptography and Network Security: Principles and Practice’*. *Pearson*, 2022.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Explain fundamental cybersecurity concepts and threats	**K1**
CO2	Apply cryptographic techniques for secure communication	**K2**
CO3	Analyze vulnerabilities in networks and industrial systems	**K3**
CO4	Implement ethical hacking concepts and manage cyber risks	**K4**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		2											
CO4				1	1	1	1						
	3	**2**		**1**	**1**	**1**	**1**						

1 – low, 2 – medium, 3 - high

25EEP07 DIGITAL IMAGE PROCESSING

3 0 0 3

DIGITAL IMAGE FUNDAMENTALS & IMAGE TRANSFORMS: Introduction – Elements of visual perception – Image Sensing and Acquisition – Image sampling and Quantization – Basic relationships between pixels -Image Transforms: DFT – properties –DWT – properties. **(9)**

IMAGE ENHANCEMENT: Intensity transformation functions – Histogram processing – Spatial filtering: Correlation and convolution – Smoothing filters – Sharpening filters, Frequency Domain: Introduction to Fourier Transform–Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement. **(9)**

IMAGE RESTORATION: Noise models – Restoration in the presence of noise only: spatial filtering – Linear, position-invariant degradation – estimating the degradation function – Inverse filtering – Wiener filtering. **(9)**

IMAGE SEGMENTATION: Point detection- line detection - Edge detection - Thresholding - Region based segmentation: Region growing by pixel aggregation – Region splitting and merging – Morphological processing-erosion and dilation, Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm. **(9)**

IMAGE COMPRESSION: Image compression model – Redundancy-Lossless compression – Run-length coding – Huffman coding – Lossy compression – predictive coding – JPEG standards of Image Compression. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Gonzalez R.C, Woods R.E, '*Digital Image Processing*'. 4th Edition, Pearson, New Delhi, 2018.
2. Jayaraman S, Esakkirajan S, Veerakumar T, '*Digital Image Processing*'. Tata McGraw Hill, New Delhi, 2015.

REFERENCES:

1. Jain A.K, '*Fundamentals of Digital Image Processing*'. Prentice Hall of India, New Delhi, 2019.
2. Sridhar S, '*Digital Image Processing*'. Oxford University Press, New Delhi, 2013.
3. William K Pratt, '*Digital Image Processing*'. 4th Edition, Wiley India, New Delhi, 2011.
4. Munesh Chandra Trivedi, '*Digital Image Processing*'. 1st Edition, Khanna Publishing, New Delhi, 2014.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the fundamental concepts of digital image processing.	**K2**
CO2	Apply the knowledge of image enhancement, image restoration and image segmentation techniques for both grayscale and colour images.	**K3**
CO3	Analyze the performance of different image processing techniques	**K4**
CO4	Simulate the basic concepts of image processing techniques using MATLAB.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											3	
CO3		2										2	
CO4					1							1	
	3	**2**			**1**							**3**	

1 – low, 2 – medium, 3 - high

25ICP23 MICRO ELECTRO MECHANICAL SYSTEMS

3 0 0 3

INTRODUCTION: Intrinsic Characteristics of Micro systems – Macro and micro-Sensors and Actuators –Scaling laws- Silicon and polymer-based MEMS processes and MEMS Materials. **(9)**

MICROMACHINING: Bulk Micromachining - Surface micromachining, LIGA processes and Polymer MEMS fabrication process. **(9)**

SENSORS AND ACTUATORS – I: Electrostatic sensors – Parallel plate capacitors – Applications – Micro motors – Inter digitated Finger capacitor – Comb drive devices – Thermal Sensing and Actuation – Thermal expansion– Thermal couples – Thermal resistors – Applications – Microfluidics for sensing and actuation applications. **(9)**

SENSORS AND ACTUATORS – II: Piezo resistive sensors – Piezo resistive sensor materials - Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and Flow sensors, Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials. **(9)**

APPLICATIONS: Application to Acceleration, Pressure, Flow, Chemical, Inertial sensors - Optical MEMS – Bio MEMS – RF MEMS – Energy Harvesting. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Tai Ran Hsu, *'MEMS and Micro systems Design and Manufacture'*. Tata McGraw Hill, New Delhi, 2006.
2. Stephen D Senturia, *'Micro system Design'*. Springer International Edition, 2006.
3. Chang Liu, *'Foundations of MEMS'*. Pearson Education, 2012.

REFERENCES:

1. Gregory T. Kovacs, *'Micro machined Transducers Source Book'.* McGraw-Hill High Education, 1998.
2. M.H. Bao, *'Micromechanical Transducers: Pressure sensors, Accelerometers and Gyroscopes'*. Elsevier, New York, 2000.
3. Tai Ran Hsu, *'MEMS & Micro Systems Design, Manufacture and Nanoscale Engineering'*. John Wiley, New Jersy, 2008.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe various micromachining and microfabrication techniques, and explain the working principles of different micro sensors and actuators.	**K2**
CO2	Apply the concepts of MEMS to design the sensors and actuators.	**K3**
CO3	Identify the right MEMS device against the applications and design MEMS devices for given applications.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		1											
	3	**1**											

1 – low, 2 – medium, 3 - high

25EEP35 VLSI DESIGN TECHNIQUES

3 0 0 3

OVERVIEW OF VLSI DESIGN AND BASIC ELECTRICAL PROPERTIES OF CMOS CIRCUITS: VLSI design process - Architectural design - Logical design - Physical design - Layout styles – Full-custom – Semi-custom approaches- Basic Electrical Properties of CMOS Circuits **:** MOS Transistor – Threshold voltage - Pass transistor
- Transmission gate - Basic DC equations - Second order effects - MOS modules - Small signal AC characteristics - CMOS inverter - DC characteristics -Inverter delay – Power consumption in CMOS gates – Static dissipation Dynamic dissipation. **(10)**

VLSI FABRICATION TECHNIQUES: An overview of wafer fabrication - Wafer processing - Oxidation - Patterning- Diffusion - Ion implantation - Deposition - CMOS processes – Nwell - Pwell - Twintub - Silicon on Insulator – CMOS process enhancements - Interconnect - Circuit elements - Latchup - Latchup prevention techniques. **(8)**

LAYOUT DESIGN RULES & PARAMETERS ESTIMATION: Layer representations - Stick diagrams- CMOS design style - Design rules - Need for design rules - Mead Conway design rules - CMOS n-well / p-well lambda-based design rules - Simple layout examples. Sheet resistance - Resistance estimation - Capacitance estimation - Driving large capacitive loads. **(8)**

CMOS CIRCUIT FAMILIES: COMBINATIONAL AND SEQUENTIAL LOGIC DESIGN: CMOS circuit families- Static CMOS -Ratioed circuits- Pseudo nMOS - Cascade voltage switch Logic-Dynamic circuits; Domino Logic-Pass transistor circuits- CMOS Transmission gates-Structured design - Simple combinational logic design examples - Parity generator – Multiplexers. Sequential logic design**:** Clocked sequential circuits –Single phase clocking -Max-delay Constraints- Min-delay Constraints -Two-phase clocking - Charge storage - clock skew-Clocked CMOS (C2MOS) - Logic-CMOS Dynamic register element -Dynamic shift register – Semi-static register – CMOS Latches-D- flip-flop**.** **(10)**

SUBSYSTEM DESIGN PROCESS: General arrangement of a 4-bit arithmetic processor - Design of a 4-bit shifter - Design of an ALU subsystem - Implementation of ALU functions with an adder - Carry look ahead adder – Multipliers – Serial-parallel multipliers - Pipelined multiplier array – Design for testability. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Douglas A Pucknell, and Kamran Eshraghian, *'Basic VLSI design'*. Prentice Hall of India, New Delhi, 2015.
2. Neil H E Weste, David Harris, 'CMOS VLSI design: Circuits and System Perspective'. Pearson Education, New Delhi, 2015.

REFERENCES:

1. Jan M Rabaey, Chandrakasan A, Nikolic B, *'Digital Integrated Circuits'*. PHI Learning, NewDelhi, 2013.
2. Amar Mukherjee, '*Introduction to nMOS and CMOS VLSI System Design'*. Prentice Hall, New Jersey, 1986.
3. Wayne Wolf, *'Modern VLSI Design: Systems on Chip Design'*. Pearson Education, New Delhi, 2008.
4. John P. Uyemura, *'Chip Design for Submicron VLSI Design: CMOS Layout and Simulation'*. Cengage Learning, New Delhi, 2010.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the VLSI design process, CMOS circuit properties, and fabrication techniques.	**K2**
CO2	Implement static and dynamic technique-based CMOS logic circuits for digital systems.	**K3**
CO3	Design basic VLSI subsystems (e.g., ALU, shifters, adders) using structured design methods.	**K3**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	**3**												
CO3			**2**		**2**								
	3		**2**		**2**								

1 – low, 2 – medium, 3 - high

25ICP24 REAL TIME EMBEDDED SYSTEMS

3 0 0 3

INTRODUCTION TO EMBEDDED COMPUTING AND ARM PROCESSORS: Complex systems and microprocessors – Embedded system design process – Formalism for system design– Design example: Model train controller- ARM Processor Fundamentals Instruction Set and Programming using ARM Processor. **(9)**

COMPUTING PLATFORM: CPU: Programming input and output – Supervisor mode, exception and traps – Coprocessor – Memory system mechanism – CPU performance – CPU power consumption- CPU buses – Memory devices – I/O devices – Component interfacing- System Level Performance Analysis Parallelism. Design Example: Data Compressor. **(9)**

PROGRAM DESIGN AND ANALYSIS: Program design – Model of programs – Assembly and Linking – Basic compilation techniques – Program Optimization- Analysis and optimization of execution time, power, energy, program size – Program validation and testing- Example: Software Modem. **(9)**

PROCESS AND OPERATING SYSTEMS: Multiple tasks and Multi processes – Processes – Context Switching – Operating Systems – Priority based Scheduling- RMS and EDF - Inter Process Communication mechanisms – Evaluating operating system performance – Power optimization strategies for processes. **(9)**

HARDWARE ACCELERATORS & NETWORKS: Multiprocessors- CPUs and Accelerators – Performance Analysis-Distributed Embedded Architecture – Networks for Embedded Systems: - I2C, CAN Bus, Ethernet, Myrinet – Network based design – Internet enabled systems. Design Example: Elevator Controller. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Wayne Wolf, '*Computers as Components - Principles of Embedded Computing System Design'*. Morgan Kaufmann Publisher (An imprint of Elsevier), 3rd Edition, 2008.
2. Andrew N Sloss, Dominic Symes, Chris Wright, *'ARM System Developer 's Guide- Designing and Optimizing System Software'*. Elsevier/Morgan Kaufmann Publisher, 2008

REFERENCES:

1. David E-Simon, *'An Embedded Software Prime'*. Pearson Education,2010.
2. Tammy Noergaard, 'Embedded Systems Architecture'. Elsevier,2006.
3. Jane.W.S.Liu ,'Real-Time Systems'. Pearson Education Asia,2011.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe fundamentals of ARM processor, computing platform, program design and analysis, process and operating systems, networks and communication protocols.	**K2**
CO2	Apply the knowledge of scheduling algorithm to optimize the performance of processor.	**K3**
CO3	Analyze and optimize the system level performance for real time applications	**K4**
CO4	Design and develop ARM processor-based systems	**K6**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		3											
CO4				2	2								
	3	**3**		**2**	**2**								

1 – low, 2 – medium, 3 – high

25EEP34 DATA ANALYTICS

3 0 0 3

INTRODUCTION: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – data preparation - Exploratory Data analysis – build the model – presenting findings and building applications - Data Mining - Data Warehousing – Basic statistical descriptions of Data. **(9)**

DATA MANIPULATION: Python Shell - Jupyter Notebook - IPython Magic Commands - NumPy Arrays- Universal Functions – Aggregations – Computation on Arrays – Fancy Indexing – Sorting arrays – Structured data – Data manipulation with Pandas – Data Indexing and Selection – Handling missing data – Hierarchical indexing – Combining datasets – Aggregation and Grouping – String operations – Working with time series – High performance. **(9)**

MACHINE LEARNING: The modeling process - Types of machine learning - Supervised learning - Unsupervised learning - Semi-supervised learning- Classification, regression - Clustering – Outliers and Outlier Analysis. **(9)**

DATA VISUALIZATION: Importing Matplotlib – Simple line plots – Simple scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three-dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn. **(9)**

HANDLING LARGE DATA: Problems - techniques for handling large volumes of data - programming tips for dealing with large data sets- Case studies: Predicting malicious URLs, building a recommender system - Tools and techniques needed - Research question - Data preparation - Model building – Presentation and automation. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, '*Introducing Data Science*'. Manning Publications, 2016.
2. Jake VanderPlas, '*Python Data Science Handbook*'. O'Reilly, 2016.
3. Juuso Koponen, Jonatan Hildén, '*Data Visualization Handbook*'. Aalto University Publication, 2019.

REFERENCES:

1. Allen B. Downey, '*Think Stats: Exploratory Data Analysis in Python*'. Green Tea Press, 2014.
2. Kieran Healy, '*Data Visualization: A Practical Introduction'*. Princeton University Press, 2018.
3. Cole Nussbaumer Knaflic, '*Storytelling with Data: A Data Visualization Guide for Business* Professionals'. John Wiley, 2015.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain fundamental principles of information visualization, human perception, and to interpret and communicate data effectively through visual representations.	**K2**
CO2	Estimate statistical functions or parameters by selecting and implementing appropriate computational statistics techniques	**K3**
CO3	Analyze a given problem/ large data set by comparing the computational statistics technique using their performance parameters	**K4**
CO4	Design and implement data analysis on datasets using R and Python programming.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2			2								
	2	**2**			**2**								

1 – low, 2 – medium, 3 - high

25ICP25 INDUSTRY 4.0

3 0 0 3

INTRODUCTION: Evolution of Industry 1.0 to 4.0 – Purpose and transformation - System architecture of I4.0-Networking Topology – IoT Data Management and Computing. **(9)**

SMART OBJECTS IN IIOT NETWORK: Smart sensors and transducers – Discrete and data output – Edge control devices – Industry Communication protocols – Ethernet IP, Profinet, Ethercat, Modbus, CAN bus – Applications - networking Adapters. **(9)**

TYPES OF AUTOMATION AND ELEMENTS OF I4.0-IIOT: M2M – RFID - WSN – SCADA – Purpose – Applications/use cases in manufacturing and process industry – Automotive component manufacturing and assembly line automation – Shop floor to top floor - Oil and Gas industry – Introduction to Smart city and their elements. **(9)**

DATA ANALYTICS: Seamless data connectivity –Data logging, analysis and decisions. Big Data Handling in I4.0 Environment – Introduction to SPC: Statistical Process Control and SQC: Statistical Quality Control in I4.0 – Application. **(9)**

OUTCOME OF INDUSTRY 4.0: Seamless Data connectivity – History – Collaborative automation – Quality improvement – Productivity – Original Equipment Effectiveness OEE- improvement with cost analysis of automatic inspection system in an automotive industry. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, *'IoT Fundamentals'*. CIscopress, 2020.
2. Honbo Zhou, *'The Internet of Things in cloud*'. CRC Press, 2025.

REFERENCES:

1. https://ieeexplore.ieee.org/abstract/document/9285283: ' *Industrial Artificial Intelligence in Industry 4.0 - Systematic Review, Challenges and Outlook'*.
2. https://www.academia.edu/108767367:Industry 4.0: *'The New Quality Management Paradigm in Era of Industrial Internet of Things'*.
3. Sudip Mishra, Chandana Roy, and Anandarup Mukherjee, *'Introduction to Industrial Internet of Things and Industry 4.0*', CRC Press, 2020.
4. Sam Goundar, J. Avanija, Gurram Sunitha, K. Reddy Madhavi, S. Bharath Bhushan '*Innovations in the Industrial Internet of Things (IIoT) and Smart Factory'*. IGI Global 2021.
5. Brojo Kishore Mishra, Sandipan Mallik, Dac-Nhuong Le, '*Smart Sensors for Industry 4.0'*. Wiley 2024.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the evolution, architecture, networking topology, data management concepts, and enabling technologies of Industry 4.0 and IIoT.	**K2**
CO2	Apply knowledge of smart sensors, edge devices, and industrial communication protocols in designing IIoT-based automation systems.	**K3**
CO3	Analyze the role of big data, seamless connectivity, and statistical quality control in improving industrial decision-making in I4.0 environments.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3										3		
CO3		2									2		
	3	**2**									**3**		

1 – low, 2 – medium, 3 - high

25ICP26 MACHINE LEARNING AND DEEP LEARNING

3 0 0 3

FOUNDATIONS OF MACHINE LEARNING: Introduction to Machine Learning – Types of Learning – Performance Measures – Bias–Variance Tradeoff – Linear Regression – Bayes Decision Theory – Normal Density and Discriminant Functions – Bayes Decision Theory with Binary Features – Bayesian Belief Networks. **(9)**

CLASSIFICATION AND DENSITY ESTIMATION: Parametric and Non-Parametric Density Estimation – Maximum Likelihood and Bayesian Estimation – Parzen Window – K-Nearest Neighbour (KNN) – Perceptron Criteria – Discriminative Models – Support Vector Machines (SVM) – Logistic Regression – Decision Trees – Hidden Markov Model (HMM). **(9)**

CLUSTERING AND ENSEMBLE LEARNING: Ensemble Methods – Ensemble Strategies – Boosting and Bagging – Random Forest – Dimensionality Problem – Principal Component Analysis (PCA) – Linear Discriminant Analysis (LDA) – Mixture Models – Gaussian Mixture Model – Expectation Maximization Algorithm – K-Means Clustering – Fuzzy K-Means Clustering – Hierarchical Agglomerative Clustering – Mean Shift Clustering. **(9)**

NEURAL NETWORKS AND DEEP LEARNING FUNDAMENTALS: Artificial Neural Networks – Perceptron – Multilayer Neural Networks – Backpropagation Algorithm – Radial Basis Function (RBF) Neural Networks – Introduction to Deep Learning – Convolutional Neural Networks (CNN) – Vanishing and Exploding Gradients – Deep Learning Architectures: LeNet-5, AlexNet, VGGNet, GoogleNet and ResNet – Applications. **(9)**

ADVANCED DEEP LEARNING MODELS AND APPLICATIONS: Generative Adversarial Networks (GAN) – Auto Encoders and Relation to PCA – Recurrent Neural Networks (RNN) – U-Net Architecture – Deep Learning Applications and Case Studies in Image Processing, Natural Language Processing and Industrial Automation. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Ethem Alpaydin, *'Introduction to Machine Learning'*. Prentice Hall (India), 2015.
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, *'Deep Learning'*. MIT Press, 2016.

