SYLLABUS
FOR
V and VI semester B.E.

2024 – 2025

Sree Siddaganga Education Society®

Siddaganga Institute of Technology

(An Autonomous Institution affiliated to V.T.U., Belagavi, Approved by AICTE, New Delhi, Accredited by NAAC with 'A++' Grade and ISO 9001:2015 Certified)

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Siddaganga Institute of Technology, Tumkur-572103
Department of Electronics & Instrumentation Engineering

Vision of the Institute

To develop thoughtful and creative young minds in a learning environment of high academic ambience by synergizing spiritual values and technological competence.

Mission of the Institute

1. To continuously strive for the total development of students by educating them in state-of-the-art-technologies and managerial competencies providing best in class learning experience with emphasis on skills, values and learning outcomes and helping them imbibe professional ethics and societal commitment.

2. To create a research ambience that promotes interdisciplinary research catering to the needs of industry and society.

3. To collaborate with premier academic and research institutions and industries to strengthen multidisciplinary education, applied research, innovation, entrepreneurship and consulting ecosystems.

Quality Policy

Siddaganga Institute of Technology is Committed to:

1. Impart Quality Education by establishing effective learning - teaching - learning processes to produce competent engineers and managers with high professional ethics and societal responsibility.
2. Create congenial environment and provide state-of the-art infrastructure.
3. Continually improve the effectiveness of the Quality Management System.
4. Satisfy applicable requirements.

Vision of the Department

To become a premier Electronics and Instrumentation Engineering Department by imparting quality education in the fields of electronics, instrumentation and cutting edge technologies developing competence to meet industrial norms and to pursue research and innovation contributing to socioeconomic development.

Mission of the Department

1. Develop competent professionals by offering industry aligned curriculum in Electronics, Instrumentation and VLSI and embedded systems along with an exposure to cutting edge technologies by providing best in class learning, promoting interdisciplinary research and innovation catering to industrial and societal needs.

2. Encourage and prepare students for higher studies to promote lifelong learning.
3. Imbibe professional ethics and skills in students to provide engineering service to the society.
4. Collaborate with industries to inculcate industry readiness, creativity, managerial competence, experiential learning and entrepreneurship skills.

Program Educational Objectives (PEOs)

Graduates of the Electronics and Instrumentation Programme

PEO 1: Contribute effectively in industry and excel in higher education by applying the knowledge of Science, Technology, Engineering and Math (STEM) principles.

PEO 2: Engage in lifelong learning by adapting emerging technologies, and excel in research pursuits and entrepreneur to meet the global challenges.

PEO 3: Exhibit professional skills, communication skills, team work and leadership qualities imbibing ethical values in their profession for the benefit of society.

Programme Outcomes (PO):

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop 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.

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.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modeling, analysis & interpretation of data to provide valid conclusions.

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

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.

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

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.

Programme specific Outcomes (PSO):

Student will be able to

PSO1: Apply the technical knowledge of measurement techniques, instrumentation, control, communications and the state - of - the art technologies in process, healthcare and related domains.

PSO2: Apply the knowledge of Signal Processing, Electronic Circuits and Programming Skills to design embedded systems for real time applications.

YoA 2022-23

SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU

(An autonomous institution affiliated to VTU, Belagavi, Approved by AICTE, New Delhi, Accredited by NAAC with 'A++' grade & ISO 9001:2015 Certified)

B.E. in Electronics & Instrumentation Engineering

SCHEME OF TEACHING AND EXAMINATION FOR THE AY 2024-25 NEP2

V Semester

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching hours per semester				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	SDA/SSC/ W	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	HSMS	SHS03	Management and Entrepreneurship	ME, IM, CH	42	0	0	48	3	50	50	100	3
2.	IPCC	S5EII01	Digital Signal processing	EIE	42	0	28	50	3	50	50	100	4
3.	IPCC	S5EII02	Process Control Systems	EIE	42	0	28	50	3	50	50	100	4
4.	PCCL	S5EIL01	Signal Conditioning circuits and Data converters Lab	EIE	0	0	28	2	3	50	50	100	1
5.	PEC	S5EIPE1x	Professional Elective Course-I	EIE	42	0	0	48	3	50	50	100	3
6.	PROJ	S5EIMP	Mini Project / Extension Survey Project	EIE	0	0	56	4	3	50	50	100	2
7.	AEC	SHS04	Research Methodology and IPR	IM	42	0	0	48	2	50	50	100	3
8.	MC	SHS05	Environmental Studies	CV	28	0	0	32	2	50	50	100	2
9.	AEC/ SEC	S6EIA0x	Ability Enhancement Course/ Skill Enhancement Course – V	T&P	If offered as Theory Course				3	50	50	100	1
					14	0	0	16					
					If offered as Integrated Course								
					0	0	28	2					
10.	MC	SMC01	National Service Scheme (NSS)	NSS CO	0	0	28	-	-	100	-	100	0
		SMC02	Physical Education (PE) (Sports and Athletics)	PED									
		SMC03	Yoga	PED									
			Total		**252**	**0**	**196**	**300**	**25**	**550**	**450**	**1000**	**23**
		AAP	AICTE Activity Points (Applicable for both Regular and Lateral Entry students)	40 hours community service to be documented and produced for the examination									

Note: HSMC: Humanity and Social Science and Management Courses, **PCC:** Professional Core Course, **IPCC:** Integrated Professional Core Course, **PCCL:** Professional Core Course laboratory, **MC:** Mandatory Course, **AEC:** Ability Enhancement Course, **PEC:** Professional Elective Course, **PROJ:** Project

L: Lecture, **T:** Tutorial, **P:** Practical, **S=SDA:** Skill Development Activity, **SSC:** Self Study Component, **TW:**Term Work, **CIE:** Continuous Internal Evaluation, **SEE:** Semester End Evaluation.

Professional Elective Course (PEC) (Offered by the Department)

S5EIPE11	Advanced Control Systems	S5EIPE12	Device and Peripheral Drivers in Embedded Systems.
S5EIPE13	Computer Networks	S5EIPE14	AI for Biomedical Applications

Ability Enhancement Course – V (Offered by the Department)

S5EIA01	Aptitude Related Analytical Skills	S5EIA02	Embedded applications using ARM Cortex M4 based Renesas microcontroller
S5EIA03	Digital IC Design using EDA tools	S5EIA04	Machine learning using Python

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B.E. in Electronics & Instrumentation Engineering

SCHEME OF TEACHING AND EXAMINATION FOR THE AY 2024-25 NEP2

VI Semester

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching hours per semester				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	SDA/SSC TW	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	IPCC	S6EII01	Internet of Things.	EIE	42	0	28	50	3	50	50	100	4
2.	PCC	S6EI02	Digital VLSI Design	EIE	42	0	28	50	3	50	50	100	4
3.	PEC	S6EIPE2x	Professional Elective Course-II	EIE	42	0	0	48	3	50	50	100	3
4.	OEC	S6EIOE0x	Open Elective Course-I		42	0	0	48	3	50	50	100	3
5.	PROJ	S6EIMP	Major Project Phase I		0	0	56	4	3	100	-	100	2
6.	PCCL	S6EIL01	Process Automation Lab	EIE	0	0	28	2	3	50	50	100	1
7	MC	SHS06	Soft Skills	T&P	0	28	0	-	-	100	-	100	0
8.	MC	SMC01	National Service Scheme (NSS)	NSS CO	0	0	28	-	-	100	-	100	0
		SMC02	Physical Education (PE) (Sports and Athletics)	PED									
		SMC03	Yoga	PED									
			Total		**168**	**28**	**168**	**202**	**18**	**550**	**250**	**800**	**17**
		AAP	AICTE Activity Points (Applicable for both Regular and Lateral Entry students)	40 hours community service to be documented and produced for the examination									

Note: **PCC:** Professional Core Course, **IPCC:** Integrated Professional Core Course, **PCCL:** Professional Core Course laboratory, **MC:** Mandatory Course, **AEC:** Ability Enhancement Course, **SEC:** Skill Enhancement Course, **PEC:** Professional Elective Course, **PROJ:** Project

L: Lecture, **T:** Tutorial, **P:** Practical, **S=SDA:** Skill Development Activity, **SSC:** Self Study Component, **TW:**Term Work, **CIE:** Continuous Internal Evaluation, **SEE:** Semester End Evaluation.

Professional Elective Course-II (PEC) (Offered by the Department)			
S6EIPE21	Analytical Instrumentation	S6EIPE22	System Identification
S6EIPE23	Industrial Safety & Communication	S6EIPE24	Digital Image Processing

YoA 2022-23

5th Semester

MANAGEMENT AND ENTREPRENEURSHIP

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3
Total Lecture Hours:	42	CIE Marks:	50
Total Tutorial Hours:	0	SEE Marks:	50
Total Practical Hours:	0	Course Code:	SHS03
Course Type:	Theory (HSMS)	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Understand the principles and functions of management through planning.
2.	Analyze the importance of organizing and staffing in an organization
3.	Analyze the importance of leading and controlling in an organization
4.	Inculcate entrepreneurial qualities and understand the need of rural entrepreneurship
5.	Acquire knowledge about funding agencies, understand procedure in applying for funds and analyze the cases of successful entrepreneurs

UNIT I

Introduction to Management: Definition of management, management skills, productivity and effectiveness, efficiency, functions and principles of management.
Planning: Nature of planning, types of plans- purpose of vision, mission, goals, objectives strategies, policies; steps in planning, MBO, Strategic planning.

8 Hours

UNIT II

Organizing: Formal and informal organization, span of management, the structure and Process of organizing, Organizational structure: line and staff organization, Functional organization, matrix organization.
Staffing: Definition, systems approach to HRM, factors affecting staffing, recruitment and selection, job design, skill and characteristics of a manager, selection process and techniques

9 Hours

UNIT III
Leading: Human factors in managing, motivation, Theory X and Y, the hierarchy of needs theory, leadership behavior and styles. **Controlling:** Basic control process, critical control points and standards, Benchmarking requirements for effective control**.**
7 Hours

UNIT IV
Entrepreneur & Entrepreneurship: Introduction, concept of Entrepreneur, characteristics of an entrepreneur, and qualities of an entrepreneur, functions of an entrepreneur, characteristics of entrepreneurship, factors affecting entrepreneurial growth. Entrepreneurship and economic development-rural, woman and social entrepreneurship **Financing and Institutional Support for Entrepreneurship:** Startups, business plans, venture capitalists, angel investors, funding agencies -commercial banks, development banks, NBFCS and incubation centres. Innovations and project trends.
12 Hours

UNIT V
Taxation benefits: Depreciation allowances, rehabilitation allowance, investment allowance and other tax concession benefits to an entrepreneur. **Case studies** 1. Happily Bootstrapping: Zoho CEO Sridhar Vembu (2007) 2. Thought Leaders in Cloud Computing: Sridhar Vembu, CEO of Zoho (2016) 3. Building India's Amazon: Flipkart CEO Sachin Bansal 4. Rohith Bhat's Exhilarating Journey with Robosoft from Udupi, Karnataka
6 Hours

TEXT BOOKS		
1	Harold Koontz, Heinz Weihric	Essentials of Management, McGraw Hill Education, 10th Edition, 2015
2	Lucy C. Morse	Managing Engineering and Technology, Pearson Education, 6th Edition, 2015.
3	S.S. Khanka	Entrepreneurial Development, S. Chand Publishing, 4th Edition, Reprint, 2020, ISBN 978-81-219-1801-5

REFERENCE BOOKS		
1	James A.F. Stoner, R. Edward Freeman, Daniel R. Gilbert	Management, Pearson Education, 6th Edition, 2018

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Explain various functions of management (L2).
CO2	Apply the knowledge of management principles and strategies in various functional areas such as organizing and staffing. (L3).
CO3	Apply the knowledge of management principles and strategies in various functional areas such as Leading and Controlling. (L3).
CO4	Describe entrepreneurship, its characteristics, and benefits and identify various funding sources for starting a business venture (L3).
CO5	Explain various taxation benefits enjoyed by an entrepreneur and analyze the characteristics and strategies adopted by successful entrepreneurs. (L2 & L3)

DIGITAL SIGNAL PROCESSING

Contact Hours/ Week:	3+0+2 (L+T+P)	Credits:	4
Total Lecture Hours:	42	CIE Marks:	50
Total Tutorial Hours:	0	SEE Marks:	50
Total Practical Hours:	28	Course Code:	S5EII01
Course Type:	Integrated(IPCC)	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Study DFT and its properties, and learn computation of convolution
2.	Learn FFT algorithm.
3.	Understand the design of FIR and IIR Filters.
4.	Learn filter realization techniques.

UNIT I

Introduction to Digital Signal Processing: Basic elements of a Digital Signal Processing system, advantages of digital over analog signal processing.
Fourier representations and its applications: Introduction, Frequency response of LTI systems. Introduction to DTFT.
Discrete Fourier transform: Introduction to DFT, properties of DFT, Convolution of long sequences: Overlap Save method, Computation of Circular convolution, relationship between DFT and Z transforms.

9 Hours

UNIT II

Computation of DFT: Decimation-in-time radix-2 FFT and IFFT algorithms.
Convolution using DFT: Linear convolution and Circular convolution using DFT/FFT.

9 Hours

UNIT III
Filter design techniques: Ideal filter characteristics, low-pass, high-pass and band-pass filters. Design of FIR filters: Issues in filter design, importance of linear phase, frequency response of linear phase FIR filters, Significance of zeros of FIR filters, design techniques of FIR filters, windowing (rectangular window, Hamming Window).
8 Hours

UNIT IV
Design of IIR filters: Introduction to IIR filters, Design of Butterworth analog filter. Frequency transformations in analog domain. Introduction to Chebyshev filters. Design of digital filters from analog filters, bilinear transformation methods, comparison of FIR and IIR filters.
8 Hours

UNIT V
Implementation of discrete-time systems: Basic structures for FIR systems: Direct, Linear Phase structures. Structures for IIR systems: Direct, Cascade and Parallel structures. DSP Processor: Introduction, Basic Computational Blocks.
8 Hours

TEXT BOOKS		
1	J.G. Proakis and D. G. Manolakis	Digital Signal Processing: Principles, Algorithms and Applications, 4th Edition 2007, PHI.
2	V. Udayashankara	Modern Digital Signal Processing PHI Learning Pvt. Ltd, Second Edition 2012

REFERENCE BOOKS		
1	S. K. Mitra	Digital Signal Processing: A computer-Based Approach, 2nd Edition, 2001, TMH.
2	Lonnie C. Ludeman	Fundamentals of Digital Signal Processing, 1st Edition, 2012, John Wiley & sons.
3	A. V. Oppenheim and R. W. Shafer	Discrete-Time Signal Processing, 2nd Edition, PHI 2000

Digital Signal Processing Lab: (Only for CIE) (2 Hours per week per batch) 13 Lab sessions + 1 Lab assessment **List of Experiments:**	
1	Verification of the Sampling Theorem.
2	Linear Convolution of a given sequence in Time domain.
3	Circular Convolution of a given sequence in Time domain.
4	Convolution in frequency domain.
5	Spectrum of a sequence.
6	Design and verification of FIR filter.
7	Design and verification of IIR filter.
8	Implementation of Basic DSP operations (Linear Convolution and Circular Convolution) on DSP processor
Open Ended Experiment:	
1	Recording of speech signal and computation of power spectrum and design of filters to remove noise.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Represent the discrete-time signals in time and frequency domain. Compute DFT and Convolution of sequences in time domain. Develop programs to implement basic DSP operations.
CO2	Apply FFT algorithms to compute the DFT of discrete time sequences and develop programs to implement basic DSP operations in frequency domain.
CO3	Design FIR filters for given specifications and develop programs to verify FIR filters.
CO4	Design IIR filters for given specifications and develop programs to verify IIR filters.
CO5	Develop the structures to realize the FIR and IIR filters and develop C programs to implement linear and circular convolution operations on DSP processor.

PROCESS CONTROL SYSTEMS

Contact Hours/Week:	3+0+2 (L+T+P)	Credits:	4.0
Total Lecture Hours:	42	CIE Marks:	50
Total Tutorial Hours:	00	SEE Marks:	50
Total Practical Hours:	28	Course Code:	S5EII02
Course Type:	Integrated (IPCC)	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Learn the working of different types of controller modes.
2.	Learn the design and implementation of analog controllers.
3.	Study control loops, tuning methods, converters and valves used in process industry
4.	Understand the basics of Computer-Aided process control.
5.	Understand the P&ID symbols used in process industry

UNIT I

Controller Principles: Introduction, Process-Control Block Diagram, Manipulated variable, Controlled variable, Uncontrolled variable. Process Characteristics, Process Equation, Process Load, Process Lag, Self-Regulation. Control System Parameters: Error, Variable Range, Control Range, Control Lag, Dead Time, Cycling.
Controller Modes: Discontinuous Controller Modes: Two-Position (ON/OFF) Mode, Multi-position Mode, Floating Control Mode.
Continuous Controller Modes: Proportional Control Mode, Integral Control Mode, Derivative Control Mode, Composite Control Mode, Proportional-Integral (PI) Control Mode, Proportional-Derivative (PD) Control Mode, Proportional- Integral- Derivative (PID) Control Mode.