REFERENCES:

1. R. O. Duda, P. E. Hart and D. G. Stork, *'Pattern Classification'*. Wiley India, 2007.
2. C. M. Bishop, *'Pattern Recognition and Machine Learning'*. Springer, 2006.
3. S. O. Haykin, *'Neural Networks and Learning Machines'*. Pearson Education (India), 2016.
4. Michael A. Nielsen, *'Neural Networks and Deep Learning'*. Determination Press, 2015.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental concepts, probabilistic models and classification techniques used in Machine Learning.	**K2**
CO2	Apply machine learning algorithms for regression, classification, clustering and dimensionality reduction problems.	**K3**
CO3	Analyze ensemble learning methods, neural networks and deep learning architectures for solving real-world applications.	**K4**
CO4	Design and implement deep learning models for industrial and intelligent automation applications.	**K5**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3				3								
CO3		2			2								
CO4			1		1								
	3	**2**	**1**		**3**								

1 – low, 2 – medium, 3 - high

25ICP27 MULTI SENSOR DATA FUSION

3 0 0 3

MULTISENSOR DATA FUSION: Introduction –Sensors and sensor data - Use of multiple sensors - Fusion applications. The inference hierarchy: Output data - Data fusion model- Architectural concepts and issues - Benefits of data fusion. Mathematical tools used: Algorithms, coordinate transformations, and rigid body motion. Dependability and Markov chains- Meta-heuristics. **(9)**

ESTIMATION: Kalman filtering - Practical aspects of Kalman filtering - Extended Kalman filter. Decision level identify fusion - Knowledge-based approaches. Data information filter- Extended information filter. **(8)**

DECENTRALIZED ESTIMATION: Decentralized and scalable decentralized estimation - Sensor fusion and approximate agreement - Optimal sensor fusion using range trees recursively - Distributed dynamic sensor fusion - Limitations of fully connected decentralization. **(9)**

ALGORITHMS FOR DATA FUSION: Taxonomy of algorithms for multisensor data fusion - Data association - Identity declaration. High-performance data structures: Tessellated, trees, graphs and functions. Representing ranges and uncertainty in data structures - Designing optimal sensor systems with in dependability bounds - Implementing a data fusion system. **(10)**

STATE ESTIMATION AND LOCALIZATION FOR SELF-DRIVING CARS: Use of Kalman filter variants- H∞ filtering- GNSS/INS sensing for position and orientation estimation- Basics of LIDAR sensing - Fusion of sensor data for an autonomous vehicle state estimator. **(9)**

Total: L: 45 Periods

TEXT BOOKS:

1. David L. Hall, Sonya A H McMullen, *'Mathematical Techniques in Multisensor Data Fusion'*. Artech House, Boston, Second Edition, 2004.
2. R. R. Brooks, S.S. Iyengar, *'Multisensor Fusion: Fundamentals and Applications with Software'*. Prentice Hall Inc., New Jersey, 1998.

REFERENCES:

1. Jitendra R Raol, '*Data Fusion Mathematics: Theory and Practice'*. CRC Press, 2016.
2. Yaakov Bar-Shalom, Peter K Willett, and Xin Tian, '*Tracking and Data Fusion: A Handbook of Algorithms'*. YBS Publishing, 2011.
3. Thor I. Fossen, Kristin Y. Pettersen and Henk Nijmeijer, *'Sensing and Control for Autonomous Vehicles: Applications to Land, Water and Air Vehicles'*. Springer, 2017.
4. Dan Simon, *'Optimal State Estimation Kalman, H-infinity and Non-linear Approaches'*. John Wiley and Sons, 2006.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental concepts of multisensor data fusion, its architecture, and its practical applications in real-world systems.	**K2**
CO2	Apply Kalman filtering and its variants for state estimation and evaluate their effectiveness in dynamic systems.	**K3**
CO3	Analyze decentralized estimation techniques and assess their performance in distributed sensor networks.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											3	
CO3		3			2			2				3	
	3	**3**			**2**			**2**				**3**	

1 – low, 2 – medium, 3 - high

25ICP28 BIOMEDICAL INSTRUMENTATION

3 0 0 3

ELECTRO PHYSIOLOGY: Review of physiology and anatomy, resting potential, action potential, bioelectric potentials, electrode theory, bipolar and uni-polar electrodes, surface electrodes, needle electrode and microelectrode, physiological transducers-selection criteria and its application. **(9)**

BIOELECTRIC POTENTIAL AND CARDIOVASCULAR MEASUREMENTS: ECG recording system, Heartsound measurement - stethoscope, phonocardiograph (PCG), Foetal monitor-ECG- phonocardiography, vector cardiograph, cardiac arrhythmia's monitoring system. EMG, EEG - Evoked potential response, ERG and EOG recording system. Measurement of blood pressure using a sphygmomanometer instrument based on Korotkoff sound, indirect measurement of blood pressure, automated indirect measurement, and direct measurement techniques. **(9)**

CLINICAL LABORATORY EQUIPMENT: Chemical tests in clinical laboratory, Spectrophotometry and its type of instrument, Automated Biochemical Analysis System, Flame photometer. Blood gas analyzer, Acid – base balance, Blood, pH measurement, blood pCO2, blood pO2, Intra–arterial blood gas analyzers, Blood cell counters-types of blood cells, - methods of cell counting -coulter counter- Automatic recognition and differential blood cell counting. **(9)**

RESPIRATORY AND PULMONARY MEASUREMENTS: Physiology of the respiratory system, respiratory rate measurement- artificial respirator- oximeter, pulmonary function measurements–spirometer–photo plethysmography and body plethysmography. Principles and techniques of impedance pneumography, Apnea monitor. **(9)**

ELECTRICAL SAFETY: Sources of electrical hazards in the medical environment and safety techniques for checking safety parameters of biomedical equipment. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. John G. Webster, John W. Clark Jr., *'Medical Instrumentation: Application and Design*'. 4th Edition, John Wiley and Sons, New York, 2010.
2. Arthur Guyton, John E. Hall, *'Textbook of Medical Physiology'*. 14th Edition, Elsevier Saunders, 2020.

REFERENCES:

1. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, '*Biomedical Instrumentation and Measurements'*. 2nd Edition, Prentice Hall of India, New Delhi, 1990.
2. R. S. Khandpur, '*Handbook of Biomedical Instrumentation'*. 3rd Edition, McGraw Hill Education (India) Private Limited, 2014.
3. Shakti Chatterjee, Aubert Miller, '*Biomedical Instrumentation Systems*'. Cengage Learning Publishing, 2010.
4. Joseph J. Carr, John M. Brown, '*Introduction to Biomedical Equipment Technology*'. 4th Edition, Pearson Publishing, 2000.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamentals of electrophysiology, bioelectric potentials, electrodes, and physiological transducers used in biomedical measurements	**K2**
CO2	Apply appropriate biomedical instrumentation techniques for measuring ECG, EEG, EMG, blood pressure, and respiratory parameters, and operate clinical laboratory equipment	**K3**
CO3	Analyze biomedical signal acquisition systems, clinical instrumentation, and electrical safety mechanisms for accurate diagnosis and safe operation.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				2							3	
CO3		2										2	
	3	**3**			**2**							**3**	

1 – low, 2 – medium, 3 - high

25ICP29 MEDICAL IMAGING EQUIPMENT

3 0 0 3

X-RAYS: Nature of X-rays- Block diagram of X-Ray Equipment: XRay Tube, the collimator, Bucky Grid, power supply-Digital Radiography X-ray Image Intensifier tubes – Fluoroscopy – Digital Fluoroscopy. Angiography, cine Angiography. Digital subtraction Angiography. Mammograph. **(9)**

COMPUTED TOMOGRAPHY: Principles of tomography, CT Generations, X- Ray sources- collimation- X- Ray detectors – Viewing systems – spiral CT scanning – Ultra fast CT scanners. Image reconstruction techniques – back projection and iterative method. **(9)**

MAGNETIC RESONANCE IMAGING: Fundamentals of magnetic resonance- Interaction of Nuclei with static magnetic field and Radio frequency wave- rotation and precession – Induction of magnetic resonance signals – bulk magnetization – Relaxation processes T1 and T2. Block Diagram approach of MRI system – system magnet (Permanent, Electromagnet and Superconductors), generations of gradient magnetic fields, Radio Frequency coils, shim coils, electronic components. **(9)**

NUCLEAR IMAGING: Radioisotopes- alpha, beta, and gamma radiations- Radiation detectors –ionization chambers, proportional counter, GM counter and scintillation Detectors, Gamma camera – Principle of operation, collimator, photomultiplier tube, X-Y positioning circuit, pulse height analyzer. Principles of SPECT and PET. **(9)**

RADIATION THERAPY AND RADIATION SAFETY: Radiation therapy – linear accelerator, Tele gamma Machine. Stereotactic radiosurgery (SRS) – Stereotactic radiotherapy (SRT) – Recent Techniques in radiation therapy – radiation measuring instruments Dosimeter – electronic dosimeter – Radiation protection in medicine. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Andreas Maier, Stefan Steidl, Vincent Christlein, Joachim Hornegger, *'Medical Imaging Systems: An Introductory Guide'*. Springer, 2018.
2. Khin Wee Lai, Dyah Ekashanti Octorina Dewi, *'Medical Imaging Technology'*. Springer Singapore, 2015.

REFERENCES:

1. Isaac Bankman, I. N. Bankman, '*Handbook of Medical Imaging: Processing and Analysis (Biomedical Engineering)'*. Academic Press, 2000.
2. Khandpur R.S, '*Handbook of Biomedical Instrumentation'*. Tata McGraw – Hill, New Delhi, 2003.
3. Jacob Beutel, M. Sonka, '*Handbook of Medical Imaging'*. Volume 2. Medical Image Processing and Analysis, SPIE Press, 2000.
4. J. L. Prince and J. M. Links, '*Medical Imaging Signals and Systems'*. Pearson Prentice Hall, 2006.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the principles, components, and imaging techniques of major medical imaging modalities, including X-ray, CT, MRI, and nuclear imaging.	**K2**
CO2	Apply the knowledge of imaging and therapy equipment to identify appropriate diagnostic or therapeutic tools and ensure radiation safety in clinical practice.	**K3**
CO3	Analyze the subsystems of Magnetic Resonance Imaging (MRI), and compare the radiation types and detection techniques used in nuclear imaging systems such as Gamma cameras, SPECT, and PET.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				2								
CO3		3											
	3	**3**			**2**								

1 – low, 2 – medium, 3 – high

25ICP30 DIAGNOSTIC AND THERAPEUTIC INSTRUMENTATION

3 0 0 3

PATIENT MONITORING AND TELEMEDICINE SYSTEMS: Physiological parameter monitoring: ECG, heart rate, blood pressure, respiration, temperature – Bedside and central monitoring systems – Intensive Care Unit (ICU) and Cardiac Care Unit (CCU) monitoring – Infusion pumps – Centralized monitoring consoles – Data acquisition and alarm systems – Patient monitoring through telemedicine and remote healthcare systems. **(9)**

MEDICAL IMAGING SYSTEMS: X-ray imaging system: components and operation – Computed Tomography (CT): principles and system components – Ultrasonic imaging system: principles and applications – Magnetic Resonance Imaging (MRI): basic concepts and block diagram – Thermal imaging system – Positron Emission Tomography (PET). **(9)**

CARDIAC AND RESPIRATORY THERAPEUTIC EQUIPMENT: Cardiac pacemaker – Defibrillator – Pneumotachometer – Thoracic pressure measurement – Heart-lung machine: bubble, disc type and membrane type oxygenators – Finger pump and roller pump – Electronic monitoring of functional parameters – Types of ventilators – Humidifiers – Nebulizers – Inhalators – Hemodialyzer unit – Incubators. **(9)**

ADVANCED THERAPEUTIC AND DIAGNOSTIC TECHNIQUES: Infrared (IR), Ultraviolet (UV) and LASER applications – Short wave diathermy – Ultrasonic diathermy – Microwave diathermy – Electrosurgical unit: current waveforms and tissue responses – Lithotripsy – Principles of cryogenic techniques and applications – Endoscopy – Laparoscopy – Otoscope – Audiometer – Tonometer. **(9)**

ELECTRICAL SAFETY IN MEDICAL INSTRUMENTATION: Sources of electrical hazards in medical environment – Physiological effects of electric current – Patient electrical environment – Built-in safety features for biomedical instruments – Safety techniques for checking parameters – Electrical safety codes and standards. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. D. N. Chesney, M. O. Chesney, *'Radiographic Imaging'*. 4th Edition, CBS Publications, New Delhi, 2007.
2. M. A. Flower, *'Webb's Physics of Medical Imaging'*. 2nd Edition, CRC Press, New York, 2012.

REFERENCES:

1. Dwight G. Nishimura, '*Principles of Magnetic Resonance Imaging'*. Stanford University, Lulu Publishing, 2010.
2. Jerry L. Prince, Jonathan M. Links, '*Medical Imaging Signals and Systems'*. 2nd Edition, Pearson Education, 2014.
3. Rangaraj M. Rangayyan, '*Biomedical Image Analysis'*. CRC Press, Boca Raton, FL, 2005.
4. Donald W. McRobbie, Elizabeth A. Moore, Martin J. Graves, Martin R. Prince, '*MRI from Picture to Proton*'. 2nd Edition, Cambridge University Press, New York, 2007.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the principles, components, and working of major medical imaging modalities including X-ray, CT, MRI, and nuclear imaging systems	**K2**
CO2	Apply the knowledge of imaging and radiation therapy equipment to select appropriate diagnostic and therapeutic techniques and ensure radiation safety in medical applications.	**K3**
CO3	Analyze the subsystems of advanced imaging systems, such as MRI and nuclear imaging, and evaluate radiation detection methods and safety instrumentation used in medical practice.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2										2	
	3	**2**										**2**	

1 – low, 2 – medium, 3 - high

25ICP31 BIO-SIGNAL ANALYSIS

3 0 0 3

INTRODUCTION TO BIOSIGNALS: Electrical activity of cells – Action potential – Nature and classification of biomedical signals – Examples of bio signals – Objectives and challenges in bio signal processing and analysis. **(9)**

CARDIAC SIGNAL PROCESSING: Electrocardiogram (ECG): origin and electrode placement – Lead systems – ECG signal characteristics and parameter estimation – Role in cardiovascular diagnosis – Denoising and preprocessing – Feature extraction – Time domain, frequency domain and wavelet analysis – Classification techniques. **(9)**

NEURAL SIGNAL PROCESSING: Electroencephalogram (EEG): origin and characteristics – EEG rhythms and evoked potentials – Role in diagnosis of CNS disorders – Signal processing and denoising – Feature extraction – Time domain, frequency domain, correlation and wavelet analysis – Classification methods. **(9)**

MYO-SIGNAL PROCESSING: Electromyogram (EMG): origin and characteristics – Significance in neuromuscular disorders – Signal acquisition and denoising – Feature extraction – Time domain, frequency domain and time-frequency analysis. **(9)**

ANALYSIS OF OTHER BIOSIGNALS: Blood pressure and blood flow analysis – Photoplethysmography (PPG) signal processing – Electrooculogram (EOG) and Electroretinogram (ERG) – Magnetoencephalogram (MEG) – Respiratory signal analysis. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Kayvan Najarian, Robert Splinter, *'Biomedical Signal and Image Processing'*. 2nd Edition, CRC Press, 2005.
2. R. M. Rangayyan, *'Biomedical Signal Analysis: A Case Study Approach'*. IEEE Press, John Wiley & Sons, 2002.

REFERENCES:

1. Willis J. Tompkins, '*Biomedical Digital Signal Processing'*. PHI Learning, 2004.
2. D. C. Reddy, '*Biomedical Signal Processing: Principles and Techniques'*. Tata McGraw-Hill Publishing Company Limited, 2005.
3. John G. Webster, '*Medical Instrumentation: Application and Design'*. John Wiley & Sons, 2001.
4. Kavyan Najarian, Robert Splinter, '*Biomedical Signals and Image Processing'*. 2nd Edition, CRC Press, 2012.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the origin, characteristics, and classification of various biomedical signals such as ECG, EEG, and EMG, and the challenges involved in bio signal analysis.	**K2**
CO2	Apply appropriate signal processing techniques such as time-domain, frequency-domain, and wavelet analysis for denoising, feature extraction, and interpretation of biomedical signals.	**K3**
CO3	Analyze different bio signal processing methods and evaluate their effectiveness in diagnosing physiological conditions using cardiac, neural, and other bio signals.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		1											
	3	**1**											

1 – low, 2 – medium, 3 – high

25ICP32 BIOMEDICAL IMAGE PROCESSING

3 0 0 3

MEDICAL IMAGE MODALITIES: Principles and characteristics of X-ray-Computed Tomography (CT)-Magnetic Resonance Imaging (MRI)-Positron Emission Tomography (PET) - ultrasound. **(9)**

IMAGE RECONSTRUCTION FROM PROJECTION: Radon transform – Fourier-slice theorem – Filtered back projection – Fan-beam filtered back projection –Challenges: image reconstruction with incomplete and noisy data. **(9)**

SEGMENTATION: Threshold-based segmentation- region-based approach – clustering-based approach – Mean shift algorithm- semantic segmentation – Atlas-based segmentation – Graph cut - deep learning-based image segmentation – challenges in image segmentation. **(9)**

IMAGE REGISTRATION: Rigid body transformation, principal axes registration - Landmark-based approach – warping and non-linear image registration – Mutual information-based registration - Deep learning-based image registration. **(9)**

SHAPE ANALYSIS AND CLASSIFICATION: Shape description – Chain code - Topological descriptor - Fourier descriptor –Hough transform- Active Shape models – Active Appearance models – machine learning-based image classification – deep learning-based image classification. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Rangaraj M. Rangayyan, *'Biomedical Image Analysis'*. CRC Press, 2010.
2. Issac Bankman, *'Handbook of Medical Imaging'*. Academic Press, 2004.

REFERENCES:

1. Atam P. Dhawan, *'Medical Image Analysis'*. Wiley-Blackwell, 2003.
2. S. Kevin Zhou, Hayit Greenspan and Dinggang Shen, *'Deep learning for Medical Image Analysis'*. Academic Press, 2017.
3. Geoff Dougherty, *'Digital Image Processing for Medical Applications'*. Cambridge University Press, 2009.
4. Joseph V. Hajnal, Derek L.G. Hill, *'Medical Image Registration'*. CRC Press, 2019.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the principles and characteristics of various medical imaging modalities including X-ray, CT, MRI, PET, and ultrasound.	**K2**
CO2	Apply mathematical methods such as Radon transform and filtered back projection for image reconstruction from projections.	**K3**
CO3	Analyze segmentation and registration techniques, both traditional and deep learning-based, along with shape descriptors and classification methods using statistical and machine learning approaches for interpreting biomedical images	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		1											
	3	**1**											

1 – low, 2 – medium, 3 – high

25ICP33 PHYSIOLOGICAL CONTROL SYSTEMS

3 0 0 3

INTRODUCTION TO PHYSIOLOGICAL CONTROL SYSTEMS: Introduction to Human Physiology - Analysis of Physiological Control Systems- Difference between engineering and physiological control systems. **(9)**

STATIC ANALYSIS OF PHYSIOLOGICAL SYSTEMS: Open loop and Closed loop systems- Steady state analysis- Regulation of Cardiac Output- Regulation of Glucose- Chemical regulation of ventilation. **(9)**

TIME AND FREQUENCY DOMAIN ANALYSIS OF LINEAR PHYSIOLOGICAL CONTROL SYSTEMS: Linearized respiratory mechanics- Open loop and Closed loop transient responses- First order and second order models-Impulse and Step response descriptors- Open and closed loop dynamics- Graphical representations of frequency response-Frequency response of Glucose- Insulin regulation and Circulatory Control Model. **(9)**

NON-LINEAR ANALYSIS OF PHYSIOLOGICAL CONTROL SYSTEM: Difference between linear and non-linear systems- The Hodgkin-Huxley model - van der Pol model of Neuronal dynamics - Spontaneous Variability-Delayed feedback Nonlinear Control systems- Coupled non-linear Oscillators- Time-varying Physiological closed loop systems-Sleep Apnea model. **(9)**

CASE STUDIES AND SIMULATION: Simulation of cardiovascular variability (stroke volume constant and stroke volume variable)- Simulation of glucose- insulin regulation (Stolwijk and Hardy model)-Simulation of neuromuscular reflex model -Simulation of patient- ventilator system-Simulation of respiratory sinus arrhythmia (Saul model). **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Michael. C. K. Khoo, *'Physiological Control Systems'*. IEEE Press, Ed., Robert. S. Herrick, Prentice – Hall of India, New Delhi, 2001.
2. Milhorn, H. T., *'The Application of Control Theory to Physiological Systems'*. Saunders, W. B., Philadelphia, 1996.

REFERENCES

1. Kuo, B. C., '*Automatic Control Systems'*. 4th edition, Prentice- Hall, Englewood Cliffs, NJ, 1994.
2. Dorf, R. C. and Bishop, R. H., '*Modern Control Systems*'. 7th edition, Addison- Wesley Reading, MA, 1995.
3. Thompson, J. M. T. and Stewart, H. B., '*Nonlinear dynamics and chaos'*. Wiley, New York, 1986.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Learn the basic principles of human physiology and differentiate between engineering and physiological control systems.	**K2**
CO2	Apply time frequency domain analysis to linear physiological control systems.	**K3**
CO3	Analyze linear and non-linear physiological control systems by performing static analysis of physiological systems, including open loop and closed loop systems	**K4**
CO4	Perform simulation of various physiological control systems including cardiovascular variability, glucose-insulin regulation, neuromuscular reflex models, patient-ventilator systems, and respiratory sinus arrhythmia and evaluate the relevant parameters	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2											
CO4			1										
	3	**2**	**1**										

1 – low, 2 – medium, 3 - high

25ICP34 BIOMECHANICS

3 0 0 3

FUNDAMENTALS OF BIOMECHANICS AND HUMAN BODY MECHANICS: Introduction to biomechanics – Basic principles of statics and dynamics – Human body as a biomechanical system – Anatomical terminology – Structure and function of skeletal muscles – Mechanism of force production – Sliding filament theory – Force-length relationship. **(9)**

BIOMECHANICAL ANALYSIS OF JOINTS AND MOVEMENT: Biomechanics of upper limb joints: shoulder, elbow, wrist, hand and fingers – Biomechanics of lower limb and spine: hip, knee, ankle – Multi-link system analysis of human movement – Forward and inverse kinematics – Denavit - Hartenberg (D-H) parameters – Velocity and Jacobian analysis. **(9)**

MECHANICS OF HARD AND SOFT TISSUES: Bone structure and properties – Wolff's law – Stress-strain relationship – Elastic properties and bending of bones – Soft tissues: cartilage, ligaments, tendons – Tendon forces and properties – Friction, gliding resistance, and wrapping effects. **(9)**

VISCOELASTICITY AND NEUROMECHANICS: Viscoelastic properties of biological tissues – Maxwell, Voigt, and Kelvin models – Viscoelastic behavior in bones and soft tissues – Neuromechanics concepts – Finger force production and enslaving effect – Wrist posture and interdependence of joints. **(9)**

KINEMATICS, STABILITY AND GAIT ANALYSIS: Measurement of orientation in 3D space – Rotation matrices and composite rotations – Quaternions and parameterization – Gimbal lock and singularity – IMU-based motion measurement systems – Stability analysis – Introduction to gait analysis. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Y. C. Fung, *'Biomechanics: Mechanical Properties of Living Tissues'*. 2nd Edition, Springer, New York, 1993.
2. Susan J. Hall, *'Basic Biomechanics'*. 7th Edition, McGraw-Hill Education, New York, 2015.

REFERENCES

1. Nihat Özkaya, Margareta Nordin, David Goldsheyder, Dawn Leger, '*Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation*'. 4th Edition, Springer, 2016.
2. Donald R. Peterson, Joseph D. Bronzino, '*Biomechanics: Principles and Applications'*. CRC Press, Boca Raton, 2008.
3. Duane Knudson, '*Fundamentals of Biomechanics'*. 2nd Edition, Springer, 2007.
4. C. Ross Ethier, Craig A. Simmons, '*Introductory Biomechanics: From Cells to Organisms'*. Cambridge University Press, 2007.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental principles of biomechanics, including statics, dynamics, and the structure and function of the musculoskeletal system.	**K2**
CO2	Apply biomechanical principles to analyze joint movements, human motion, and kinematics using appropriate mathematical models.	**K3**
CO3	Analyze the mechanical behavior of biological tissues, including hard and soft tissues, under different loading and viscoelastic conditions.	**K4**
CO4	Evaluate human motion and stability using kinematic analysis, gait analysis, and modern measurement techniques such as IMU-based systems.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				1								
CO3		1		1									
CO4			1		1								
	3	**1**	**1**	**1**	**1**								

1 – low, 2 – medium, 3 - high

25ICP35 REHABILITATION INSTRUMENTATION

3 0 0 3

INTRODUCTION: Rehabilitation concepts - Engineering concepts: Sensory rehabilitation, Motor rehabilitation, Communication disorders - Examples of rehabilitation engineering. **(9)**

WHEELCHAIR ENGINEERING: Categories of wheelchairs - Wheelchair structure and component design - Ergonomics of wheelchair propulsion - Power wheelchair electrical system - Personal transportation - Wheelchair: Standards, Transportation safety. **(9)**

SENSORY REHABILITATION: Sensory augmentation and substitution: Visual system, Auditory system, Tactual system - Aids for vision and hearing impaired - Automatic speech synthesis and voice recognition – Audiometry and speech therapy aids. **(9)**

MOTOR REHABILITATION: Orthopaedic prosthetics and orthotics in rehabilitation: Fundamentals, Applications – Computer Aided Engineering(CAD) in customized component design - Examples of innovative component design: Intelligent prosthetic knee, Hierarchically controlled prosthetic hand, Self-aligning orthotic knee joint - Externally powered and controlled orthotics and prosthetics: FES systems: Restoration of hand function, Restoration of standing and walking, Hybrid Assistive Systems (HAS) - Active prostheses: Active above knee prosthesis, Myoelectric hand and arm prostheses, MARCUS intelligent hand prosthesis. **(9)**

COMPUTER APPLICATIONS IN REHABILITATION: Augmentative and Alternative Communication (AAC): Acceleration techniques, User interface, Outputs, Intervention and training - Computer and web access - Performance measurement - Cost - effectiveness of high vs low technology approaches - Environmental control systems and access to computers - Robotic manipulation aids. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Joseph D. Bronzino, *'Biomedical Engineering Handbook: Volume II'*. CRC Press, New York, 2013.
2. Rory A. Cooper, *'An Introduction to Rehabilitation Engineering'*. Taylor and Francis, New York, 2006.

REFERENCES

1. Randall L. Braddom, '*Handbook of Physical Medicine and Rehabilitation'*. W.B. Saunders Publications, Pennsylvania, 2006.
2. Horia-Nicolai L.T, Lakhmi C.J, '*Intelligent Systems and Technologies in Rehabilitation Engineering'*. CRC Press, New York, 2001.
3. Tan Y. Kheng, '*Rehabilitation Engineering'*. In-Teh, Croatia, 2009.
4. Alex Mihalidis, '*Rehabilitation Engineering Principles and Practice Synopsis'*. CRC Press, New York, 2019.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental engineering concepts in rehabilitation, including sensory, motor, and communication aspects with practical examples.	**K2**
CO2	Demonstrate the application of prosthetics, orthotics, and advanced systems such as FES and HAS in motor rehabilitation with the aid of CAD tools.	**K3**
CO3	Classify different types of wheelchairs and analyze the design features, ergonomics, and electrical systems used in power wheelchairs	**K4**
CO4	Compare various sensory rehabilitation aids and evaluate their role in augmenting or substituting vision, hearing, and speech functionalities.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		1											
CO4				1									
	3	**1**		**1**									

1 – low, 2 – medium, 3 - high

ELECTIVES FOR MINOR DEGREE IN INDUSTRIAL INSTRUMENTATION
25ICM01 TEST AND MEASURING INSTRUMENTS

3 0 0 3

ANALOG INDICATING INSTRUMENTS: PMMC, MI, Electrodynamometer, Rectifier instruments, range extension. Bridge Measurements: Wheatstone, Kelvin Double, Maxwell, Hay, Schering, Anderson, Owen bridges. Instrument Transformers and Q-Meter: CT, PT, ratio error, phase angle error, Q-meter, signal generators. **(9)**

CRO & DSO: CRO: block diagram, CRT deflection, voltage/frequency/phase measurement, Lissajous figures, probes. DSO: ADC architecture, sampling modes, pre/post-trigger capture, auto-measurement functions. Electronic Counters and Analysers: universal counter, spectrum analyser (swept & FFT), logic analyser. **(9)**

DIGITAL INSTRUMENTS AND DAQ: DVMs and DMMs: ramp, dual-slope DVM, DMM, ADC/DAC types and parameters. DAQ Systems: Nyquist theorem, aliasing, S/H, multi-channel acquisition, data loggers. Virtual Instruments and Bus Standards: LabVIEW, NI DAQ, GPIB, USB, LAN/LXI, PXI. **(9)**

SIGNAL CONDITIONING AND WAVEFORM ANALYZERS: Signal Conditioning: Instrumentation amplifier, precision rectifier, S/H, Butterworth/Chebyshev/Bessel active filters. Noise Analysis: thermal, shot, 1/f noise, NF, SNR, Friis cascade, lock-in amplifier, chopper amp. Power and Harmonic Measurement: wattmeter, digital power analyser, power factor meter, THD, wave analyser. **(9)**

SMART SENSORS: Smart sensors — definition, IEEE 1451 standard for smart transducer interface; sensor with embedded signal conditioning, ADC and communication interface on a single chip. Multi-variable smart transmitters - simultaneous measurement of pressure, temperature and flow with digital output. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. K. Sawhney, '*A Course in Electrical and Electronic Measurements and Instrumentation*'. Dhanpat Rai & Co., 17th Edition, 2015.
2. W. D. Cooper and A. D. Helfrick, '*Electronic Instrumentation and Measurement Techniques*'. Prentice Hall, 5th Edition, 1999.
3. E. Noltingk (Ed.), '*Instrumentation Reference Book'*. Butterworth-Heinemann, 3rd Edition, 2010.

REFERENCES

1. E. O. Doebelin, '*Measurement Systems – Application and Design'*. McGraw-Hill, 5th Edition, 2003.
2. B. E. Noltingk, '*Instrumentation Reference Book'*. Butterworth-Heinemann, 3rd Edition, 2010.
3. J. J. Carr, '*Elements of Electronic Instrumentation and Measurement'*.Prentice Hall, 3rd Edition, 1999.
4. Kevin James, '*PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control'*. Newnes, 2000.
5. Paul Horowitz and Winfield Hill, '*The Art of Electronics'*. Cambridge University Press, 3rd Edition, 2015.
6. Clarence W. de Silva, '*Sensor Systems: Fundamentals and Applications'*. CRC Press, 2016.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Apply principles of analog and electronic measuring instruments, including bridges, CRO/DSO, and instrument transformers, for accurate measurement of electrical quantities.	**K3**
CO2	Analyze digital instruments, data acquisition systems, signal conditioning circuits, and waveform analyzers considering noise, sampling, and system performance.	**K4**
CO3	Evaluate modern measurement systems including virtual instrumentation, bus standards, and smart sensors for industrial and advanced engineering applications.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2		1	1								
	3	**2**	**1**	**1**	**1**								

1 – low, 2 – medium, 3 - high

25ICM02 TRANSDUCER ENGINEERING

3 0 0 3

SCIENCE OF MEASUREMENTS AND CLASSIFICATION OF TRANSDUCERS: Units and standards – Calibration methods – Static calibration – Classification of errors - Limiting error and probable error – Error analysis: – Statistical methods – Odds and uncertainty – Classification of transducers – Selection of transducers. **(9)**

CHARACTERISTICS OF TRANSDUCERS: Static characteristics: – Accuracy, precision, resolution, sensitivity, linearity, span and range - Dynamic characteristics: – Mathematical model of transducer – Zero, I and II order transducers- Response to impulse, step, ramp and sinusoidal inputs. **(9)**

VARIABLE RESISTANCE TRANSDUCERS: Principle of operation, construction details, characteristics and applications of potentiometer, strain gauge, resistance thermometer, Thermistor, hot-wire anemometer, piezoresistive sensor and humidity sensor. **(9)**

VARIABLE INDUCTANCE AND VARIABLE CAPACITANCE TRANSDUCERS: Induction potentiometer – Variable reluctance transducers – EI pick up – Principle of operation, construction details, characteristics, and applications of LVDT –Capacitive transducer and types – Capacitor microphone – Frequency response. **(9)**

OTHER TRANSDUCERS: Piezoelectric transducer – Hall Effect transducer – Magneto elastic sensor- Digital transducers Smart sensors – Fiber optic sensors- Film Sensors-Introduction to MEMS and Nano sensors. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Neubert H.K.P., '*Instrument Transducers – An Introduction to their Performance and Design*'. Oxford University Press, Cambridge, 2003.
2. Doebelin E.O. and Manik D.N., '*Measurement Systems – Applications and Design*'. Special Indian Edition, Tata McGraw Hill Education Pvt. Ltd., 2007.
3. D. Patranabis, '*Sensors and Transducers*'. 2nd edition, Prentice Hall of India, 2010. E.A.