9 Hours

UNIT II

Analog Controllers: Introduction, General features, Design of electronic controllers: Error Detector, ON/OFF controller, Proportional controller, Integral controller, derivative controller, PI controller, PD controller, PID controller.

9 Hours

UNIT III
Control loop Characteristics: Introduction, Control system configurations, feed forward, single, multivariable, Ratio, Split-range, Inferential and cascade control system. Control system quality, stability. Process loop tuning: Open-Loop Transient Response Method and Ziegler-Nichols Method. Final Control Elements: Final control operation. Converters-I/P, P/I. Actuators – pneumatic, hydraulic and electric actuators. Valve types, characteristics, capacity of a control valve, valve sizing and selection. Valve rangeability, selection factors. Cavitation, choking, flashing.
8 Hours

UNIT IV
Computer-Aided process control: Introduction, Role, Elements, Architecture and classification. Man-Machine Interface, Economics of Computer-Aided Process Control, Benefits of Using Computers in a Process Control. Process related interfaces: Analog, digital, pulse and standard interfaces. Design of digital control algorithms - dead beat and dahlin.
8 Hours

UNIT V
Process and Instrumentation Drawing (P and ID) Symbols & Diagrams: Objectives, Characteristics, Line Symbols, Identification Letters, Valve Symbols, General Instrument or Function Symbols, Transmitter Symbols, Miscellaneous Symbols Interlock logic symbols. Graphic symbols. Representation of process loops using P and ID symbols.
8 Hours

TEXT BOOKS

1	Curtis D. Johnson	Process Control Instrumentation Technology, PHI, 8th Edition, 2014
2	S K Singh	Computer Aided Process Control, PHI, 2004
3	Stephano Poulos G	Chemical Process Control: An Introduction to Theory and Practice, PHI. 2015

REFERENCE BOOKS		
1	N.A. Anderson	Instrumentation for Process measurement and control, CRC Press.3rd edition 2001
2	Bela G. Liptak	Instrument Engineers Handbook, Process Measurement volume1; Process Control volume2, Chilton Book Company/ Radnor, 4th Edition, Pennsylvania, 2003.

Process Control Systems Lab:(Only for CIE)
(2 Hours per week per batch) 13 Lab sessions + 1 Lab assessment
List of Experiments:
(Note: Using MATLAB-Simulink/LABVIEW software)

1	Implementation of Two-Position (ON/OFF), Multi-position and Floating control modes.
2	Implementation of analog controllers: P, I, PI and PID.
3	Implementation of ratio, cascade and feed forward control in feedback control loops.
4	PID tuning using Ziegler Nichols method for temperature control.
5	Development of a system to study the operation of hydraulic and electric actuators.
6	Development of motor control using the deadbeat algorithm.
7	Development of motor control using the Dahlin algorithm.
8	PID tuning using Ziegler Nichols method for water tank level and Flow rate using P & ID symbols.

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

CO1	Analyze the performance of different types of controller modes.
CO2	Analyze and design analog controllers for the given specifications.
CO3	Identify different types of control systems and apply tuning methods for controllers.
CO4	Design digital control algorithms for process control applications
CO5	Analyze the process & instrumentation diagram (P&ID) for a given process.

SIGNAL CONDITIONING CIRCUITS AND DATA CONVERTERS LAB

Contact Hours/Week:	0+0+2 (L+T+P)	Credits:	1.0
Total Lecture Hours:	00	CIE Marks:	50
Total Tutorial Hours:	00	SEE Marks:	50
Total Practical Hours:	28	Course Code:	S5EIL01
Course Type:	Practical (PCCL)	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Learn the design of signal conditioning circuits
2.	Learn the operation of data converter circuits.

(2 Hours per week per batch) 13 Lab sessions + 1 Lab assessment

List of Experiments

1.	Sample and Hold circuits
2.	Instrumentation Amplifier
3.	I to V and V to I converters
4.	Schmitt Trigger
5.	Active Filters
6.	Digital to Analog Converter (IC - Verification).
7.	4-bit R-2R ladder and Binary weighted DAC.
8.	Analog to Digital Converter (IC - Verification)

Open ended experiments

1.	Programmable gain amplifier.
2.	Voltage controlled oscillator using IC 566.
3.	3-bit flash ADC.

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

CO1	Design and test signal conditioning circuits using Op-Amp.
CO2	Design and test data converter circuits.

Professional Elective Courses - I

ADVANCED CONTROL SYSTEMS

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3
Total Lecture Hours:	42	CIE Marks:	50
Total Tutorial Hours:	0	SEE Marks:	50
Total Practical Hours:	0	Course Code:	S5EIPE11
Course Type:	Theory (PEC)	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Study the various compensation techniques used in control system
2.	Learn the stability analysis of discrete time system
3.	Study the state space model of electrical and mechanical systems
4.	Learn the design concept of Optimal and Adaptive control systems
5.	Learn the analysis of nonlinear systems using describing functions

UNIT I

Compensation techniques: Introduction, Compensating electrical networks (lead, lag, lead-lag), Frequency response. Design of Proportional (P), Integral (I), Derivative (D), PI, PD, PID controllers (Frequency domain).

9 Hours

UNIT II

Discrete- time systems: Introduction to discrete time systems, Review of Z-Transforms, solution of difference equation, Pulse Transfer Function, time response analysis of discrete time systems, mapping between the S-plane and Z-plane, Stability analysis in the Z-plane (Jury's and bilinear transformation).

9 Hours

UNIT III
State space analysis of system: Introduction, state space model of linear system from differential equations, state space model for physical systems, state space model from transfer function and vice versa, state transition matrix.
8 Hours

UNIT IV
Optimal and adaptive control systems: Controllability, observability for continuous system, control system design via pole placement by state feedback, state observer.
8 Hours

UNIT V
Describing function analysis of non-linear control systems: Introduction to non-linear control systems, characteristics of non linear systems, classification of nonlinearities, Describing function analysis: Ideal relay, dead zone, relay with dead zone, saturation, relay with hysteresis and dead zone and stability of Non-linear control systems.
8 Hours

TEXT BOOKS		
1	K.Ogata	Modern Control Engineering, PHI, 2009, 5th Edition.
2	K.Ogata	Discrete Time Control Systems, PHI, 2005, 2nd Edition.
3	K P Mohan das	Modern control engineering, Sanguine technical publishers, 2016, 2nd Edition.

REFERENCE BOOKS		
1	Madan Gopal	Digital control and state variables methods, MC Craw Hill Education, 2017, 4th Edition.
2	Nagoor Kani	Advanced Control Theory, CBS Publishers & Distributors pvt ltd., 2020, 3rd Edition.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Identify and select the appropriate compensator for the design of linear time-invariant control system.
CO2	Analyze the stability of linear time-invariant discrete time systems.
CO3	Formulate and analyze state models for linear time invariant control systems.
CO4	Analyze and interpret controllability and observability of a continuous systems.
CO5	Analyze various nonlinear control characteristics using describing functions.

DEVICE AND PERIPHERAL DRIVERS IN EMBEDDED SYSTEMS

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3
Total Lecture Hours:	42	CIE Marks:	50
Total Tutorial Hours:	0	SEE Marks:	50
Total Practical Hours:	0	Course Code:	S5EIPE12
Course Type:	Theory (PEC)	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Understand the architecture of ARM Cortex M3
2.	Learn the operations and addressing modes of assembly level instructions in ARM Cortex M3
3.	Learn Exceptions and Interrupts of ARM Cortex M3
4.	Explore peripheral interfacing and programming ARM Cortex M3
5.	Understand Serial communication protocols in ARM Cortex M3

UNIT I

Cortex M3 Core: Architecture and Features of ARM Cortex M3 processors. Programmer's model: Operation Modes and States, General purpose Registers, Special function Registers, Behaviour Application Program Status Register PSR.
Embedded Software development: Embedded Software Development and compilation flow, Data types in C – programming used for Cortex M3 processors.

9 Hours

UNIT II

Instruction set: Operation and addressing modes of MOV instruction, Arithmetic instructions, Logical instructions, Memory access instructions, Program flow control instructions, Shift and rotate instructions, Data conversion instructions, Bit-field processing

instructions, compare and test instructions. Use of suffix in instructions. ARM Assembler directives, Assembly level programming examples.
Cortex M3 based Microcontroller: Introduction to Cortex M3 based Microcontroller, Features, Memory map. Basic configuration and programming GPIO. Interfacing basic Input output devices to Cortex M3 based Microcontroller: LEDs, Switches, push button keys and 7-segment display, Liquid Crystal Display, MxN matrix keypad. Assembly level and C-Programming examples.

9 Hours

UNIT III

Exceptions and interrupts: Program flow (Software Flow). Overview of Exceptions and Interrupts, Exception types, Vector table and Reset status, Exception entrance sequence, Exception handler execution, Exception return, Interrupt latency, NVIC registers for interrupt control, Exception handlers in C and assembly level programming, Stack Frames, Exceptions entrance and stacking, Exception return and unstacking. Programming Examples (Both assembly and C).

8 Hours

UNIT IV

Peripherals in Cortex M3 based Microcontroller: Configuration and programming (both assembly and C) Nested Vectored Interrupt Controller (NVIC), External interrupt inputs and Timers. Configuration and programming (Only C) PWM unit, Watchdog timer, Analog to Digital Converter (ADC), Digital to Analog Converter (DAC).

8 Hours

UNIT V

Serial communication modules in Cortex M3 based microcontroller: Introduction to serial communication, Universal Asynchronous Receiver Transmitter (UART), SPI, I2C communication protocol.

8 Hours

TEXT BOOKS		
1	Joseph Yiu	The Definitive guide to ARM Cortex M3 and Cortex M4 processor, Elsevier, 3rd Edition, 2013.
2	Cortex-M Technical Reference Manual. revision r1p1	
3	LPC17xx Reference Manual.	

REFERENCE BOOKS		
1	Ming-Bo Lin	An Introduction to Cortex-M3-Based Embedded Systems: Cortex-M3 Assembly Language Programming, Createspace Independent Publishing Platform, 2019.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Analyze the programmer's model, memory map and architecture of Cortex M3 based Microcontroller.
CO2	Analyze the assembly level instructions of Cortex M3 core and interface basic input output devices to Cortex M3 based microcontroller.
CO3	Configure NVIC register for interrupt handling and Timers, and develop programs for exception handling.
CO4	Develop drivers for different peripheral devices.
CO5	Develop drivers for serial communication protocols.

COMPUTER NETWORKS

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3
Total Lecture Hours:	42	CIE Marks:	50
Total Tutorial Hours:	0	SEE Marks:	50
Total Practical Hours:	0	Course Code:	S5EIPE13
Course Type:	Theory (PEC)	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Learn the concepts of data communication and functions of OSI layer
2.	Study the transmission media, flow control and error detection & correction utilized in data link layer
3.	Study the fundamental concepts in routing algorithms of network layer
4.	Study transport layer regarding its service and protocol usage for data transfer via TCP/IP
5.	Study the utilization of application layer for wireless LAN's & Wireless Sensor Networks

UNIT I

Introduction: Network Hardware-Wireless network, Network Software-Design issues for the layers, OSI reference model, TCP/IP reference model.

Physical Layer: Guided transmission media, Unguided Wireless Transmission, Public switched telephone network, Second Generation mobile Phones: Digital Voice, Third Generation mobile Phones: Digital Voice and Data

9 Hours

UNIT II
Data Link Layer: Data link layer design issues-Service Provided to network layer, framing methods, error control, flow control, error detection and correction-hamming code, cyclic redundancy check (CRC), elementary data link protocols, sliding window protocols-one bit sliding, Go Back N protocol, selective repeat, protocol verification-finite state machine, petri net model, HDLC, CSMA/CD protocol, point to point protocol
9 Hours

UNIT III
Network Layer: Network layer design issues, routing algorithms: desirable properties, categories of algorithm, optimality principle, shortest path routing (Dijkstra's Algorithm), illustration on shortest path algorithms, flooding, distance vector routing, illustration on distance vector routing, Count to infinity problem.
8 Hours

UNIT IV
Transport Layer: Transport service, transport service primitives, Berkeley sockets, elements of transport protocols-addressing, connection establishment, connection release, flow control and buffering, multiplexing, simple transport protocol, internet transport protocols: User Datagram Protocol- remote procedure call, real time protocol, Transmission control protocol-service model, segment header, TCP connection establishment and release, management modeling
8 Hours
UNIT V
Application Layer: Domain Name System (DNS): Introduction to DNS, Name Space, Domain resource records-record types of IPv4, Name Servers- resolver looks up a remote name in eight and steps. **Electronic Mail (E-Mail)**: Architecture and service, user agent, message format, message transfer-RFC822 header fields, MIME (Multipurpose Internet Mail Extensions), Message transfer-SMTP, final delivery, POP3, IMAP.
8 Hours

TEXT BOOKS		
1	Andrews S Tanenbaum	Computer Networks, 6th Edition, Pearson Education, 2022

REFERENCE BOOKS		
1	William Stallings	Data and Computer Communications, 9th Edition, Prentice Hall of India 2013.
2	Behrouz A. Foruzan	Data Communication and Networking, 5th edition, Science Engineering & Math Publications, 2012

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Describe the concepts of data communication and functions of OSI layer.
CO2	Analyze and interpret the transmission media, data flow control and error detection & correction.
CO3	Analyze the fundamental concepts in routing, addressing & working of network layer.
CO4	Describe the transport layer service and protocol usage for data transfer via TCP/IP elements.
CO5	Analyze and interpret the usage of application layer for wireless LAN's & wireless sensor networks.

AI FOR BIOMEDICAL APPLICATIONS

Contact Hours/Week:	3+0+0 (L+T+P)	Credits:	3
Total Lecture Hours:	42	CIE Marks:	50
Total Tutorial Hours:	0	SEE Marks:	50
Total Practical Hours:	0	Course Code:	S5EIPE14
Course Type:	Theory (PEC)	Exam Hours:	3

Course objectives:
This course will enable students to:
Study artificial intelligence and its application in clinical decision support systems.

1.	Understand scope of AI in medicine and healthcare applications.
2.	Learn mathematical models for Computer-Assisted Decision Making
3.	Learn Reasoning Methodologies in biomedical expert systems.
4.	Study Supervised and Unsupervised Learning algorithms for biomedical applications.
5.	Understand scope and use of AI in Personalized Healthcare and treatment planning.

UNIT I

Introduction: Artificial Intelligence in Medicine, Definition and scope of AI in healthcare, Historical perspective and milestones in AI research, Applications of AI in clinical practice and biomedical research. AI in Diagnostics and Disease Prediction, Predictive modeling for disease risk assessment, Diagnostic decision support systems, Early detection of diseases using AI algorithms.

9 Hours

UNIT II

Artificial Intelligence- Foundations of Computer-Assisted Decision Making: Mathematical Modeling and Simulation, Pattern Recognition, Bayesian Analysis, Decision Theory, Symbolic Reasoning Techniques. Knowledge Representation: Production Rules-Introduction, Frames, Databases, Knowledge Acquisition: Introduction, Learned Knowledge, Meta-Knowledge.

9 Hours

UNIT III
Reasoning Methodologies: Introduction, problem representations, blind searching, ordered search, AND/OR trees, searching game trees, searching graphs, rule base searching, higher-level reasoning methodologies, cognitive models, automatic deduction, examples in biomedical expert systems.
8 Hours

UNIT IV
Supervised Learning: Decision Surfaces, Two-Category Separation, Linearly Separable Sets, Nonlinearly Separable Sets, Unsupervised Learning- Clustering, Kohonen Networks and Competitive Learning, Hebbian Learning, Biomedical Applications, Diagnosis of CAD as a Clustering Problem, Other Biomedical Applications.
8 Hours

UNIT V
AI in Personalized Medicine and Treatment Planning: Pharmacogenomics and precision medicine, Treatment recommendation systems, Drug discovery and repurposing using AI approaches. Natural Language Processing (NLP) in Healthcare, Text mining and information extraction from clinical notes, Clinical language understanding and medical coding, Applications of NLP in electronic health records (EHR) analysis and clinical documentation.
8 Hours

TEXT BOOKS		
1	Mesko B	A guide to artificial intelligence in healthcare: The Medical Futurist, Wiley-IEEE Press, 2017
2	Donna L. Hudson, Maurice E. Cohen	Neural Networks and Artificial Intelligence For Biomedical Engineering, IEEE Press Series in Biomedical Engineering, 1999.

REFERENCE BOOKS		
1	B Yegnanarayana	Artificial Neural Networks, PHI, 2001
2	Jacek M Zurada	Introduction To Artificial Neural Systems, Jaico publishing, 6th Edition, 2007

Course Outcomes: Upon completion of this course, the student will be able to:	
CO1	Describe the applications of AI in clinical practice and biomedical research.
CO2	Develop a mathematical models for Computer-Assisted Decision Making systems.
CO3	Analyze and apply reasoning methodologies to solve problems in biomedical expert systems.
CO4	Analyze and apply Machine learning algorithms to develop computer aided diagnosis.
CO5	Apply AI approaches to analyze and create electronic health records (EHR) and clinical documentation.