REFERENCES

1. John P. Bentley, '*Principles of Measurement Systems*'. 3rd edition, Pearson Education, 2000.
2. Murthy, D.V.S., '*Transducers and Instrumentation*'. 2nd edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
3. Bela G.Liptak, '*Instrument Engineers' Handbook, Process Measurement and Analysis*'. 4th edition, Vol. 1, ISA/CRC Press, 2003.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the basic concepts of measurement, types of errors, calibration methods, and classification of transducers.	**K2**
CO2	Apply the characteristics of various transducers to measure physical quantities in practical applications.	**K3**
CO3	Analyze the principles and performance of different types of transducers, including modern sensors like smart, MEMS, and nano sensors.	**K4**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		2		1	1								
	3	**2**		**1**	**1**								

1 – low, 2 – medium, 3 - high

25ICM03 PROCESS INSTRUMENTATION

3 0 0 3

MEASUREMENT OF TEMPERATURE: Definitions and standards – Resistance Temperature Detectors – Thermocouple- Radiation thermometers – Fiber optic temperature sensor– Temperature sensor selection, Installation and Calibration. **(9)**

MEASUREMENT OF PRESSURE: Units of pressure – Manometers- Elastic type pressure gauges - Electrical pressure transducers- Fiber optic pressure sensor Measurement of vacuum: McLeod gauge, Cold cathode type and hot cathode type ionization gauges – Pressure gauge selection, installation and calibration. **(9)**

MEASUREMENT OF FLOW: Variable head flow meters – positive displacement flow meters-variable area flow meters- Electrical type flow meters – Open channel flow measurement –Solid flow measurement. **(9)**

MEASUREMENT OF LEVEL: Float gauges – Displacer type – Bubbler system – Load cell – Conductivity sensors – Capacitive sensors – D/P methods – Ultrasonic level sensors –Solid level measurement. **(9)**

INSTRUMENTS FOR CHEMICAL ANALYSIS: Ion selective electrodes – pH and Conductivity measurement – UV Visible and IR Spectrometry- Gas & Liquid Chromatography – Mass Spectrometry- Oxygen analyzers for gas and liquid – CO, CO2, NO and SO Analyzers. **(9)**

Total L: 45 Periods

TEXT BOOK

1. Doebelin, E. O. and Manik D. N., '*Measurement systems Application and Design'*. 5th Edition, Tata McGraw-Hill Education Pvt. Ltd, 2009.
2. Braun, R. D., '*Introduction to Instrumental Analysis'*. Pharma Book Syndicate, Singapore, 7th Edition 2012
3. Donald P Eckman, '*Industrial Instrumentation'*. CBS Publisher, 2004.

REFERENCES

1. Walt Boyes, '*Instrumentation Reference Book'*. Elsevier Science, 2010.
2. Paul Gruhn, P. E., CFSE and Harry Cheddie, P. E., '*Safety Instrumented Systems: Design, Analysis, and Justification*'. 2nd edition, ISA, 2006.
3. B. G. Liptak, '*Instrumentation Engineers Handbook (Process Measurement & Analysis)*'. Fourth Edition, Chilton Book Co, CRC Press, 2005.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the fundamental concepts, standards, and working principles of temperature, pressure, flow, and level measurement systems using devices like RTDs, thermocouples, manometers, flow meters, and level sensors	**K2**
CO2	Apply knowledge of sensor technology including fiber optic and electrical transducers in practical measurement applications.	**K3**
CO3	Interpret and analyze data obtained from chemical analyzers like spectrophotometers, chromatographs, and gas analyzers.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2		1	1								
	3	**2**		**1**	**1**								

1 – low, 2 – medium, 3 - high

25ICM04 INTRODUCTION TO PROCESS CONTROL

3 0 0 3

PROCESS DYNAMICS: Need for process control – Hierarchical decomposition of control functions – Servo and regulatory operations – Continuous and Batch processes – Mathematical Modeling of Processes: Level, Flow and Thermal processes – Lumped and Distributed parameter models – Degrees of Freedom – Interacting and non-interacting systems – Self regulation – Linearization of nonlinear systems – Dynamic behavior of processes. **(9)**

CONTROL VALVE: Actuators: Pneumatic and electric actuators – I/P converter – Control Valve Terminology - Characteristic of Control Valves: Inherent and Installed characteristics - Valve Positioner – Modeling of a Pneumatically Actuated Control Valve – Valve body: Commercial valve bodies – Control Valve Sizing: ISA S 75.01 standard flow equations for sizing Control Valves – Cavitation and flashing – Materials for Control Valves – Control Valve selection. **(9)**

CONTROL ACTIONS: Characteristic of ON-OFF, Proportional, Single speed floating, Integral and Derivative controllers – P+I, P+D and P+I+D control modes – Practical forms of PID Controller – PID Implementation Issues: Bumpless Auto/manual Mode transfer, Anti-reset windup Techniques and Direct/reverse action – Realization of PID Controller using Analog Circuits – Introduction to fractional order PID controller. **(9)**

PID CONTROLLER TUNING: PID Controller Design Specifications: Criteria based on Time Response and Criteria based Frequency Response - PID Controller Tuning: Z-N and Cohen-Coon methods, Continuous cycling method and Damped oscillation method, optimization methods, Auto tuning – Cascade control – Feed-forward control – Ratio control – Inferential control – Split-range – override control – Adaptive Control. **(9)**

MODEL BASED CONTROL SCHEMES & MULTILOOP CONTROL: Smith Predictor Control Scheme - Internal Model Controller – IMC PID controller – Single Loop Dynamic Matrix Control – Introduction to Multi-loop Control Schemes – Control Schemes for Distillation Column, CSTR, pH, and Heat Exchanger – Three-element Boiler drum level control – P&I diagram. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Bequette, '*Process Control: Modeling, Design, and Simulation*'. Prentice Hall of India, 2004
2. Antonio Visioli, '*Practical PID Control*'. Springer- Verlag London, 2006.
3. Aidan O'Dwyer, '*Handbook of PI and PID Controller Tuning Rules*'. Imperial College Press, 2009.

REFERENCES

1. Seborg, D. E., Mellichamp, D. P., Edgar, T. F., and Doyle, F. J., III, '*Process Dynamics and Control*'. John Wiley and Sons, 3rd Edition, 2010.
2. Michael King, '*Process Control: A Practical Approach*'. Wiley, 2010.
3. Baumann, H. D., '*Control Valve Primer – A User's Guide*'. ISA, 2008.
4. George Stephanopoulos, '*Chemical Process Control – An Introduction to Theory and Practice*'. Prentice Hall of India, 2005.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the significance of process control and model the dynamic behavior of systems such as level, flow, and temperature, while describing and applying control actions like ON-OFF, P, I, D, and PID tuning methods	**K2**
CO2	Apply advanced control strategies such as cascade, feed-forward, ratio, override, split-range, and adaptive control in process industries.	**K3**
CO3	Select and size control valves and actuators based on process requirements using ISA standards and understand valve characteristics.	**K4**
CO4	Design and implement model-based and multi-loop control systems such as Smith Predictor, IMC, DMC, and develop control schemes for systems like CSTRs, pH, heat exchangers, and distillation columns.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2		1	1								
CO4			1	1	1								
	3	**2**	**1**	**1**	**1**								

1 – low, 2 – medium, 3 – high

25ICM05 ESSENTIALS OF CONTROL ENGINEERING

3 0 0 3

FUNDAMENTALS OF CONTROL SYSTEMS AND MODELING: Introduction to control systems – Open loop and closed loop systems – Feedback system characteristics – Block diagram reduction – Signal flow graph. **(9)**

SYSTEM RESPONSE AND STABILITY ANALYSIS: Order and type of systems – Time domain and frequency domain response – Simulation-based analysis – Introduction to stability – Routh-Hurwitz stability criterion. **(9)**

FREQUENCY RESPONSE AND ROOT LOCUS TECHNIQUES: Introduction to root locus – Root locus plotting and stability analysis using simulation – Bode plot and Nyquist plot – Gain margin and phase margin. **(9)**

CONTROLLER DESIGN AND COMPENSATION TECHNIQUES: Introduction to compensators – Design of lead, lag, and lead-lag compensators using simulation – PID controller design and tuning. **(9)**

APPLICATIONS OF CONTROL SYSTEMS: Applications of control systems in various engineering domains – Case studies and practical implementations. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. R. C. Dorf, R. H. Bishop, ‘*Modern Control Systems*’. 13th Edition, Prentice Hall, 2016.
2. Katsuhiko Ogata, ‘*Modern Control Engineering*’. 5th Edition, Pearson Education, 2009.

REFERENCES

1. G. F. Franklin, J. D. Powell, A. Emami-Naeini, ‘*Feedback Control of Dynamic Systems*’. 7th edition, Pearson Education, 2015.
2. B. C. Kuo, Farid Golnaraghi, ‘*Automatic Control Systems*’. 8th Edition, Wiley India, 2003.
3. Ramakalyan A., ‘*Control Engineering: A Comprehensive Foundation*’. Vikas Publishing House, New Delhi, 2004.
4. Norman S. Nise, ‘*Control Systems Engineering*’. 7th edition, Wiley, 2015.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Explain the fundamental concepts of control systems, including open-loop and closed-loop systems, feedback characteristics, and system modeling techniques.	**K2**
CO2	Apply time-domain and frequency-domain analysis methods to evaluate system response and determine stability using Routh-Hurwitz criterion.	**K3**
CO3	Analyze control systems using root locus, Bode plots, and Nyquist plots, and interpret system stability through gain and phase margins.	**K4**
CO4	Evaluate and design appropriate compensators and PID controllers using simulation tools to meet desired performance specifications in practical control systems.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2		1	1								
CO4			1	1	1								
	3	**2**	**1**	**1**	**1**								

1 – low, 2 – medium, 3 – high

25ICM06 FUNDAMENTALS OF INDUSTRIAL DATA COMMUNICATION

3 0 0 3

NETWORKING FUNDAMENTALS: Standards – Protocols – Network Models:- OSI Model – TCP/IP Model – Network Types Network Topologies – Network Devices – Ethernet Standards. **(9)**

SERIAL COMMUNICATION INTERFACES II: RS232, RS422, RS485:- Features – Signal levels – USB:- Types – Features – Signal levels Data encoding – Packet types -Transfer types – CAN:- – Features – Signal levels – Message types – Message frames. **(9)**

MODBUS AND HART: MODBUS: - Protocol Description – Transaction – Function codes – Message format – HART:- Communication modes – Networks – Command set – Telegram structure. **(9)**

FOUNDATION FIELDBUS AND PROFIBUS: FIELDBUS: - Architecture – Communication protocols – Topology – Standards – PROFIBUS:- Introduction – Types – Operational Characteristics – Transmission technology – Introduction to PROFINET. **(9)**

WIRELESS TECHNOLOGIES FOR INDUSTRIAL APPLICATIONS: Wireless sensor networks: - Hardware components – Energy consumption of sensor nodes – Network architecture – ISA100 – Wireless HART – IEEE802.11 – IEEE 802.15.4. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Mackay, S., Wright, E., Reynders, D., and Park, J., *'Practical Industrial Data Networks: Design, Installation and Troubleshooting'*. Newnes Publication,1st edition, Elsevier, 2004.
2. Buchanan, W., '*Computer Busses: Design and Application'*. CRC Press, 2000.
3. Bela G.Liptak, '*Instrument Engineers' Handbook, Volume 3: Process Software and Digital Networks'*. 4th Edition, CRC Press, 2011.

REFERENCES

1. Bowden, R., '*HART Application Guide'*. HART Communication Foundation, 1999.
2. Berge, J., '*Field Buses for Process Control: Engineering, Operation, and Maintenance'*. ISA Press, 2004.
3. Lawrence (Larry) M. Thompson and Tim Shaw, '*Industrial Data Communications'*. 5th Edition, ISA Press, 2015.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental concepts of networking including standards, protocols, models, topologies, and devices.	**K2**
CO2	Compare various serial communication interfaces such as RS232, RS422, RS485, USB, and CAN in terms of features, signal levels, and data formats for different applications	**K3**
CO3	Analyze the architecture, protocols, and transmission technologies used in FOUNDATION Fieldbus and PROFIBUS,	**K4**
CO4	Evaluate the role of wireless technologies in industrial applications, including WSNs, ISA100, Wireless HART, IEEE 802.11, and IEEE 802.15.4, with emphasis on architecture, components, and energy efficiency.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2		1	1								
CO4			1	1	1								
	3	**2**	**1**	**1**	**1**								

1 – low, 2 – medium, 3 - high

25ICM07 ANALYTICAL INSTRUMENTATION SYSTEMS

3 0 0 3

SPECTROPHOTOMETRY: Spectral methods of analysis – Beer-Lambert law – UV-Visible spectroscopy – IR Spectrophotometry - FTIR spectrophotometry – Atomic absorption spectrophotometry - Flame emission and atomic emission photometry – Construction, working principle, sources detectors and applications. **(9)**

CHROMATOGRAPHY: General principles – classification – chromatographic behavior of solutes – quantitative determination – Gas chromatography – Liquid chromatography - High-pressure liquid chromatography – Applications. **(9)**

INDUSTRIAL GAS ANALYZERS AND POLLUTION MONITORING INSTRUMENTS: Gas analyzers Oxygen, NO2 and H2S types, IR analyzers, thermal conductivity detectors, analysis based on ionization of gases. Air pollution due to carbon monoxide, hydrocarbons, nitrogen oxides, sulphur dioxide estimation - Dust and smoke measurements. **(9)**

PH METERS AND DISSOLVED COMPONENT ANALYZERS: Selective ion electrodes - Principle of pH and conductivity measurement - dissolved oxygen analyzer – Sodium analyzer – Silicon analyzer – Water quality Analyzers. **(9)**

NUCLEAR MAGNETIC RESONANCE AND MASS SPECTROMETRY: NMR – Basic principles – Continuous and Pulsed Fourier Transform NMR spectrometer – Mass Spectrometry – Sample system – Ionization methods – Mass analyzers – Types of mass spectrometry. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Willard, H.H., Merritt, L.L., Dean, J.A., Settle, F.A., '*Instrumental methods of analysis*'. CBS publishing & distribution, 7th Edition, 2012.
2. Ewing G W, '*Instrumental Methods of Analysis*'. McGraw-Hill, New York, 5th Edition, 2013.

REFERENCES

1. Braun, R.D., '*Introduction to Instrumental Analysis*'. Pharma Book Syndicate, Singapore, 2nd edition 2012.
2. Robert E. Sherman., '*Analytical Instrumentation, Instruments*'. Society of America, 1996
3. Khandpur, R.S., '*Handbook of Analytical Instruments*'. Tata McGraw Hill publishing Co. Ltd., 5th edition 2018.
4. Liptak, B.G., '*Process Measurement and Analysis*'. CRC Press, 5th Edition, 2016.

COURSE OUTCOMES

At the end of the course, students will be able to		**Bloom's Level**
CO1	Describe the principles and applications of nuclear magnetic resonance spectroscopy and Mass Spectrometry, including ionization methods, mass analyzers, and sample systems.	**K2**
CO2	Apply industrial gas analyzers and pollution monitoring instruments to measure gases like oxygen, NO2, H2S, CO, hydrocarbons, nitrogen oxides, and sulphur dioxide, and analyze dust and smoke levels.	**K3**
CO3	Analyze the chromatographic separation methods, including gas chromatography (GC), high-pressure liquid chromatography (HPLC), and liquid chromatography, and their applications in quantitative and qualitative chemical analysis.	**K4**
CO4	Evaluate pH meters and dissolved component analyzers, including selective ion electrodes, dissolved oxygen analyzers, and water quality analyzers, to measure and assess water quality.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2		1	1								
CO4			1	1	1								
	3	**2**	**1**	**1**	**1**								

1 – low, 2 – medium, 3 – high

25ICM08 INSTRUMENTATION PRACTICES IN INDUSTRIES

3 0 0 3

SELECTION AND APPLICATION: Introduction to selection procedures. Selection of temperature, pressure, flow, pH, and level measuring instrumentation techniques for Process industries – Cement, Oil & gas, Food. **(9)**

STANDARDS AND CALIBRATION: Introduction to standards and calibration, calibration of temperature, pressure and flow measuring devices. Introduction to ISO, IEC and API standards pertaining to temperature, pressure and flow instrumentation. **(9)**

EMI AND EMC: Introduction, interference coupling mechanism, basics of circuit layout and grounding, concepts of interfaces, filtering and shielding. **(9)**

SAFETY: Introduction, electrical hazards, hazardous areas and classification, non-hazardous areas, enclosures-NEMA types, fuses and circuit breakers. Protection methods: Purging, explosion proofing and intrinsic safety. **(9)**

SPECIFICATIONS: Specification of instruments, preparation of project documentation, process flow sheet, instrument index sheet, instrument specifications sheet, panel drawing and specifications, instrument specifications. Project procedure, schedules, vendor drawing, tender documentation, selection of measurement method and control panels. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Liptak B.G, '*Process Measurement and Analysis'*. Chilton Book Company, Radnor, Pennsylvania, 4th Edition, 2003.
2. Andrew W.G, '*Applied Instrumentation in Process Industries – A survey'*. Vol I and Vol II, Gulf Publishing Company, Houston, 2001
3. Spitzer D. W., '*Industrial Flow measurement'*. ISA press, 3rd Edition, 2005.