RESEARCH METHODOLOGY AND IPR

Contact Hours/Week:	2+2+0 (L+T+P)	Credits:	3
Total Lecture Hours:	28	CIE Marks:	50
Total Tutorial Hours:	28	SEE Marks:	50
Total Practical Hours:	0	Course Code:	SHS04
Course Type:	Theory	Exam Hours:	3

UNIT-I

RESEARCH METHODOLOGY: Objectives and motivation of research - Types of research - Research approaches - Significance of research - Research methods verses methodology - Research and scientific method - Importance of research methodology - Research process - Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations- Criteria of good research. Defining the research problem: Definition of research problem - Problem formulation - Necessity of defining the problem - Technique involved in defining a problem.

8 Hours

UNIT-II

LITERATURE SURVEY AND DATA COLLECTION: Importance of literature survey - Sources of information - Assessment of quality of journals and articles

- Information through internet. Effective literature studies approaches, analysis, plagiarism, and research ethics. Data - Preparing, Exploring, examining and displaying. Referencing methods

8 Hours

UNIT-III

RESEARCH DESIGN AND ANALYSIS: Meaning of research design - Need of research design - Different research designs - Basic principles of experimental design - Developing a research plan - Design of experimental set-up - Use of standards and codes.

Overview of Univariate/Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.
9 Hours
UNIT-IV
INTELLECTUAL PROPERTY RIGHTS (IPR): Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. Role of WIPO and WTO ni IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.
8 Hours
UNIT-V
PATENT RIGHTS (PR): Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs. Licenses, Licensing of related patents, patent agents, Registration of patent agents.
9 Hours

TEXT BOOKS:		
Sl. No.	**Author/s**	**Title, Publisher, Edition, Year, ISBN**
1.	Prof. Kothari C. R.	"Research methodology: Methods and techniques", New Age International, 5th Edition, 2023. ISBN-13: 978-9389802559
2.	R. Ganesan	"Research Methodology for Engineers", MJP Publishers, Chennai, 2011.

REFERENCE BOOKS:		
Sl. No.	**Author/s**	**Title, Publisher, Edition, Year, ISBN**
1.	Cooper Donald R, Schindler Pamela S and Sharma JK	"Business Research Methods", Tata McGraw Hill Education, 11th Edition, 2012.
2.	Catherine J. Holland	"Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3.	David Hunt, Long Nguyen, Matthew Rodgers	"Patent searching: tools &techniques", Wiley, 2007.
4.	The Institute of Company Secretaries of India, Statutory body under an Act of parliament	"Professional Programme Intellectual Property Rights, Law and practice", September 2013.
5.	Peter S. Menel Mark A. Lemley, Robert P. Merges	"Intellectual Property in the New Technological-Vol. I Perspectives, 2021.
6.	Laura R. Ford	"The Intellectual Property of Nations: Sociological and Historical Perspectives on a Modern Legal Institution Paperback -2021.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Describe the research process & formulate research problem
CO2	Perform literature review, manage data & practice research ethics
CO3	Practice basic principles of experimental design, use standard codes and carry out research analysis
CO4	Distinguish between types of innovation, describe patenting procedure, maintenance and role of IPR establishments
CO5	Identify the significance of patent rights, licensing, technology transfer & manage patenting system

ENVIRONMENTAL STUDIES

Contact Hours/ Week:	2+0+0+2 (L+T+P+S)	Credits:	2
Total Lecture Hours:	28	CIE Marks:	50
Total Tutorial Hours:	0	SEE Marks:	50
Total Practical Hours:	0	Course Code:	SHS05
Course Type:	Theory	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Describe the problems of depletion of natural resources due to deforestation, agricultural practices, and adverse environmental effects, pesticides, soil erosion, mining.
2.	Explain the different types of energy- renewable, non-renewable and energy conservation, the impact of environmental pollution on water quality, air quality, soil pollution and noise pollution.
3.	Describe solid waste management- disposal, treatment of different types of solid waste including MSW, e-waste, biomedical waste, the societal impact of environmental issues-ozone layer depletion, GHG effects, water conservation and harvesting and environmental protection & Acts

UNIT I

Introduction: Components of Environment and their interactions **Natural Resources:** Forest Resources-Deforestation, Causes of deforestation, Environmental effects of deforestation and solutions • Water resources, World's water reserves, Hydrological cycle • Land resources, Land degradation. Soil erosion, Causes and prevention, Soil conservation and its types• Numerical problems on rainfall & runoff

6 Hours

UNIT II

Energy and resources: • Types of Energy-Renewable, Non renewable & sustainable energy & their advantages and disadvantages• Renewable energy sources- Solar energy, Wind energy, Tidal energy, Ocean thermal energy. Geothermal energy, Hydroelectric power, Biomass energy, Hydrogen energy, Thermal power- environmental impacts • Conservation of energy • Numerical problems on Solar energy, Wind power. **6 Hours**

UNIT III
Environmental pollution: • Sources of pollution- Natural and anthropogenic sources • Pollutants - Classification & their effects on environment • Air Pollution -Composition of clean air, Sources of air pollution, Effect of air pollution on human health and climate • Water quality – Potable water, Wholesome water, Sources of water pollution Polluted water & Contaminated water• Common impurities in water(physical, chemical and bacteriological), Effects of impurities on human health • Soil Pollution – Sources, effects, and its control • Noise pollution- Sources of noise, Effects on human health & its control Numerical problems on pH, hardness of water, noise pollution
6 Hours

UNIT IV
Solid Waste Management: • Refuse, Garbage, Rubbish, Ash, types of solid waste• Necessity of safe disposal, Impacts on human health and environment• Classification of solid wastes- Quantity and composition of MSW, Collection of solid waste- methods• Disposal of solid waste-Sanitary land-fill• E-waste- Problems and solutions• Biomedical waste-Impacts on human health, storage, treatment methods and disposal• Numerical problems on moisture content, density & proportioning of land fill
5 Hours

UNIT V
Sustainable development: Issues on energy utilization, water conservation, concept of 3 R's, Rain water harvesting- methods • **Global environmental issues**: Population growth, Urbanization, Global warming, Acid rains, Ozone layer depletion & controlling measures. • Environmental acts, Regulations, Role of state & central governments, • Numerical problem on carbon foot print & rainwater harvesting.
5 Hours

TEXT BOOKS		
1	Joseph, B	Environmental Studies (2009), India: Tata McGraw-Hill. ISBN: 9781283922524
2	Tripathi, A. K	Environmental Studies(2016), India: Energy and Resources Institute. ISBN:9788179935828

REFERENCE BOOKS		
1	Erach Bharucha	Environmental studies for Undergraduate Courses, 1st Edition, University Press, (2013)
2	Santhosh Kumar Garg	Environmental Science and Engineering Ecology and Environmental Studies, Khanna Publishers, (2015), ISBN-10 : 8174092188 ISBN-13 : 978-8174092182

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Explain the importance of forestation, effects of deforestation, land degradation, adverse effects of mining on environment, using the principles of natural sciences compute the runoff from rainfall & estimates the conservation of water for beneficial use of humans.
CO2	Choose appropriate renewable energy sources by formulating, reviewing the literature, calculating the power potential of solar & wind energy and using the principles of natural sciences.
CO3	Explain the effects of pollution of air, water, soil & noise on humans and the environment, identify and analyze the pollution problems related to air, water, soil & noise and quantify pollution levels & draw valid inferences using the principles of engineering sciences
CO4	Describe Impact of solid waste on human health and environment, its safe disposal. Use population data & compute percapita solid waste generation, land area requirement for sanitary landfill
CO5	Appreciate the importance of sustainable development, current global environmental issues, present state & central governments protection acts, compute carbon footprint using data(vehicles/industries) & asses its impact on the environment.

Ability Enhancement Courses – V
EMBEDDED APPLICATIONS USING ARM CORTEX M4 BASED RENESAS MICROCONTROLLER

Contact Hours/ Week:	0-0-2 (L+T+P)	Credits:	1
Total Lecture Hours:	0	CIE Marks:	50
Total Tutorial Hours:	0	SEE Marks:	50
Total Practical Hours:	28	Course Code:	S5EIA02
Course Type:	Practical (AEC)	Exam Hours:	3

Course objective: This course will enable students to:	
1	Analyze and design digital integrated circuits using Renesas microcontroller.