REFERENCES

1. Patranabis D., '*Principles of Industrial Instrumentation*'. Tata McGraw Hill Publishing Company Ltd, 3rd Edition, 2010.
2. Lawrence D. Goettsche, '*Maintenance of Instruments and Systems*'. International society of automation, 2nd Edition, 2005.
3. Henry W.Ott, '*Electromagnetic Compatibility Engineering*'. A John Wiley and Sons, INC., Publication, 2009.
4. Noltingk B.E., '*Instrumentation Reference Book*'. Butterworth Heinemann, 2nd Edition, 1995.
5. Bela G. Liptak (Editor), Kriszta Venczel, '*Instrument and Automation Engineers' Handbook: Process Measurement and Analysis*'. CRC Press, 5th Edition, 2016.

COURSE OUTCOMES

At the end of the course, students will be able to:		Bloom's Level
CO1	Apply selection principles to choose appropriate measurement instruments for temperature, pressure, flow, level, and pH in various process industries.	**K3**
CO2	Analyze calibration procedures, industrial standards (ISO, IEC, API), and EMI/EMC issues to ensure accurate and reliable instrumentation systems.	**K4**
CO3	Evaluate safety requirements and develop instrument specifications, documentation, and project procedures for industrial measurement and control systems.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2		1	1								
	3	**2**		**1**	**1**								

1 – low, 2 – medium, 3 – high

OPEN ELECTIVES

25EEO01 INDUSTRIAL AUTOMATION

3 0 0 3

INTRODUCTION TO FACTORY & PROCESS AUTOMATION: Industrial Versions - Introduction to Architecture of Totally Integrated Automation (TIA) - Components of TIA and its Functions - Industrial Automation Control Elements IEC/ ISA symbols and Utilization category of Control Elements - Relay Ladder logic using control elements. **(9)**

PROGRAMMABLE LOGIC CONTROLLERS: Architecture of PLC - Types of PLC - PLC Configuration - PLC modules -Selection criteria for PLC - PLC Wiring - Installation of PLC and its modules. **(9)**

PROGRAMMING OF PLC: Types of Programming - Bit Instructions - Timers and counters - PLC arithmetic functions PTO / PWM generation - High Speed Counter - Analog Scaling - Encoder Interfacing - Servo drive control -Stepper Motor Control. **(9)**

HMI SYSTEMS: Need for HMI in Industrial Automation, - Types of HMI - Configuration of HMI, Screen development and navigation - Configuration of HMI elements / objects and Interfacing with PLC. Supervisory control and data acquisition (SCADA): Architecture - Tools - Tags - Graphics – Alarm logging - Tag logging - Trends - History - Report generation, Global Scripts for SCADA application. **(9)**

INDUSTRIAL NETWORKING: Types and comparison of Industrial Buses - Proprietary and open Protocols - OLE/OPC Networking standards & IEEE Standard - Introduction to Ether CAT - Applications of Various industrial Buses. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. W. Bolton, *'Programmable logic controllers'*. Elsevier Ltd, 2015.
2. Gordon Clarke, Deon Reyneders, Edwin Wright, *'Practical Modern SCADA Protocols: DNP3, 60870.5 and Related systems'*. Newnes Publishing, 2004.

REFERENCES

1. John R Hackworth and Fredrick D Hackworth Jr, *'Programmable Logic Controllers: Programming Methods and Applications*'. Pearson Education, India, 2006.
2. SIEMENS, *'SIMATIC Programming with STEP 7'*. SIEMENS Manual, 2014.
3. SIEMENS, *'SIMATIC STEP 7 in the Totally Integrated Automation Portal'*. SIEMENS AG, 2012.
4. William T Shaw, *'Cybersecurity for SCADA systems'*. PennWell, USA, 2006.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the process of Totally Integrated Automation (TIA), PLC architecture, HMI, SCADA systems, and industrial networking concepts.	**K2**
CO2	Apply PLC programming techniques to control industrial processes.	**K3**
CO3	Analyse user-friendly HMI interfaces and SCADA operations for monitoring and controlling processes	**K4**
CO4	Design and implement automation systems for integrating PLC, HMI and SCADA.	**K6**

COs-POs & PSOs MAPPING

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		2											
CO4			1										
	3	**2**	**1**										

1 – low, 2 – medium, 3 – high

25EEO02 EMBEDDED SYSTEMS AND INTERNET OF THINGS

3 0 0 3

FUNDAMENTALS OF EMBEDDED SYSTEMS: Basic Terminologies – Characteristics of Embedded Computing Applications– Embedded Software Development Process – Challenges in Embedded System Design – Compiler Optimization Techniques – Performance Optimization – UML Diagrams – Examples. **(9)**

EMBEDDED SYSTEM DESIGN USING MIXED SIGNAL PROCESSORS: GPIO- Interrupts –Timers – Watchdog Timers – Analog to Digital Converter – Serial Communication – Low Power Modes. **(9)**

REAL-TIME OPERATING SYSTEMS: Concept of OS-based Software Development – Real-Time Operating Systems: Definition, Characteristics and Structure – Task Management: Classification, Structure, States, and Scheduling – Concept of Pseudo Multitasking and True Multitasking – Task Synchronization – Inter-task Communication – Features of FreeRTOS. **(9)**

INTERNET OF THINGS: Introduction to Industry 4.0 – Machine to Machine (M2M) – Evolution of IoT - Consumer IoT vs Industrial IoT - Functional Components of a typical IoT System – Fog Computing - Introduction to Cloud Computing. **(9)**

IOT PROTOCOLS: Physical and Data Link Layer Protocols: RFID: NFC, FFC, ZigBEE, Bluetooth Low Energy, Z-Wave, Wi-Fi, Wireless HART - Network Layer Protocols: IPv4, IPv6, TCP & UDP, 6LoWPAN - Application Layer Protocols: COAP, MQTT – Security Issues – serial communication protocols: SPI, I2C, CAN - IoT Applications: Health Care, Connected Vehicles, Smart Grid, Smart Home, and Smart City. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. K V Shibu, '*Introduction to Embedded Systems'*. 2nd Edition, McGraw Hill Education India Private Limited, India, 2017.
2. Olivier Hersent, David Boswarthick, Omar Elloumi, '*The Internet of Things: Key Applications and Protocols'*. 2nd Edition, John Wiley and Sons Ltd, United Kingdom, 2012.

REFERENCES

1. David A. Simon, '*An Embedded Software Primer*'. 1st Edition, Pearson Education, India, 2002.
2. Qing Li, '*Real-Time Concepts for Embedded Systems*'. 1st Edition, CRC Press, US, 2003.
3. Wayne Wolf, '*Computers as Components: Principles of Embedded Computer Systems Design*'. Reed Elsevier Publications, Gurgaon, Haryana, 2009.
4. Adrian McEwen, Hakim Cassimally, '*Designing the Internet of Things'.* John Wiley and Sons Ltd, UK, 2014.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamentals of embedded systems, design challenges, and optimization techniques.	**K2**
CO2	Apply mixed-signal processor features (GPIO, ADC, timers) to design basic embedded applications.	**K3**
CO3	Analyze IoT protocols (BLE, Zigbee, MQTT) and their roles in consumer/industrial IoT systems.	**K4**
CO4	Evaluate embedded system architectures, RTOS features, IoT protocols, and communication technologies for developing efficient IoT-based applications.	**K5**

COs-POs & PSOs MAPPING

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		2											
CO4				1									
	3	**2**		**1**									

1 – low, 2 – medium, 3 – high

25EEO03 ENERGY TECHNOLOGIES

3 0 0 3

INTRODUCTION: Units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, Renewable and non-renewable energy sources and their availability. Prospects of Renewable energy sources**.** **(9)**

CONVENTIONAL ENERGY: Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion. **(9)**

NON-CONVENTIONAL ENERGY: Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy. **(9)**

BIOMASS ENERGY: Biomass origin - Resources – Biomass estimation. Thermochemical conversion – Biological conversion, Chemical conversion – Hydrolysis & hydrogenation, solvolysis, biocrude, biodiesel power generation gasifier, biogas, integrated gasification. **(9)**

ENERGY CONSERVATION: Energy conservation - Act; Energy management importance, duties and responsibilities; Energy audit – Types methodology, reports, instruments. Benchmarking and energy performance, material and energy balance, thermal energy management**.** **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Rao, S. and Parulekar, B.B,'*Energy Technology*'. Khanna Publishers, 2005.
2. Rai, G.D., '*Non-conventional Energy Sources*'. Khanna Publishers, New Delhi, 1984.
3. Bansal, N.K., Kleeman, M. and Meliss, M., '*Renewable Energy Sources and Conversion Technology*'. Tata McGraw Hill, 1990.
4. Nagpal, G.R., '*Power Plant Engineering*'. Khanna Publishers, 2008.

REFERENCES

1. Nejat Vezirog, '*Alternate Energy Sources*'. Hemisphere Publishing Corporation, 1978.
2. El. Wakil,'*Power Plant Technology*'. Tata McGraw Hill, New York, 2002.
3. Sukhatme. S.P., '*Solar Energy - Thermal Collection and Storage*'. Tata McGraw hill, New Delhi, 1981.

COURSE OUTCOMES

At the end of the course, students will be able to:		Bloom's Level
CO1	Describe the fundamentals and main characteristics of renewable energy sources.	**K2**
CO2	Apply renewable energy technologies such as solar, wind, ocean, geothermal, and biomass for sustainable energy applications.	**K3**
CO3	Analyze the performance and suitability of solar, wind, ocean, geothermal, and biomass energy systems.	**K4**

COs-POs & PSOs MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	2												
CO3		1				1							
	2	**1**				**1**							

1 – low, 2 – medium, 3 - high

25EEO04 SENSORS AND ACTUATORS

3 0 0 3

SENSORS: Difference between sensor, transmitter and transducer - Primary measuring elements - selection and characteristics: Range; resolution, Sensitivity, error, repeatability, linearity and accuracy, impedance, backlash, Response time, Dead band. Signal transmission - Types of signal: Pneumatic signal; Hydraulic signal; Electronic Signal. Principle of operation, construction details, characteristics and applications of potentiometer, Proving Rings, Strain Gauges, Resistance thermometer, Thermistor, Hot-wire anemometer, Resistance Hygrometer, Photo-resistive sensor. **(9)**

INDUCTIVE AND CAPACITIVE TRANSDUCER: Inductive transducers: - Principle of operation, construction details, characteristics and applications of LVDT, Induction potentiometer, variable reluctance transducer, synchros, microsyn. Capacitive transducers: - Principle of operation, construction details, characteristics of Capacitive transducers – different types & signal conditioning- Applications: - capacitor microphone, capacitive pressure sensor, proximity sensor. **(9)**

ACTUATORS: Definition, types and selection of Actuators; linear; rotary; Logical and Continuous Actuators, Pneumatic actuator- Electro-Pneumatic actuator; cylinder, rotary actuators, Mechanical actuating system: Hydraulic actuator - Control valves; Construction, Characteristics and Types, Selection criteria. Electrical actuating systems: Solid-state switches, Solenoids, Electric Motors- Principle of operation and its application: D.C motors - AC motors - Single phase & 3 Phase Induction Motor; Synchronous Motor; Stepper motors - Piezoelectric Actuator. **(9)**

MICRO SENSORS AND MICRO ACTUATORS: Micro Sensors: Principles and examples, Force and pressure micro sensors, position and speed micro sensors, acceleration micro sensors, chemical sensors, biosensors, temperature micro sensors and flow micro sensors. Micro Actuators: Actuation principle, shape memory effects-one way, two way and pseudo elasticity. Types of micro actuators- Electrostatic, Magnetic, Fluidic, Inverse piezo effect, other principles. **(9)**

SENSOR MATERIALS AND PROCESSING TECHNIQUES: Materials for sensors: Silicon, Plastics, metals, ceramics, glasses, nano materials Processing techniques: Vacuum deposition, sputtering, chemical vapour deposition, electro plating, photolithography, silicon micro machining, Bulk silicon micro machining, Surface silicon micro machining, LIGA process. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Patranabis.D, ‘*Sensors and Transducers*’. Wheeler publisher, 1994.
2. Sergej Fatikow and Ulrich Rembold, ‘*Microsystem Technology and Microbotics*’. 1st edition, Springer – Verlag Newyork, Inc, 1997.

REFERENCES

1. Thomas. G. Bekwith and Lewis Buck.N, ‘*Mechanical Measurements*’. Oxford and IBH publishing Co. Pvt. Ltd., 2007.
2. Massood Tabib and Azar, ‘*Microactuators Electrical, Magnetic, thermal, optical, mechanical, chemical and smart structures*’. 1st edition, Kluwer academic publishers, Springer, 1997.
3. Manfred Kohl, ‘*Shape Memory Actuators*’. 1st edition, Springer, 2004.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Explain the fundamental concepts of sensors, transducers, transmitters, their characteristics, and signal transmission methods.	**K2**
CO2	Apply the principles of resistive, inductive, and capacitive transducers for measurement of physical parameters in practical systems.	**K3**
CO3	Analyze the performance and selection of actuators including pneumatic, hydraulic, and electrical actuating systems based on application requirements.	**K4**
CO4	Evaluate the operation and effectiveness of micro sensors and micro actuators, including MEMS-based devices and smart materials.	**K5**

COs-POs & PSOs MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2											
CO4				1									
	3	**2**		**1**									

1 – low, 2 – medium, 3 – high

25EEO05 ELECTRICAL DRIVES

3 0 0 3

DRIVE CHARACTERISTICS: Electric drive - Equations governing motor load dynamics - steady state stability - multi quadrant Dynamics: acceleration, deceleration, starting & stopping - typical load torque characteristics- Selection of motor. **(9)**

CONVERTER / CHOPPER FED DC MOTOR DRIVES: Steady state analysis of the single and three phase converter fed separately excited DC motor drive - continuous and discontinuous conduction - Time ratio and current limit control - 4 quadrant operation of converter / chopper fed drive. **(9)**

AC MOTOR DRIVES: Induction Motor Drives - Stator voltage control-energy efficient drive-v/f control-constant airgap flux-field weakening mode - voltage / current fed inverter - closed loop control. Synchronous Motor Drives V/f control and self-control of synchronous motor: Margin angle control and power factor control**.** **(9)**

SPECIAL MACHINE DRIVES: PMSM: Types - Principle-Field Oriented Control of PMSM – Field weakening - BLDC motor – Trapezoidal Drive scheme – Sensor less Control scheme. Stepper motor: principle of operation – Bipolar & Unipolar Drive schemes - SRM drive: principle of operation - Introduction to SynRM drive. **(9)**

DIGITAL CONTROLLERS FOR DRIVES: Digital techniques in speed control - Microprocessor/Microcontroller & PLC based control of drives- networking of drives - Selection of drives and control schemes for Steel rolling mills, Paper mills, Cement mills, Machine tools, Lifts and Cranes. Robot - AGVs. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Dubey G K, *‘Fundamentals of Electrical Drives’*. Narosa Publishing House, New Delhi, 2012.
2. Vedam Subramanyam, *‘Electric Drives: Concepts and Applications’*. Tata McGraw-Hill, New Delhi, 2011.

REFERENCES

1. Ramu Krishnan R, ‘*Permanent-Magnet Synchronous and Brushless DC Motor Drives’*. CRC Press, 2017
2. Ned Mohan, Siddharth Raju, ‘*Analysis and Control of Electric Drives: Simulations and Laboratory Implementation*’. Wiley, 2021
3. JuhaPyrhonen, Valeria Hrabovcova, R. Scott Semken, ‘*Electrical Machine Drives Control: An Introduction*’. Wiley, 2016.
4. Peter, Vas, ‘*Vector control of AC machines’*. Oxford University Press,1990.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom’s Level**
CO1	Explain the motor load characteristics, power converters and controllers for electric drives.	**K2**
CO2	Compute the performance parameters for converter fed DC/AC & special drives.	**K3**
CO3	Analyse the working of different digital controllers employed for an electric drive application.	**K4**

COs-POs & PSOs MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		1			1								
	3	**1**			**1**								

1 – low, 2 – medium, 3 – high

25EEO06 ELECTRIC VEHICLE TECHNOLOGY

3 0 0 3

VEHICLE ARCHITECTURE AND SIZING: Electric Vehicle History, and Evolution of Electric Vehicles. Series, Parallel and Series parallel Architecture, Micro and Mild architectures. Mountain Bike - Motorcycle- Electric Cars and Heavy Duty EVs. -Details and Specifications. **(9)**

VEHICLE MECHANICS: Vehicle mechanics - Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire – Road mechanics, Propulsion System Design. **(9)**

POWER COMPONENTS AND BRAKES: Power train Component sizing- Gears, Clutches, Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Powertrain sizing, Example. **(9)**

HYBRID VEHICLE CONTROL STRATEGY: Vehicle supervisory control, Mode selection strategy, Modal Control strategies. **(9)**

PLUG-IN HYBRID ELECTRIC VEHICLE: Introduction-History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV-Block diagram and components-Charging Mechanisms-Advantages of PHEVs. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Shashank Arora, Alireza Tashakori Abkenar, Shantha Gamini Jayasinghe, Kari Tammi, *‘Heavy-duty Electric Vehicles from Concept to Reality’.* Elsevier Science, 2021
2. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, *‘Electric Vehicles Modern Technologies and Trends’.* Springer, 2020
3. Rogelio León , Christian Montaleza , José Luis Maldonado , Marcos Tostado-Véliz and Francisco Jurado, *‘Hybrid Electric Vehicles: A Review of Existing Configurations and Thermodynamic Cycles’*. Thermo, 2021.

REFERENCES

1. Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, *‘Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals’.* Theory and Design', CRC Press, 2004.
2. Seth Leitman & Bob Brant, ‘*Build Your Own Electric Vehicle’*. Mc Graw Hill, 3rd Edition 2013.
3. Ali Emadi, ‘*Advanced Electric Drive Vehicles’*. CRC Press, 1st edition 2017.
4. Mark Warner, ‘*The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles, and Bicycles -- Includes EV Components, Kits, and Project Vehicles*’. HP Books, 2011.

COURSE OUTCOMES

Upon completion of the course, students will be able to:		**Bloom’s Level**
CO1	Explain the architecture, evolution, and classification of electric and hybrid electric vehicles.	**K2**
CO2	Apply vehicle mechanics principles to evaluate vehicle performance, propulsion requirements, and road load characteristics.	**K3**
CO3	Analyze the sizing and selection of powertrain components, transmission systems, and braking systems for EVs and HEVs.	**K4**

COs-POs & PSOs MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	2												
CO3		1											
	2	**1**											

1 – low, 2 – medium, 3 - high

25EEO07 BIOMEDICAL INSTRUMENTATION

3 0 0 3

BIOELECTRIC POTENTIALS AND ELECTRODES: Cells and their structures - Transport of ions through cell membrane - Electrode-electrolyte interface, electrode– skin Interface - Origin of bio potential and its propagation - action and resting potential - Bioelectric potential - Bio potential electrodes – Types of electrodes: surface, needle and microelectrodes. **(12)**

CARDIO SYSTEM AND MEASUREMENTS: Heart and cardiovascular system – ECG – 12 lead system - principle of vector cardiography - blood pressure and its measurement – Measurements of heart sounds – PCG - Defibrillator: principle and types -pacemakers: principle and types. **(9)**

NERVOUS SYSTEM AND MEASUREMENTS: Central and peripheral nervous system - parts of human brain- Action potential of brain - brain wave – EEG- 10-20 electrode system – Nerve stimulator. **(8)**

RESPIRATORY SYSTEM AND MEASUREMENTS: Physiology of respiratory system - Principle of pneumograph - Spirometer - ventilators: principle and types. **(8)**

MEDICAL IMAGING: X-ray imaging - Computed Tomography (CT) - Ultrasonic Scanner- Magnetic Resonance Imaging - Positron Emission Tomography (PET). **(8)**

Total L: 45 Periods

TEXT BOOKS

1. Leslie Cromwell, Fred J Weibell, Erich A. Pfeiffer, ‘*Biomedical Instrumentation and Measurements’*. Pearson Education, India, 2nd Edition, 2018.
2. Khandpur R S, ‘*Handbook of Biomedical Instrumentation’*. McGraw Hill Education (I) P Ltd, Chennai, 5th Edition, 2018.

REFERENCES

1. John G Webster, ‘*Medical Instrumentation: Application and Design’*. John Wiley and Sons, 5th Edition, 2020.
2. Joseph J Carr, John M Brown, ‘*Introduction to Biomedical Equipment Technology’*. Pearson Education, India, 4th Edition, 2006.
3. L.A.Geddes, L.E. Baker, ‘*Principles of Applied Biomedical Instrumentation’*. John Wiley and Sons, 3rd Edition, 2009.
4. Richard Aston, ‘*Principles of Biomedical Instrumentation and Measurement’*. Merril Publishing Company, New York,1St Edition, 1990.

COURSE OUTCOMES:

Upon successful completion of the course, the students should be able to:		**Bloom’s Level**
CO1	Describe the origin and propagation of bioelectric potentials and explain the types and functions of biopotential electrodes	**K2**
CO2	Apply the principles of measurement techniques for monitoring cardiac, nervous, and respiratory system functions	**K3**
CO3	Analyse the operation and significance of biomedical instruments such as ECG, EEG, defibrillators, pacemakers, spirometers, and ventilators.	**K4**

COs-POs & PSOs MAPPING

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		1											
	3	**1**											

1 – low, 2 – medium, 3 – high

25EEO08 ELECTRICAL SAFETY PRACTICES AND STANDARDS

3 0 0 3

INTRODUCTION TO ELECTRICAL SAFETY: Fundamentals of Electrical safety – Electric Shock – Physiological effects of electric current – Safety requirements – Hazards of electricity – Arc – Blast – Causes for electrical failure. **(9)**

SAFETY COMPONENTS: Introduction to conductors and insulators – Voltage classification – Safety against over voltages – Safety against static electricity – Electrical safety equipment – Fire extinguishers for electrical safety – Introduction to modern protective technologies including smart protection devices and IoT-enabled relays. **(9)**

GROUNDING: General requirements for grounding and bonding – Definitions – System grounding – Equipment grounding – The Earth – Earthing practices – Determining safe approach distance – Determining arc hazard category. **(9)**

SAFETY PRACTICES: General first aid – Safety in handling hand-held electrical appliances and tools – Electrical safety in train stations, swimming pools, external lighting installations, and medical locations – Safety practices in electric vehicle (EV) charging infrastructure – Case studies. **(9)**

STANDARDS FOR ELECTRICAL SAFETY: Electricity Acts – Rules & regulations – Electrical standards – NFPA 70E – OSHA standards – IEEE standards – National Electrical Code 2023 – National Electrical Safety Code (NESC) – Statutory requirements from Electrical Inspectorate. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Dennis K. Neitzel, Mary Capelli-Schellpfeffer, Al Winfield, '*Electrical Safety Handbook'. McGraw-Hill*, USA, 2019.
2. National Fire Protection Association (NFPA), '*NFPA 70E: Handbook for Electrical Safety in the Workplace'. NFPA*, USA, 2024.
3. Charles R. Miller, '*Illustrated Guide to the National Electrical Code'. Cengage Learning*, USA, 2023.

REFERENCES

1. John Cadick, Mary Capelli-Schellpfeffer, Dennis K. Neitzel, '*Electrical Safety Handbook'. McGraw-Hill*, USA, 2012.
2. Dale R. Patrick, Stephen W. Fardo, '*Principles of Electrical Safety'. CRC Press*, Boca Raton, USA, 2020.
3. Richard A. Cox, '*Electrical Safety in the Workplace'. Jones & Bartlett Learning*, Burlington, USA, 2019.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand different types of electrical hazards, electrical safety standards and regulations	**K2**
CO2	Apply the knowledge of electrical safety standards and regulations like OSHA, IEEE and National Electrical Code during installation, testing and commissioning procedure	**K3**
CO3	Analyze electrical hazards and provide solutions to minimize risks of electrical accidents	**K4**

COs-POs & PSOs MAPPING

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3					2	2						
CO3		2				2	2						
	3	**2**				**2**	**2**						

1 – low, 2 – medium, 3 - high

ONE CREDIT COURSE SYLLABUS

25EE901 PCB DESIGNING
(Common to EEE & ICE)

0 0 2 1

INTRODUCTION TO PCB DESIGN CONCEPTS: Introduction and Brief History – PCB Types: Single Sided and Multi-Layer – PCB Materials – Introduction to Electronic Design Automation (EDA). **(6)**

COMPONENT CATEGORIES AND PACKAGE TYPES: Active Components: Diode, Transistor, MOSFET, LED, SCR, Integrated Circuits – Passive Components: Resistor, Capacitor, Inductor, Transformer – Reading Component Package Types and Footprints from datasheet. **(6)**

PCB DESIGN: Introduction to PCB Software Platform – Schematic Drawing – Component Library and Footprint Assignment – PCB Layout Design– Gerber File Generation and Export. **(8)**

PCB LAYOUT DESIGN, FABRICATION AND ASSEMBLY: Prototype Design – Printing, Etching and Drilling – Component Assembly and Testing. **(10)**

Total P: 30 Periods

TEXT BOOKS

1. R. S. Khandpur, '*Printed Circuit Boards: Design, Fabrication, and Assembly'*. McGraw-Hill, 2005
2. Walter C. Bosshart, '*Printed Circuit Boards: Design and Technology'*. McGraw-Hill, 1983.

REFERENCES

1. EasyEDA Documentation, Available: https://docs.easyeda.com/en/Introduction/PCB-Layout/
2. https://docs.kicad.org/

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the basic concepts of PCB design including types and materials.	**K2**
CO2	Apply knowledge of active and passive components and their package types in PCB design.	**K3**
CO3	Analyse different PCB design stages including schematic creation, net-listing, layout and prototype assembly.	**K4**
CO4	Design a complete PCB incorporating appropriate components, footprints and assembly techniques for the given application.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3										3		3
CO3		1									1		1
CO4			3		3			2	2		3		3
	3	**3**	**3**		**3**			**2**	**2**		**3**		**3**

1 – low, 2 – medium, 3 – high

25EE902 MODELLING AND COMPUTATIONAL TOOLS FOR ELECTRICAL ENGINEERS
(Common to EEE & ICE)

0 0 2 1

MATLAB FOR ELECTRICAL ENGINEERS: Matrix Operations for KVL and KCL – Plotting: Time-domain Waveforms and Multi-plot Figures – User-defined Functions – Loops and Conditional Statements. **(6)**

DATA ACQUISITION, LOGGING AND PREDICTION: Serial Communication between Arduino and MATLAB – Real-time Data Capture and Plotting – Threshold-based Event Detection – Data Storage and CSV Export – Curve Fitting and Regression toolbox. **(6)**

SOLVING ODES IN MATLAB: RC Circuit: Analytical Solution – RC Circuit: Euler Method – RC Circuit: ODE45 – DC Motor: Equation and Problem Statement – DC Motor: Euler Method – DC Motor: ODE45. **(6)**

MODEL-BASED SYSTEM DESIGN (MBSD) USING SIMULINK: Introduction to Simulink Environment – Counter – Edge Detector – Latch – Windshield Wiper Model – Simple Vehicle Model: Equation to Simulink. **(6)**

DC MOTOR MODELLING AND MINI PROJECT: Introduction to Simscape Physical Modelling – DC Motor in Simscape: Comparison with Simulink Model – DC Motor Thermal Modelling – Closed-loop Speed Control – Mini Project: Simulation and Performance Analysis of an Electrical or Electromechanical System, MBSD for electromechanical system.

(6)

Total P: 30 Periods

TEXT BOOKS

1. Rudra Pratap, '*Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers'*. Oxford University Press, 2019
2. Stormy Attaway, '*MATLAB: A Practical Introduction to Programming and Problem Solving'*. 5th Edition, Butterworth-Heinemann, 2022
3. MathWorks, '*Simulink Getting Started Guide'*. MathWorks Documentation, 2024, Available: https://www.mathworks.com/help/simulink

REFERENCES

1. MathWorks, '*Simscape User's Guide'*. MathWorks Documentation, 2024, Available: https://www.mathworks.com/help/physmod/simscape
2. NPTEL Course '*MATLAB Programming for Numerical Computation'*. Prof. Niket Kaisare, IIT Madras.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain MATLAB programming environment and matrix methods for electrical engineering problems.	**K2**
CO2	Apply MATLAB to acquire, log, analyse and predict from real-time engineering data.	**K3**
CO3	Analyse physical systems using Simulink and Simscape toolbox.	**K4**
CO4	Build	**K5**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3											1	1
CO3		3			3							1	1
CO4										3			
	3	**3**			**3**					**3**		**1**	**1**

1 – low, 2 – medium, 3 – high

25EE903 VHDL AND VERILOG PROGRAMMING
(Common to EEE & ICE)

0 0 2 1

COMBINATIONAL CIRCUIT DESIGN USING VERILOG/VHDL: Introduction to Verilog and VHDL – VHDL File Structure and Operators – How to Write Verilog Code – Hands-on using Simulation – Code Development for Combinational Circuits: Multiplexers, Demultiplexers, Adders, Subtractors, Encoders, Decoders, Code Converters. **(6)**

SEQUENTIAL CIRCUIT DESIGN AND TEST BENCH: Verilog/VHDL Code for Synchronous Sequential Circuits – Latches and Flip-flops – Counters and their Types – Shift Registers – Test Bench Development. **(6)**

FSM DESIGN AND IMPLEMENTATION: Finite State Machine: Mealy and Moore Models – Sequence Detector using FSM – Complete Memory Design – FPGA Board. **(6)**

DIGITAL SYSTEM DESIGN AND FPGA DEMONSTRATION: Smart Traffic Light Controller using FSM: Mealy/Moore, Counters, Multiplexers – Digital Voting Machine: Sequential Circuits, Shift Registers, Encoders – 4-bit Arithmetic Logic Unit: Combinational Logic, Adders, Subtractors – Automatic Vending Machine using FSM: Decoders, Counters – FPGA Board Implementation and Demonstration. **(12)**

Total P: 30 Periods

TEXT BOOKS

1. M. G. Arnold, '*Verilog Digital Computer Design: Algorithms into Hardware*'. New York, NY, USA: McGraw-Hill Education, 1999.
2. J. Cavanagh, '*Digital Design and Verilog HDL Fundamentals*'. Boca Raton, FL, USA: CRC Press, 2008.

REFERENCES

1. P. D. Minns and I. J. Elliott, '*Digital System Design Using FSMs: A Practical Learning Approach*'. Chichester, U.K.: Wiley, 2008.
2. D. Thomas, '*Digital VLSI Design Using Verilog*'. New York, NY, USA: Springer, 2008.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Write Verilog/VHDL code using software for combinational and sequential circuits including multiplexers, counters and FSMs.	**K2**
CO2	Develop and demonstrate a functional digital system on FPGA integrating FSM and combinational or sequential logic.	**K3**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3												
CO2			3		3						1		3
	3		**3**		**3**						**1**		**3**

1 – low, 2 – medium, 3 - high

25EE904 ELECTRIC VEHICLE TECHNOLOGY
(Common to EEE & ICE)

0 0 2 1

BATTERY TECHNOLOGY FOR ELECTRIC VEHICLES: Introduction to Energy Storage Systems – Types of Batteries – Battery Characteristics – Thermal Effects in Batteries – Battery Packaging and Safety Considerations. **(6)**

EV CHARGING TECHNOLOGY: Types of EV Chargers – AC Charging – DC Fast Charging – Wireless Charging – Charging Standards and Protocols – Charging Infrastructure Requirements. **(6)**

BATTERY MANAGEMENT SYSTEM: Functions of BMS – Cell Balancing – SOC and SOH Estimation Techniques – Communication Protocols in BMS – Thermal Management in BMS – Fault Detection and Diagnostics. **(6)**

SUSTAINABILITY OF EVs: Life Cycle Assessment of EVs – Battery Cycler with Data Analytics – Policies and Regulations for EV Adoption. **(6)**

EV DRIVE TRAIN MODELLING AND SIMULATION: Components of EV Drive Train – Mathematical Modelling of EV Drive Train – Vehicle Dynamics and Load Modelling – Performance Analysis – Case Study and Mini Project on EV. **(6)**

Total P: 30 Periods

TEXT BOOKS

1. Iqbal Husain, '*Electric and Hybrid Vehicles: Design Fundamentals*'. CRC Press, 2021.
2. Davide Andrea, '*Battery Management Systems for Large Lithium-Ion Battery Packs*'. ARTECH House, 2010.
3. Gregory L. Plett, '*Battery Management Systems, Volume I: Battery Modelling*'. Artech House, 2015.