(2 Hours per week per batch) 13 Lab sessions + 1 Lab assessment **List of Experiments:**	
1.	Design of calculator to perform the basic arithmetic operations.
2.	Design of real time clock using Renesas microcontroller.
3.	Design of temperature control system and develop a C-program to control the temperature control system interfaced to Renesas microcontroller.
4.	Development of a C-program to measure the weight in Kg. and display it on LCD for the weighing machine interfaced to Renesas microcontroller.
5.	Design of traffic control system and develop a C-program to control the traffic control system interfaced to Renesas microcontroller.
6.	Development of a C-program to control the speed and direction of a Robot vehicle designed using Renesas microcontroller.
7.	Design of signal generator using Renesas microcontroller.

8.	Design of system to measure and display the frequency of the input signal on LCD.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Design embedded applications using Cortex M4 based microcontroller
CO2	Interface Input/Output devices to Cortex M4 based microcontroller

DIGITAL IC DESIGN USING EDA TOOLS

Contact Hours/ Week:	0-0-2 (L+T+P)	Credits:	1
Total Lecture Hours:	0	CIE Marks:	50
Total Tutorial Hours:	0	SEE Marks:	50
Total Practical Hours:	28	Course Code:	S5EIA03
Course Type:	Practical (AEC)	Exam Hours:	3

Course objective: This course will enable students to:	
1	Analyze and design digital integrated circuits using EDA tools.

(2 Hours per week per batch) 13 Lab sessions + 1 Lab assessment **List of Experiments:**	
1.	Design and simulate the following circuits using NG-Spice for the given specifications. 1. Characterization of NMOS transistor. 2. Design the following static CMOS gates a. Inverter b. 2-input NAND c. 2-input NOR d. 2-input XOR e. 2-input XNOR.
2.	Design (Schematic and Layout) and simulate the following circuits using Mentor graphics or Cadence for the given specifications and generate GDSII file.
3.	Design the following gates using Static CMOS design style, Pass transistor style and Dynamic gates style. a. Inverter b. 2-input NAND c. 2-input NOR d. 2-input XOR e. 2-input XNOR.
4.	Design of Static CMOS D-register.
5.	Design of Static CMOS Full Adder.

6.	Design of 32 bit adder using the specified topology.
7.	Design of SRAM cell.
8.	Design of 4x4 Array multiplier

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Simulate digital circuits using open source EDA tools.
CO2	Design Schematic and Layout of digital circuit using EDA tools (Mentor Graphics/Cadence).

MACHINE LEARNING USING PYTHON

Contact Hours/Week:	0+0+2 (L+T+P)	Credits:	1
Total Lecture Hours:	0	CIE Marks:	50
Total Tutorial Hours:	0	SEE Marks:	50
Total Practical Hours:	28	Course Code:	S5EIA04
Course Type:	Practical (AEC)	Exam Hours:	3

Course objective: This course will enable students to:	
1	Learn the machine learning concepts and algorithms using python.

(2 Hours per week per batch) 13 Lab sessions + 1 Lab assessment **List of Experiments:**	
1.	a) Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a CSV file1. b) Implement and demonstrate the candidate-elimination algorithm to output a description of the set of all hypotheses consistent with the training examples
2.	a) Develop a program to demonstrate the working of the decision tree based id3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample. b) Build an artificial neural network by implementing the back propagation algorithm and test the same using appropriate datasets.
3.	Develop a program to implement the Naïve Bayesian classifier for a sample training data set stored as a .csv file. Compute the accuracy of the classifier, considering few test data sets.
4.	Develop Naïve Bayesian classifier model to perform document classification. Calculate the accuracy, precision, and recall for the data set.
5.	Develop a program to construct a Bayesian Network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard heart disease data set.
6.	Apply EM algorithm to cluster a set of data stored in a .csv file. Use the same data set for clustering using k-means algorithm. Compare the results of these two algorithms and comment on the quality of clustering.

7.	Develop a program to implement k-nearest neighbour algorithm to classify the iris data set. Print both correct and wrong predictions.
8.	Implement the non-parametric locally weighted regression algorithm to fit data points. (Select Appropriate Data)

Course Outcomes: Upon completion of the course, the student will be able to:	
CO1	Develop Python programs to implement Machine Learning algorithms.
CO2	Identify and apply Machine Learning algorithms to solve real-world problems.

6th Semester

INTERNET OF THINGS

Contact Hours/Week:	3+0+2 (L+T+P)	Credits:	4
Total Lecture Hours:	42	CIE Marks:	50
Total Tutorial Hours:	0	SEE Marks:	50
Total Practical Hours:	28	Course Code:	S6EII01
Course Type:	Theory (IPCC)	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Learn the concepts of IoT levels and models
2.	Understand the design Methodology of IoT system
3.	Understand the concepts of Industry 4.0
4.	Study the application Protocols of IoT
5.	Understand the concepts of Cloud Computing

UNIT I

Introduction & Concepts: Definition and Characteristics of IoT, Things in IoT, IoT Protocols, IoT Functional Blocks, IoT Communication Models, IoT Communication APIs, IoT Enabling Technologies, IoT Levels and Deployment Templates. IOT and Machine to machine (M2M), Software defined networking (SDN) and Network Functions Virtualization (NFV) for IoT.

9 Hours

UNIT II

Developing Internet of Things: IoT Platform, Design Methodology, Specifications, Requirements, Process, Domain, Information, Services, Level, Functional, Operational, Integration, Application development. Case Study on IOT Systems for weather monitoring, Home Automation, Cities, Agriculture.

9 Hours

UNIT III
Industrial IoT: Introduction, Business Model and Reference Architecture, Industrial IoT-Layers. **Industry 4.0:** Introduction, Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis.
8 Hours

UNIT IV
Application Protocols for IoT: Transport Layer, IoT Application Transport Methods, SCADA: Background on SCADA, Adapting SCADA for IP, Tunneling Legacy SCADA over IP Networks, SCADA Protocol Translation, SCADA Transport over LLNs with MAP-T, Generic Web-Based Protocols, IoT Application Layer Protocols, Constrained Application Protocol (CoAP), Message Queuing Telemetry Transport (MQTT)
8 Hours

UNIT V
Cloud Computing Architecture: Introduction, cloud reference model, Architecture, Infrastructure and hardware-as-a-service, Platform as a service, Software as a service, Types of clouds: Public clouds, Private clouds, Hybrid clouds, Community clouds, Economics of the cloud, Open challenges: Cloud definition, Cloud interoperability and standards, Scalability and fault tolerance, Security, trust and privacy, Organizational aspects, Relationship between IoT and Cloud Computing.
8 Hours

TEXT BOOKS		
1	Arshdeep Bahga, Vijay Madisetti	Internet of Things, A Hands-on Approach, 1st Edition, 2015.
2	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry	IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Pearson Education (Cisco Press Indian Reprint), 1st Edition, 2017.
3	Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi	Mastering Cloud Computing: Foundations and Applications Programming, 2013.

REFERENCE BOOKS		
1	Sammi Salama Hussen Hajjaj, Kisheen Rao Gsangaya	The Internet of Mechanical Things: The IoT Framework for Mechanical Engineers., CRC Press Taylor and Francis Group, 1st Edition 2022,
2	Srinivasa K.G., Siddesh G.M., Hanumantha Raju R.	Internet of Things, Cengage learning India 1st Edition, 2018.

Internet of Things Lab: (Only for CIE) (2 Hours per week per batch) 13 Lab sessions + 1 Lab assessment **List of Experiments**	
1	Interface DHT11 sensor with Raspberry Pi and write a program to display temperature and humidity on Raspberry Pi console.
2	Interface Bluetooth with Raspberry Pi and write a program to send sensor data to a smartphone using Bluetooth.
3	Interface Bluetooth with Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from a smartphone using Bluetooth.
4	Write a program on Raspberry Pi to upload temperature and humidity data to Thingspeak cloud.
5	Write a program on Raspberry Pi to retrieve temperature and humidity data from Thingspeak cloud.
6	Install MySQL database on Raspberry Pi and perform basic SQL queries
7	Write a program on Raspberry Pi to publish temperature data to MQTT broker.
8	Write a program on Raspberry Pi to subscribe to MQTT broker for temperature data and print it on Raspberry Pi console.

Course Outcomes: Upon completion of the course the student will be able to:	
CO1	Identify and describe the functional units of IoT systems.
CO2	Analyze and design IOT system prototypes.
CO3	Describe the concepts of IIoT and Industry 4.0.
CO4	Identify and select appropriate protocols to design IoT systems for applications.
CO5	Analyze and select a cloud architecture for an application.

DIGITAL VLSI DESIGN

Contact Hours/ Week:	3+2+0 (L+T+P)	Credits:	4
Total Lecture Hours:	42	CIE Marks:	50
Total Tutorial Hours:	28	SEE Marks:	50
Total Practical Hours:	0	Course Code:	S6EI02
Course Type:	Theory (PCC)	Exam Hours:	3

	Course objectives: This course will enable students to:
1.	Study the design techniques of digital ICs at different levels of abstractions
2.	Learn the design techniques of combinational and sequential circuits
3.	Understand the concepts of semiconductor memories

UNIT I
Introduction: Introduction, Abstraction levels in Digital IC Design, VLSI Design Flow: FPGA and ASIC Design Flow, VLSI Design Styles: Full Custom Design, Standard cell based design and FPGA based design, Fabrication process flow, CMOS n-well process. MOS Transistor: Metal Oxide Semiconductor (MOS) Structure, MOS System under external bias, Structure and Operation of MOSFET. MOSFET Current – Voltage Characteristics, MOSFET Capacitances.
9 Hours

UNIT II
MOS Inverters: Introduction, Resistive load inverter, Static CMOS Inverter an Intuitive perspective, Static Characteristics of CMOS inverter: Switching threshold, Noise Margin, Device variations, Dynamic Characteristics of CMOS inverter: Propagation delay from a design perspective. Power dissipation in inverters.
9 Hours

UNIT III
Designing Combinational Logic gates in CMOS: Introduction, Static CMOS Design style: Complementary CMOS, Ratioed logic, Pass Transistor Logic, Dynamic CMOS Design Style: Dynamic Logic Basic Principles, Speed and power dissipation of Dynamic Logic, Issues in Dynamic Design, Cascading Dynamic Gates, np CMOS dynamic gates. Designing Sequential Logic Circuits: Introduction: Timing metrics for sequential circuits, Classification of Memory elements, Static Latches and Registers: Bistability principle, Multiplexer based latches, Master slave edge triggered registers.
8 Hours

UNIT IV
Dynamic Latches and Registers: Dynamic Transmission gate edge triggered registers, Clock skew and its effect on registers, C^2MOS, True single phase clock (TSPC) registers. Designing Arithmetic Building Blocks: Binary Adder, Full Adder Circuit Design Consideration: Static Full Adder Circuit, Mirror Adder, Transmission gate based full adder, Manchester Carry chain. Carry bypass adder, Carry select adder.
8 Hours

UNIT V
Multipliers: Array multiplier, Carry save multiplier, Wallace tree multiplier, Barrel shifter **Semiconductor Memories:** Introduction, Memory Classification, Memory Architecture and Building Blocks, Dynamic Random Access Memory (DRAM), Static Random Access Memory (SRAM), Read only Memories, Non Volatile Read Write Memories, Memory Peripheral Circuitry: Address Decoders, Sense Amplifiers.
8 Hours

TEXT BOOKS		
1	Jan M Rabaey, Anantha Chandrakasan, Borivoje Nikolic	Digital Integrated Circuit A Design Perspective, 2nd Edition PHI. 2016

REFERENCE BOOKS		
1	Sung-Mo Kang and Yusuf Leblebici	CMOS Digital Integrated Circuits Analysis and Design, 4th edition, Tata McGraw Hill publications, 2019
2	Sedra and Smith	Microelectronics, 7th Edition, Oxford University Press. 2017

DIGITAL VLSI DESIGN Lab: (Only for CIE)

(2 Hours per week per batch) 13 Lab sessions + 1 Lab assessment

List of Experiments

All the experiments need to be conducted with the help of EDA tools. (Cadence/Mentor Graphics/Open source tools)

1	Introduction to SPICE.
2	Simulation of I-V characteristics of NMOS using SPICE
3	Design and Analysis of Static CMOS inverter operation using its Voltage Transfer Characteristics (VTC).
4	Analysis of transient behaviour of Static CMOS inverter
5	Design and analysis of the combinational circuit for a given boolean expression using Static CMOS Design.
6	Design and analysis of the combinational circuit for a given boolean expression using Dynamic Design/Domino Logic/NP-CMOS logic.
7	Design and analysis of all the basic gates using Pass transistor logic with level restorer.
8	Design and analysis of Full adder using Transmission gate logic.
9	Design and Analysis of Static CMOS Master slave D-register.
10	Design and Analysis of Dynamic D-registers.
11	Design and Analysis of Carry select Adder.
12	Design and Analysis of Multipliers.
13	Design and Analysis of SRAM cell.
14	Design and Analysis of ROM array with address decoders.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Describe the fabrication process and analyze terminal characteristics of MOSFETs.
CO2	Analyze and design inverters for given specifications.
CO3	Analyze and design combinational and sequential circuits.
CO4	Analyze and design dynamic registers and adders.
CO5	Design multipliers and semiconductor memory devices at transistor level.

Professional Elective Courses - II

ANALYTICAL INSTRUMENTATION

Contact Hours/Week:	3+0+0 (L+T+P)	Credits:	3
Total Lecture Hours:	42	CIE Marks:	50
Total Tutorial Hours:	0	SEE Marks:	50
Total Practical Hours:	0	Course Code:	S6EIPE21
Course Type:	Theory (PEC)	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Study the concepts of Electromagnetic radiation properties and interaction with matter.
2.	Understand the spectroscopy and its instrumentation
3.	Study the concepts of separation science and its application

UNIT I

Introduction: Classification of analytical methods and instrumental techniques, Considerations in analytical methods, EM spectrum, Electromagnetic Radiation and its properties, interaction with matter, Atomic Energy Levels, Molecular Energy Levels, vibrational Energy levels, Emission of radiation, Absorption of Radiation.
UV Spectroscopy: Spectroscopy and Photometry, Fundamental Laws of Photometry, Radiation Sources, Wavelength selection, sampling Devices, Detectors, Readout Units.

9 Hours

UNIT II

Flame Emission and Atomic Absorption Spectroscopy: Introduction, types of emission spectra, Instrumentation for Flame Spectroscopic Methods, electrodes, sample handling, dispersive elements and detectors of Flame Emission Spectrometry.
Atomic Emission Spectroscopy: Principle and Instrumentation.

9 Hours

UNIT III
X-Ray Methods: Production of X-Rays and X-rays spectra, Instrumentation, diffraction of X-Ray from a crystal planes, collimator, dispersive elements and detectors of X-ray spectroscopy, Non dispersive X-Ray absorption methods, X-Ray diffraction methods and its applications.
8 Hours

UNIT IV
Infrared Spectroscopy: IR spectrophotometer and instrumentation, IR Radiation sources, Sample handling in IR spectroscopy, Monochromators, Detectors of IR spectroscopy, Single beam IR spectrophotometer and double beam IR spectrophotometer and applications. Mass spectrometry: Sample Flow in a Mass Spectrometer, Inlet sample systems, single beam 180° mass spectrometer and Mass Analyzers.
8 Hours

UNIT V
Chromatography: Classification of chromatographic Methods, types of chromatography, Instrumentation of gas chromatography, Gas chromatographic Columns, Detectors for Gas chromatography, High performance liquid chromatography.
8 Hours

TEXT BOOKS		
1	Willard H.W Merritt, L.L Dean J A Settie FA	Instrumental Methods of Analysis, 10th Edition, 2015.

REFERENCE BOOKS		
1	Skoog , Holler, Nieman	Principles of Instrumentation Analysis, 6th Edition,1998

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Describe the properties of Electromagnetic radiation and UV spectroscopy.
CO2	Analyze the principle of operation and instrumentation in flame emission, atomic absorption and atomic emission spectroscopy.
CO3	Describe the principle of operation and instrumentation in X-Ray spectroscopy and mass spectroscopy.
CO4	Analyze the operation of instrument based on optical properties.
CO5	Describe the working of various types of Chromatography.

SYSTEM IDENTIFICATION

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3
Total Lecture Hours:	42	CIE Marks:	50
Total Tutorial Hours:	0	SEE Marks:	50
Total Practical Hours:	0	Course Code:	S6EIPE22
Course Type:	Theory (PEC)	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Learn the model structures for System Identification
2.	Estimate the parameters of input-output model
3.	Understand the methods of open and closed loop identification

UNIT I

Introduction: Dynamic Systems, Models, System Identification Procedure. Models of Linear Time-Invariant Systems: Linear Models and Sets of Linear Models, Family of Transfer-Function Models, State-Space Models, Distributed Parameter Models, Model Sets. Model Structures and Identifiability: Some Formal Aspects, Identifiability of Some Model Structures.