REFERENCES

1. Tom Denton, '*Automotive Electrical and Electronic Systems*'. 5th Edition, 2018
2. Phil Weicker, '*Battery Management Systems and SOC Development: A Hands-On Approach*'. SAE International, 2013.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand the basics of battery and electric vehicle technology.	**K2**
CO2	Apply fundamental concepts of EV charging systems and battery charging characteristics	**K3**
CO3	Analyse battery performance data, EV driveline performance and communication protocols for EV application.	**K4**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3				2							1	1
CO3		3			3							1	1
	3	**3**			**3**							**1**	**1**

1 – low, 2 – medium, 3 - high

25EE905 DATA SCIENCE AND ANALYTICS FOR ELECTRICAL ENGINEERS
(Common to EEE & ICE)

0 0 2 1

INTRODUCTION TO DATA AND MACHINE LEARNING: Data Warehouse and Business Intelligence – Big Data – Machine Learning – Deep Learning – How these Technologies Evolved and Interconnected. **(6)**

REVIEW OF BASIC ANALYTICS METHODS: Phase 1: Discovery – Phase 2: Data Preparation – Phase 3: Model Planning – Phase 4: Model Building – Phase 5: Communicate Results and Visualization – Phase 6: Operationalize and Optimize Model – Demo and Lab Assignment. **(6)**

INTRODUCTION TO ADVANCED ANALYTICS: Unsupervised Learning: Basics of Unsupervised Learning – K-means Clustering – Association Rules – Regression Analysis: Linear and Logistic. **(6)**

INTRODUCTION TO ADVANCED ANALYTICS: Supervised Learning: Basics of Supervised Learning – Naive Bayesian Classifier – Decision Trees – Time Series Analysis – Text Analysis. **(6)**

USE CASES OF BIG DATA AND MACHINE LEARNING FOR ELECTRICAL ENGINEERS: Smart Meters and Smart Grid Applications. **(6)**

Total P: 30 Periods

TEXT BOOKS

1. Ethem Alpaydin, '*Introduction to Machine Learning*'. 2nd Edition, PHI Learning Pvt. Ltd, New Delhi, 2020.
2. Vignesh Prajapati, '*Big Data Analytics with R and Hadoop*'. 1st Edition, Packt Publishing Ltd, Mumbai, 2013.
3. Zhou Shiyu and Yong Chen, '*Industrial Data Analytics for Diagnosis and Prognosis: A Random Effects Modelling Approach*'. John Wiley and Sons, 2021.

REFERENCES

1. Lee Elisa T. and John Wang, '*Statistical Methods for Survival Data Analysis*'. Vol. 476, John Wiley and Sons, 2003.
2. Colin Ware, '*Information Visualization: Perception for Design*'. Elsevier, 2013.
3. Kieran Healy, '*Data Visualization: A Practical Introduction*'. Princeton University Press, 2018.

COURSE OUTCOMES

At the end of the course, students will be able to:		Bloom's Level
CO1	Explain the basics of data analytics and machine learning techniques.	K2
CO2	Apply data analytics and machine learning techniques to develop and implement prognostic models for electrical engineering applications.	K3
CO3	Analyse data from automotive and industrial systems to evaluate and compare machine learning models for real-time applications.	K4

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				2								2
CO3		3			3								2
	3	**3**			**3**								**2**

1 – low, 2 – medium, 3 – high

LANGUAGE ELECTIVES
25HS211 COMMUNICATION SKILLS FOR ENGINEERS
(Common to all B.E./B.Tech. Programmes)

0 0 4 2

COMMUNICATION CONCEPTS: Process of Communication – Inter and Intrapersonal Communication – Essentials for effectiveness. **(9)**

ORAL COMMUNICATION: Oral presentations with visual aids and Group discussions. **(16)**

FOCUS ON SOFT SKILLS: Etiquette – Work Place etiquette – Telephone etiquette- Body Language – Critical Reasoning and Conflict Management based on Case Studies – Group Communication- Meetings -Interview Techniques. **(14)**

TECHNICAL WRITING: Technical Writing Principles - Style and Mechanics - Technical Definitions – Physical, Functional and Process Descriptions – Technical Report Writing – Preparing Instructions – Interpretation of Technical Data. **(14)**

BUSINESS CORRESPONDENCE: Writing Emails, Preparing Resumes. **(7)**

Total P: 60 periods

TEXT BOOKS

1. Course materials prepared by the Faculty, Department of English, PSG Institute of Technology and Applied Research, Neelambur, Coimbatore.

REFERENCES

1. Jeff Butterfield, '*Soft Skills for Everyone*'. Cengage Learning, New Delhi, 2020.
2. Sabina Pillai, and Agna Fernandez, '*Soft skills and Employability Skills*'. Cambridge University Press, New Delhi, 2019.
3. Prashant Sharma, '*Soft Skills Personality Development for Life Success*'. BPB Publications, New Delhi, 2021.
4. K. N. Shoba, and D. Praveen Sam, '*Technical English*'. Cambridge University Press, New York, 2020.

COURSE OUTCOMES

At the end of the course, students will be able to:		Bloom's Level
CO1	Produce clear and concise technical reports, compose professional and effective emails and develop well-structured and impactful resumes	**K2**
CO2	Plan, organize, and deliver engaging and informative presentations using appropriate visual aids and participate positively in group discussions	**K3**
CO3	Resolve disagreements constructively, embody professional conduct and a strong work ethic and apply critical thinking to generate effective solutions	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1										2			
CO2										3			
CO3									3	3			
									3	**3**			

1-low, 2-medium, 3-high

25HS212 BASIC GERMAN
(Common to all B.E./B.Tech. Programmes)

0 0 4 2

Guten Tag! - Learning: To greet, learn numbers till 20, practice telephone numbers & e mail address, learn alphabet, speak about countries & languages; **Vocabulary:** related to the topic; **Grammar:** W – Questions, Verbs & Personal pronouns I.

Freunde, Kollegen und ich - Learning: To speak about hobbies, jobs, learn numbers from 20; **Vocabulary:** related to the topic; **Grammar:** Articles, Verbs & Personal pronouns II, sein & haben verbs, ja/nein Frage, singular/plural.

In der Stadt – Learning: To know places, buildings, question, know transport systems, understand international words; **Vocabulary**: related to the topic; **Grammar:** Definite & indefinite articles, Negotiation, Imperative with Sie.
Guten Appetit! – Learning: To speak about food, shop, converse; **Vocabulary:** related to the topic; **Grammar:** Sentence position, Accusative, Accusative with verbs.

Tag für Tag and Zeit mit Freunden – Learning: To learn time related expressions, speak about family, ask excuse, fix appointments on phone, birthdays, understand & write invitations, converse in the restaurant; **Vocabulary:** related to the topic; **Grammar:** Preposition – am, im, um, von…bis, Possessive articles, Modal verbs.

Total P: 60 periods

TEXT BOOK:

1. Dengler, Stefanie et al., '*Netzwerk A1.1*'. Klett-Langenscheidt Gmbh, München, 2013.

REFERENCES:

1. Dengler, Stefanie et al., '*Netzwerk A1'.* Klett-Langenscheidt Gmbh München, 2013.
2. Sandra Evans, Angela Pude, and Franz Specht, '*Menschen A1*'. Hueber Verlag, 2012.
3. Hermann Funk, Christina Kuhn, and Silke Demme, '*Studio d A1*'. Goyal Publishers & Distributors Pvt. Ltd, 2009.
4. Rosa-Maria Dallapiazza, Eduard von Jan, '*Til Schönherr*'. Tangram Aktuell 1 (Deutsch als Fremdsprache), Max Hueber Verlag, 2004.

25HS213 BASIC JAPANESE
(Common to all B.E./B.Tech. Programmes)

0 0 4 2

Orientation Session, Geographic & Socio, economic perspective to Japan, Japanese people and culture and Basic greetings and responses.

Basic script, Method of writing hiragana and katakana, and Combination sounds and simple words.

Topic marker "wa", Desu / dewa arimasen cupolas, Interrogative particle "ka", Grammar particles "mo", "no", "Introducing someone: "Kochira wa ~" and Self introductions: Hajimemashite"

Demonstratives "Kore", "Sore", "Are", Demonstrative "Kono", "Sono", "Ano", Possessive noun particle "no" and Japanese apartments: Greeting your neighbor.

Place markers "Koko", "Soko", "Asoko", Direction markers "Kochira", "Sochira", "Achira" and Japanese department stores: Asking for and buying something.

Asking for and telling the time, Particle "ni (at)" for time, kara (from) ~ made (until), Particle "to (and)", Time periods: Days of the week, months, time of day, Verbs (Present / future and past tense) and Telephone enquiry: Asking for a phone no. And business hours.

Destination particle "e", Particles "de (mode of transportation)" and "to (with) and Japanese train station: Asking for Fare and track no. / types of trains.

Direct object particle "o", Particle "de (place of action)", Verbs ("~masen ka", "~mashou") and "Ohanami" Cherry blossom viewing.

Particle "de (by means of)", Particle "ni (to)", Aaemasu (give) and Moraimasu (receive) and Visiting a Japanese house.
Adjectives ("i" and "na" type), Adjectives (Positive and negative usage), Particle "ga (however, but), "Dore which?)" and Leaving a room, thanking someone for hospitality.

Likes and dislikes, Potential verbs (wakarimasu and dekimasu), "Kara (~ because)", Adverbs and Asking someone out over the phone.

Verbs denoting presence: "Imasu" and "arimasu", Particle "ni (in)", "Dare (who?)", Adverbs ("Chikaku ni ~ "), Particle "dare mo (negative ~ no one)" , Dare ka (anyone), dare ga (who) , Nani ka (anything) , nani ga (what) - ~ya (and) ~ nado (etc.) and Asking for directions.

Counters and Counting suffixes.

Introduction to Adjectives (na and ii type), Different usages of adjectives, Comparison, Likes and dislikes and Going to a trip.

Need and desire (ga hoshii), Wanting to … (Tabeti desu), Going for a certain purpose (mi –ni ikimasu) and Choosing from a menu.
Verb groups, I, II and III and Exercises to group verbs.

Please do (te kudasai), Present continuous tenses (te imasu), Shall I? (~ mashou ka) and Describing a natural phenomenon (It is raining).
To grant permission (~te mo ii desu), Asking for permission (~ te mo ii desu ka) and Should not do (~ te waikemasen) Describing a continuing state and Describing a habitual action.
Roleplays in Japanese.
A demonstration on usage of chopsticks and Japanese tea party. **Total P: 60 periods**

TEXT BOOK

1. '*Minna no nohongo'.* – Romaji ban (first 10 lessons of this book).

REFERENCE

1. '*Minna no Nihongo I Honsatsu Roma – ji ban (Main Textbook Romanized Version)'.* International publisher – 3A Corporation,Tokyo, Indian distributor – Goyal Publishers & Distributors, New Delhi

MANDATORY COURSES
25MC001 ENVIRONMENTAL SCIENCE
(Common to B.E./B.Tech. Programmes)

3 0 0 3

INTRODUCTION TO ENVIRONMENT: Environment - Definition, scope and importance. Types and composition of atmosphere – particles, ions and radicals. Ozone layer- significance, formation and depletion. Ecosystems- Structure and functions, components, energy flow, food chains, food web, Biodiversity-levels, values and threats – India as a mega-diversity nation, hotspots of biodiversity, endangered and endemic species of India, conservation of biodiversity. **(9)**

ENERGY RESOURCES: Introduction – National and International status- exploitation - sustainable strategies- Fossil fuels-classification, composition, physico-chemical characteristics and energy content of coal, petroleum and natural gas; solar energy - introduction, harnessing strategies. Wind energy - availability, wind power plants, wind energy conversion systems, site characteristics, and types of wind turbines. Supporting renewable energy resources -tidal, geothermal, hydroelectric. **(9)**

ENVIRONMENTAL POLLUTION: Definition, Sources, causes, impacts and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards, RF hazards, Role of an individual in prevention of pollution. Disaster Management: Floods, earthquake, cyclone and landslides – Case studies, consequences and rescue measures. **(9)**

WASTE MANAGEMENT: Waste water - Characteristics of domestic and industrial wastewater - COD and BOD, Various stages of treatment – primary, secondary, tertiary treatment- Biological and advanced oxidation processes. Solid waste management – Characteristics of municipal solid waste (MSW), biomedical, automobile and e-wastes and their management, landfills, incineration, pyrolysis, gasification and composting**.** **(9)**

SOCIAL ISSUES AND THE ENVIRONMENT: Environmentally Sustainable work practices- Rain water harvesting, Role of non-governmental organizations. Human ethics and rights- impact on environment and human health, role of information technology on environment and human kind. Green IT policies, Process of EIA - ISO 14000. Legislation- Environment protection act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Gilbert M. Masters, '*Introduction to Environmental Engineering and Science*'. Pearson Education, New Delhi, 2004.
2. Deswal S and Deswal A, '*A Basic Course in Environmental Studies*'. Dhanpat Rai and Co, New Delhi, 2004.

REFERENCES:

1. Benny Joseph, '*Environmental Science and Engineering*'. Tata McGraw - Hill, New Delhi, 2006.
2. Koteswara Rao M V R, '*Energy Resources: Conventional & Non – Conventional*'. BSP Publications, New Delhi, 2006.
3. Botkin and Keller, '*Environmental Science*'. Wiley India Private Limited, New Delhi, 2013.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the basic concepts of environment, energy sources and waste management	**K2**
CO2	Use different renewable energy resources and environment protection measures for sustainable development	**K3**
CO3	Conduct a case study on real-time environmental issues and present findings as a team	**-**

COs-POs & PSOs MAPPING:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	1												
CO3						2	2	2			2		
	1					**2**	**2**	**2**			**2**		

1-low, 2-medium, 3-high

25MC002 INDIAN CONSTITUTION
(Common to B.E./B.Tech. Programmes)

2 0 0 0

INTRODUCTION: Evolution of Indian Constitution; significance of constitution; Composition; Preamble and its Philosophy. **(4)**

RIGHTS, DUTIES AND DIRECTIVE PRINCIPLES: Fundamental Rights- Writs and Duties, Directive Principles of State Policy. **(5)**

UNION GOVERNMENT: Union Government, President and Vice President, Houses of the Parliament and their functions; Types of Bills, Stages of passing of Bill into an Act, Veto Power, Constitution Amendment Procedure, Various Amendments made and their significance for India. **(6)**

STATE GOVERNMENT AND FEDERALISM: Composition of State Legislature; Powers, Functions and Position of Governor, Function of Chief Ministers, Council of Ministers; The Indian Federal System, Administrative Relationship between Union and States. **(8)**

JUDICIARY: Supreme Court, High Court; District Court and Lower Courts - Functions and Powers – Judges – Qualifications and Powers - Judicial Review. **(7)**

Total L: 30 periods

TEXT BOOKS:

1. Subash C Kashyap, '*Our Political System*'. National Book Trust, 2011.
2. Praveenkumar Mellalli E, '*Constitution of India, Professional Ethics and Human Rights*'. Sage Publications India Pvt. Ltd., 2015.

REFERENCES:

1. Briji Kishore Sharma, '*Introduction to the Constitution of India*'. Prentice Hall of India, 2010.
2. Basu D D, '*Introduction to the Constitution of India*'. Prentice Hall of India, 2016.
3. Jain. M C, '*The Constitution of India*'. Law House, New Delhi, 2001.
4. Shukla V N, '*Constitution of India*'. Eastern Book Company Ltd., New Delhi, 2011.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the evolution, significance, and philosophy of the Indian Constitution, including its Preamble, composition, and core principles.	**K2**
CO2	Analyze the structure, powers, and functions of the Union and State Governments, including the roles of the President, Parliament, Governor, and Council of Ministers, as well as the legislative process, types of bills, and constitutional amendments.	**K4**
CO3	Conduct a case study on the Indian Constitution, demonstrating understanding of its evolution, fundamental rights and duties, structure of Union and State governments, federal system, and the role of the judiciary in governance.	**-**

COs-POs & PSOs MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	2												
CO3								2	2		2		
	2							**2**	**2**		**2**		

1-low, 2-medium, 3-high

25MC003 INDUSTRIAL SAFETY
(Common to B.E./B.Tech. Programmes)

2 0 0 0

SAFETY TERMINOLOGIES: Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold Limit Value (TLV) -Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)- acute and chronic Effects-Routes of Chemical Entry-Personnel Protective Equipment- Health and Safety Policy-Material Safety Data Sheet MSDS. **(6)**

STANDARDS AND REGULATIONS: Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006. **(6)**

SAFETY ACTIVITIES: Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment. **(6)**

WORKPLACE HEALTH AND SAFETY: Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety- Toxic gas Release. **(6)**

HAZARD IDENTIFICATION TECHNIQUES: Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment. **(6)**

Total L: 30 periods

TEXTBOOKS

1. Jain R. K. and Sunil S. Rao, '*Industrial Safety, Health and Environment Management Systems*'. Khanna Publisher, 4th Edition, 2000.
2. Deshmukh L. M., *'Industrial Safety Management: Hazard Identification and Risk Control'.* McGraw-Hill Education, 2007.

REFERENCES

1. John Ridley, John Channing, '*Safety at Work*'. Routledge, 7th Edition, 2008.
2. Dan Petersen, '*Techniques of Safety Management*: *A System Approach*'. Amer Society of Safety Engineers, 4th Edition, 2003.

COURSE OUTCOMES

At the end of the course, students will be able to		**Bloom's Level**
CO1	Describe the safety protocols and standard operating procedures in industrial settings to ensure compliance with safety regulations and minimize hazards in the workplace.	**K2**
CO2	Implement and test emergency response plans tailored to the industrial environments, ensuring effective action during emergencies such as fires, chemical spills or equipment malfunctions.	**K3**
CO3	Review and present on risk assessments and hazards using industry-specific tools to identify potential safety risks and choose appropriate corrective actions to prevent accidents and injuries.	**-**

CO - PO & PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	2					2	2						
CO3						1	1	1	1		1		1
	2					**2**	**2**	**1**	**1**		**1**		**1**

1 - low, 2- medium, 3 – high

25MC004 DISASTER RISK REDUCTION AND MANAGEMENT
(Common to B.E./B.Tech. Programmes)

2 0 0 0

HAZARDS, VULNERABILITY AND DISASTER RISKS: Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Types of Disasters: Natural, Human induced, Climate change induced – Earthquake, Landslide, Flood, Drought, Fire, etc. – Technological disasters - Structural collapse, Industrial accidents, oil spills - Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Disaster vulnerability profile of India and Tamil Nadu - Global trends in disasters: urban disasters, pandemics, Complex emergencies, Inter relations between Disasters and Sustainable development Goals. **(6)**

DISASTER RISK REDUCTION (DRR): Sendai Framework for Disaster Risk Reduction, Disaster cycle - Community Based DRR, Structural – Non-structural measures, Roles and responsibilities of - community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders - Early Warning System – Relevance of indigenous Knowledge, appropriate technology and Local resources. **(6)**

DISASTER MANAGEMENT: Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction - Disaster Risk Management and post disaster management – Compensation and Insurance- Disaster Management Act (2005) and Policy - Institutional Processes and Framework at State and Central Level - (NDMA – SDMA – DDMA – NRDF - Civic Volunteers). **(6)**

TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT: Early warning systems - Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness) – Role of GIS and Information Technology in Disaster Management – Disaster Damage Assessment - Elements of Climate Resilient Development – Standard operation Procedure for disaster response – Financial planning for disaster Management. **(6)**

DISASTER MANAGEMENT: CASE STUDIES: Case studies in the context of disasters - Landslide Hazard Zonation, Earthquake Vulnerability Assessment of Buildings and Infrastructure, Drought Assessment, Coastal Flooding, Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding, Forest Fire, Man Made disasters. **(6)**

Total L: 30 periods

TEXTBOOKS

1. Thomas D. Schneid, and Larry Collins, '*Disaster Management and Preparedness*'. CRC Publications, 2016.
2. R. Singh, '*Disaster Management Guidelines: Earthquakes, Landslides, Avalanches and Tsunami'*. Horizon Press Publications, 2017.
3. J. P. Singhal, '*Disaster Management'*. Laxmi Publications, 2024.
4. T. Bhattacharya, '*Disaster Science and Management'*. McGraw Hill India Education Pvt. Ltd., 2012.

REFERENCES

1. Government of India, '*Disaster Management Act'*. New Delhi, 2005.
2. Government of India, '*National Disaster Management Policy'*. New Delhi, 2009.
3. R. Shaw, '*Community based Disaster risk reduction*'. Natural Hazard Science, Oxford Research Encyclopedias, 2016.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Summarize the concepts, tools, technologies and strategies for disaster risk reduction and management.	**K2**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1					1	1	1	1	1		1		
					1	**1**	**1**	**1**	**1**		**1**		

1-low, 2-medium, 3-high

25MC005 INDIAN KNOWLEDGE SYSTEMS FOR SUSTAINABLE HUMAN DEVELOPMENT

2 0 0 0

INTRODUCTION TO INDIAN KNOWLEDGE SYSTEMS & HUMAN DEVELOPMENT (6)

- Meaning, scope, and significance of Indian Knowledge Systems
- Indian view of life: Purusharthas (Dharma, Artha, Kama, Moksha)
- Relationship between individual, society, and nature
- Relevance of IKS in modern education and engineering

INDIAN PERSPECTIVES ON SUSTAINABILITY & ECOLOGY (6)

- Indian worldview on nature: Pancha Mahabhutas
- Traditional water management, agriculture, and resource conservation
- Sustainable lifestyles in Indian traditions
- Comparison with modern sustainable development goals (SDGs

HEALTH, WELL-BEING & HUMAN POTENTIAL IN IKS (6)

- Indian concept of health: Body–Mind–Spirit integration
- Introduction to Ayurveda & Yoga for sustainable health
- Mental health and emotional balance in Indian wisdom
- Food, nutrition, and lifestyle from IKS perspective
- Preventive healthcare through traditional knowledge

ETHICS, VALUES & SOCIAL SUSTAINABILITY (5)

- Work ethics and leadership in Indian tradition
- Gender dignity and social justice in Indian thought
- Professional ethics through IKS

IKS, TECHNOLOGY & SUSTAINABLE DEVELOPMENT (7)

- Science and technology in ancient India
- Sustainable engineering in traditional architecture and town planning
- Metallurgy, textiles, and indigenous manufacturing systems
- IKS and modern innovation ecosystems and ethical responsibility
- Role of engineers in sustainable human development

Total L:30 periods

TEXTBOOKS

1. Dharampal, Indian Science and Technology in the Eighteenth Century
2. Kapil Kapoor, Indian Knowledge Systems
3. S Radhakrishnan, Indian Philosophy
4. B K Matilal, The Character of Logic in India
5. UGC–IKS Documents and AICTE IKS Modules
6. David Frawley, *Ayurvedic Healing*
7. *IIT-IKS Foundation Course Materials*
8. Ministry of Education – IKS Portal Resources

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the core concepts and evolution of Indian Knowledge Systems.	**K2**
CO2	Interpret Indian views on human development, ethics, and sustainability.	**K3**
CO3	Apply IKS principles to sustainable living and professional practices.	**K3**
CO4	Demonstrate social, ecological, and ethical responsibility in real-life situations.	**K3**

COs - POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1						3	2				3
CO2						3	3				2
CO3			2			3	3		2	2	
CO4				2		3	3	2			
			2	**2**		**3**	**3**	**2**	**2**	**2**	**3**

1 - low, 2- medium, 3 - high

25MC006 STRATEGIC DATA MANAGEMENT AND GOVERNANCE
(Common to all B.E./B.Tech. Programmes)

2 0 0 0

INTRODUCTION TO STRATEGIC DATA MANAGEMENT Data and Its strategic Value; Types of Data, Data as a Source of Competitive Advantage; The Data Lifecycle; Aligning Data Management with Business Goals; Data Management challenges in Contemporary Organizations; Overview of Data driven Decision making. **(6)**

DATA GOVERNANCE AND FRAMEWORK Introduction to Data Governance; Data Management Frameworks (DAMA-DMBOK, COBIT, ISO Data management Standards); Structuring Data Leadership Roles; Implementation of Data Policies and Standards. Master Data Management (MDM) and API Integration. **(6)**

DATA PRIVACY, ETHICS AND QUALITY MANAGEMENT Data Privacy and Protection Regulations (DPDP Act, GDPR); Principles and Importance of Ethical data management; Ethical decision-making models; Key data Quality Dimensions; Role of Data Quality in Effective Decision-Making; Tools and techniques for ensuring data quality. **(6)**

DATA LITERACY AND ORGANIZATIONAL TRANSFORMATION Role of Data Literacy in Modern Organisations; Strategies for implementing data-driven transformation; Communication and training for Overcoming Resistance to Change; Cross-Functional Collaboration across Organisational Departments; Fostering a Data-Driven Culture. **(6)**

DATA ARCHITECTURE AND RECENT TRENDS Business Intelligence (BI) Architecture; Big Data Ecosystem; AI/ML data pipelines in Business enterprises, Strategic Planning for Data Infrastructure; Build vs. Buy Decisions for Data Platforms; Generative AI in Data Management. **(6)**

Total L: 30 periods

TEXT BOOKS

1. Ladley, J. & Ladley, A. '*Data Governance: How to Design, Deploy, and Sustain an Effective Data Governance Program* (3rd ed.)'. Morgan Kaufmann (Elsevier).
2. Eryurek, E., Gilad, U., Kaye, B., Sicular, S., & Schur, E. (2021). '*Data Governance: The Definitive Guide: People, Processes, and Tools to Operationalize Data Trustworthiness*'. O'Reilly Media.

REFERENCE BOOKS

1. Plotkin, D. (2020). '*Data Stewardship: An Actionable Guide to Effective Data Management and Data Governance* (2nd ed.)'. Academic Press (Elsevier).2020.
2. DAMA International. (2024). '*DAMA-DMBOK: Data Management Body of Knowledge* (2nd ed. Revised)'. Technics Publications.2024.
3. Loukides, M., Mason, H., & Patil, D. J. (2018). '*Ethics and Data Science*'. O'Reilly Media.2018.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understanding the Management role in leveraging data for competitive advantage and strategic decision-making.	**K2**
CO2	Applying governance frameworks to design policies, roles, and standards.	**K3**
CO3	Analyzing ethical challenges in data management to improve data-literacy across organization departments.	**K4**
CO4	Evaluating enterprise data architecture and modern platforms for making strategic decisions on Data Management.	**K5**

COs - POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2				3				3	3
CO2			2			2	3	2		3	
CO3						3	3		3		2
CO4	2		2	2	3	2				3	2
	2	**2**	**2**	**2**	**3**	**3**	**3**	**2**	**3**	**3**	**3**

1 - low, 2- medium, 3 - high

25MC007 PROFESSIONAL ETHICS

(Common to all B.E./B.Tech. Programmes)

2 0 0 0

INTRODUCTION TO THE CONCEPTS OF ETHICS: Introduction to ethics – meaning, definition, dimensions of ethics, determinants and consequences of ethics; ethical dilemmas – types of ethical dilemmas. Morality – definition, types of moral values, levels of moral development. Ethics Versus morality. Professional Ethics – definition, components, types and significance. **(6)**

PSYCHOLOGY OF ETHICAL BEHAVIOR: Attitude – components of attitude in promoting ethical behavior; Motivation – human drives as a trigger for ethical behavior; Role of Cognitive biases (self-serving bias, incrementalism and overconfidence bias) in shaping ethical behavior. **(6)**

WORKPLACE ETHICAL BEHAVIORS: Integrity, honesty, accountability, responsibility, fairness, civic virtue, conscientiousness, empathy, self-confidence, character, respect for others, transparency, loyalty. **(6)**

APPLICATION AREAS OF ETHICS: Application of Ethics in different fields - Engineering ethics, medical ethics, financial ethics, technological ethics, scientific ethics, legal ethics, business ethics, environmental ethics. **(6)**

INDICATORS OF PROFESSIONAL ETHICS IN ORGANIZATIONS: Corporate Governance – Definition, importance, Theories of Corporate Governance: Agency Theory, Stewardship theory, Stakeholder Theory, Resource Dependency Theory. Corporate Social Responsibility – Definition, Models of CSR. **(6)**

Total L: 30 periods

TEXT BOOKS

1. Govindarajan M, Natarajan S and Senthil Kumar VS, *'Engineering Ethics'*. Prentice Hall of India, New Delhi, 2013.
2. Stephen P. Robbins, *'Essentials of Organizational Behavior'.* Pearson Education, 2023.
3. Subramanian. R. '*Professional Ethics'*. Oxford Publication, 2013.
4. Nagarasan. R.S. *Professional Ethics and Human Values'.* New Age International Publications, 2006.

COURSE OUTCOMES:

At the end of the course, students will be able to:		Bloom's Level
CO1	Understand the fundamental concepts of ethics, morality and the psychological principles behind ethical behavior.	**K2**
CO2	Demonstrate the application of core ethical values in the different situations of the workplace.	**K3**
CO3	Analyze the ethical issues, challenges in different professional domains and the application of ethical principles to solve the issues	**K4**
CO4	Evaluate the relevance and effectiveness of corporate governance theories and CSR models in addressing ethical and managerial challenges in organizations.	**K5**

COs - POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1						2	3				3
CO2						2	3	3	2		
CO3		2	2			3	3				
CO4						3	3	2		3	2
		2	**2**			**3**	**3**	**3**	**2**	**3**	**3**

1 - low, 2- medium, 3 - high

25HSO01 PHYSICAL EDUCATION
(Common to all B.E./B.Tech./B.Des. Programmes)

0 0 2 0

INTRODUCTION TO PHYSICAL EDUCATION: Importance and scope of physical education, Physical fitness and exercise fundamentals, Conditioning and calisthenics exercises, Posture, flexibility, balance, and coordination, Warm-up, cool-down, and relaxation techniques, Basics of injury prevention and first aid practices, Importance of teamwork, discipline, and sportsmanship.

BASIC GYMNASTICS AND MOVEMENT EXERCISES: Warm-up exercises, conditioning drills, movement education, balance exercises, floor exercises, tumbling basics, swinging and grip exercises, simple apparatus activities, lead-up games, coordination drills, and safety practices.

SKILL DEVELOPMENT IN ANY ONE OF THE FOLLOWING OUTDOOR GAMES: Basketball, Volleyball, Ball Badminton, and Football.

SKILL DEVELOPMENT IN ANY ONE OF THE FOLLOWING INDOOR GAMES: Shuttle Badminton, Chess, Carrom, and Table Tennis.

Total P: 30 Periods

WEIGHTAGE

Continuous Assessment: 100%

ASSESSMENT

Attendance and Participation – 70%
Practical Assessment of Physical Fitness and Sports Skills – 30%

REFERENCES

1. Singh, A. '*Essentials of Physical Education'*. Kalyani Publishers.
2. Kamlesh, M.L. '*Psychology in Physical Education and Sport'*.
3. Mangal, S.K. '*Psychology of Sports Performance'*. Sports Publication.
4. Kandappan, K. '*Foundations of Physical Education'*. Friends Publications.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Demonstrate basic movement, balance, coordination, and fitness exercises with proper technique and safety awareness.	**K2**
CO2	Demonstrate physical fitness parameters such as endurance, agility, flexibility, speed, and strength through regular participation in physical activities.	**K2**
CO3	Develop teamwork, discipline, leadership qualities, and sportsmanship through participation in games and group activities.	**K3**
CO4	Adopt active lifestyle habits and participate regularly in physical and recreational activities for overall well-being.	**K3**

COs - POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1							2	3			2
CO2						2		3			3
CO3							3	3	2		2
CO4						2	2	3			3
						2	**3**	**3**	**2**		**3**

1 - low, 2- medium, 3 - high

25HSO02 YOGA AND HEALTH
(Common to all B.E./B. Tech./B.Des. Programmes)

0 0 2 0

INTRODUCTION TO YOGA: Yoga as a tool for physical and mental wellness, Importance of posture, breathing, relaxation, and mindfulness, Role of yoga in stress management and lifestyle balance, Basic guidelines and safety precautions for yoga practice, Introduction to healthy habits including sleep hygiene, nutrition, and digital well-being

SURYA NAMASKAR – TYPES OF POSTURES: Pranamasana (Prayer Pose), Hastauttanasana (Raised Arms Pose), Padahastasana / Hastapadasana (Standing Forward Bend), Ashwa Sanchalanasana (Equestrian Pose), Dandasana (Plank Pose), Ashtanga Namaskara (Eight-Limbed Salutation), Bhujangasana (Cobra Pose), Adho Mukha Svanasana (Downward-Facing Dog), Ashwa Sanchalanasana (Equestrian Pose), Padahastasana (Standing Forward Bend), Hastauttanasana (Raised Arms Pose), and Pranamasana (Prayer Pose).

BASIC ASANAS:
1. Standing – Tadasana, Utkatasana, Trikonasana, Virabhadrasana, and Vrikshasana
2. Sitting – Sukhasana, Dandasana, Paschimottanasana, Vajrasana, and Gomukhasana
3. Prone Position – Bhujangasana, Salabhasana, Dhanurasana, Makarasana, and Urdhva Mukha Svanasana
4. Supine Position – Apanasana, Viparita Karani, Supta Baddha Konasana, Ardha Halasana, and Savasana

PRANAYAMA TECHNIQUES & MUDRAS: Ujjayi, Nadi Shodhana, Sheetali, Sitkari, Kapalabhati, Bhastrika, and Bhramari. Gyan Mudra (Chin Mudra), Prana Mudra, Apana Mudra, Vayu Mudra, Prithvi Mudra, Varun Mudra, Surya Mudra, Shunya Mudra, Linga Mudra, and Anjali Mudra.

Total P: 30 Periods

WEIGHTAGE: Continuous Assessment: 100%
ASSESSMENT METHODOLOGY: Attendance and Participation – 70%, Practical Demonstration (Surya Namaskar, Asanas, and Pranayama) – 30%

REFERENCES

1. *'The Heart of Yoga'.* – T.K.V. Desikachar
2. *'Yoga for Holistic Health'.* – Dr. H.R. Nagendra
3. *'Light on Yoga'.* – B.K.S. Iyengar
4. *'Asana Pranayama Mudra Bandha'.* – Swami Satyananda Saraswati

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Demonstrate Surya Namaskar and basic asanas in standing, sitting, prone, and supine positions with correct alignment and breathing.	**K2**
CO2	Demonstrate pranayama techniques for stress management and respiratory health.	**K2**
CO3	Improve flexibility, balance, posture, breathing efficiency, and relaxation through regular yoga practice.	**K3**
CO4	Apply principles of healthy living such as nutrition, sleep hygiene, and digital well-being in daily life.	**K3**

COs - POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1							2	3			2
CO2						2	2				2
CO3						2	2	3			3
CO4						3	2	2			3
						3	**2**	**3**			**3**

1 - low, 2- medium, 3 - high