9 Hours

UNIT II

Models for Time-varying and Nonlinear Systems: Linear Time-Varying Models, Models with Nonlinearities, Nonlinear State-Space Models, Nonlinear Black-Box Models: Basic Principles, Nonlinear Black-Box Models: Neural Networks, Wavelets and Classical Models, Fuzzy Models, Formal Characterization of Models.

9 Hours

UNIT III

Model Estimation Methods: Nonparametric time and frequency domain methods, transient response analysis, frequency response analysis, Fourier analysis, Spectral analysis, estimating disturbance spectrum, Parameter estimation methods, guiding principles, minimizing prediction errors, linear regressions and least squares method statistical framework for parameter estimation and maximum likelihood estimation, correlation of prediction error with past data,

Instrumental variable methods using frequency domain data to fit linear models.
8 Hours

UNIT IV
Convergence And Distribution Of Parameter Estimates: Conditions of data set, prediction error approach, consistency and identifiability, linear time invariant models, correlation methods, Prediction error approach, basic theorem, expressions for asymptotic variance, frequency domain expressions for asymptotic variance, correlation approach, use and relevance.
8 Hours

UNIT V
Experimental Design Concepts: General Considerations, informative experiments, input design and open loop experiments, closed loop identification approaches, optimal experiment design, choice of sampling interval, Preprocessing of data, drifts de-trending, outliers and missing data, selecting segments of data and merging experiments, pre-filtering, formal design of pre-filtering and input properties.
8 Hours

TEXT BOOKS		
1	Arun K. Tangirala	Principles of System Identification, CRC press, 1st Edition, 2015

REFERENCE BOOKS		
1	Lennart Ljung	System Identification Theory For the User, Prentice Hall Inc, 2nd Edition, 1999
2	Harold W Sorensen	Parameter Estimation: Marcel Dekker Inc., New York, 2nd Edition 1980.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Classify the model structure of linear systems
CO2	Identify and develop appropriate models for time-varying and nonlinear systems
CO3	Analyze nonparametric and parametric model estimation techniques
CO4	Estimate the parameters of linear time invariant models and perform error analysis
CO5	Analyze open and closed loop systems and perform preprocessing of data

INDUSTRIAL SAFETY AND COMMUNICATION

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3
Total Lecture Hours:	42	CIE Marks:	50
Total Tutorial Hours:	0	SEE Marks:	50
Total Practical Hours:	0	Course Code:	S6EIPE23
Course Type:	Theory (PEC)	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Study the hazardous area & material classification as per NEC Standards and different intrinsic safety methods.
2.	Learn process safety and different safety management systems.
3.	Study Serial and parallel communication standards and commonly used industrial protocols.
4.	Learn HART communication protocol.
5.	Study FFB and PROFIBUS architecture.

UNIT I

Safety in Instrumentation & Control Systems: Hazardous Area & Material classification as per NEC/IEC Standards, ATEX classification of Hazardous Areas, ATEX Marking Example & Temperature Class.
Protection methods to control explosion: Explosion Proof enclosure, Encapsulation, Oil Immersion, Purging systems, Intrinsic Safety methods: Definition, Designing for intrinsic Safety, Isolation or Encapsulation (Zener barrier), Grounding and Shielding Techniques.

9 Hours

UNIT II

Process safety and Safety Management Systems: Introduction to process safety, risk assessment & analysis in process industries, Process Hazard Analysis (PHA), Hazard and operability study (Hazop), Safety Integrity Level (SIL), Introduction to IEC61511 standard for Functional safety, overview of IEC61508, protection layers, Safety Instrumented System for process industry sector: Function, architecture, safety life cycle.

9 Hours

UNIT III
Serial and parallel Communication Standards: 2-wire, 3-wire communication, Synchronous & asynchronous communication, RS 232, 422, 485 interface standards. General purpose interface bus (GPIB) or IEEE-488, Modbus. **Universal serial bus (USB):** Topology, packet format, Host hub, Connectors. **CAN Protocol:** OSI Model, Message Format, and Arbitration, High and low speed CAN bus. **Industrial Protocol and Applications:** XON/OFF signaling, Binary synchronous protocol (BSC), HDLC/SDLC protocol, CSMA/CD protocols, File transfer protocols-OSI analogy, ASi.
8 Hours

UNIT IV
HART Communication protocol- Evolution of signal standards, features of HART protocol, Communication modes, HART networks, HART Data format or telegram structure, field device & Control system interface to HART bus, HART cabling considerations, HART commands and types, HART field controller implementation, 3 layers of HART- OSI model, DDL and compatibility, Advantages and applications of HART protocol.
8 Hours

UNIT V
Field Bus: Basics, Architecture, Message Format, OSI-model of Field Bus, FF/FFB segments, interconnection type- distributed and Chicken foot, FFB types- H1 & HSE, Network design and system configuration, General considerations, advantages of FB & FFB and their comparison. **PROFIBUS**: Architecture, OSI-model of PROFIBUS, PROFIBUS types- PA, DP & FMS and their comparison, Introduction to ProfiNet.
8 Hours

TEXT BOOKS		
1	Steve Mackay, John Park and Edwin Wright.	Practical Data Communication for Instrumentation and Control, 1st Edition, Newnes (Elsevier), 2002.
2	Deon Reynders, Steve Mackay, Edwin Wright	Practical Industrial Data Communications Best Practice Techniques, Newnes (Elsevier), 2005

REFERENCE BOOKS		
1	David Bailey and Edwin Wright.	Practical SCADA for industry, Newnes (Elsevier), 2003
2	Dave Macdonald	Practical Industrial Safety, Risk Assessment and Shutdown Systems, Elsevier, 2004.
3	Mannan S.	Lee's Loss Prevention in the Process Industries, Vol.II & III, 3rd Ed., Butterworth Heinemann, 2005.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Identify and analyze hazardous area and materials as per Electrical industry codes, Intrinsic and extrinsic safety methods.
CO2	Analyze and describe process safety risks and Safety Management Systems in Industrial applications.
CO3	Analyze and select appropriate communication protocols for Industrial control application.
CO4	Identify and describe hybrid protocol for remote process data transmission.
CO5	Identify and describe the different protocols for remote process data transmission.

DIGITAL IMAGE PROCESSING

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3
Total Lecture Hours:	42	CIE Marks:	50
Total Tutorial Hours:	0	SEE Marks:	50
Total Practical Hours:	0	Course Code:	S6EIPE24
Course Type:	Theory (PEC)	Exam Hours:	3

Course objectives: This course will enable students to:	
1.	Study the fundamentals of digital image processing.
2.	Learn the enhancement techniques in spatial domain
3.	Learn the enhancement techniques in frequency domain and morphological image processing
4.	Learn the image compression and segmentation techniques.

UNIT I

FUNDAMENTALS: Introduction, Fundamental steps in digital image processing (DIP), components of DIP system, image formation model, Image sampling and quantization, Basic relationship between pixels, colour image processing: colour fundamentals, colour models: RGB, CMY and CMYK, HIS.

9 Hours

UNIT II

IMAGE ENHANCEMENT IN SPATIAL DOMAIN: Background, Point processing – Image negatives, Log transformations, Power law transformations, Contrast stretching, Gray level slicing, Bit plane slicing, Histogram processing – Histogram equalization, Histogram matching (specification), Local enhancement, Arithmetic/Logic operations – Image subtraction, Image averaging

SPATIAL FILTERING: Smoothing spatial filters – Smoothing linear filters, order statistics filters, Sharpening spatial filters – Foundation, Laplacian and gradient.

9 Hours

UNIT III
IMAGE ENHANCEMENT IN FREQUENCY DOMAIN: Introduction to Fourier Transform and frequency domain , Basic filtering in frequency domain, Basic filters and their properties, Smoothing frequency domain filters: Ideal low-pass filters, Butterworth low-pass filters, Gaussian low pass filters Sharpening frequency domain filters: Ideal high-pass filters, Butterworth high-pass filters, Gaussian high-pass filters, Homomorphic filtering. Morphological Image Processing: Basic concepts, Fundamental operations, Erosion and dilation, Compound operations.
8 Hours

UNIT IV
IMAGE COMPRESSION: Fundamentals: Coding redundancy, interpixel redundancy, psychovisual redundancy, Image Compression models: Source encoder and decoder, Channel encoder and decoder, Error Free compression: Variable length coding, LZW coding, Bit plane coding, Lossless predictive coding, Lossy Compression: Lossy predictive coding, transform coding fundamentals, image compression standards: basics, JPEG.
8 Hours

UNIT V
IMAGE SEGMENTATION: Detection of discontinuities: point detection, Line detection, edge detection, Edge Linking and boundary Detection: Local Processing, Global processing via the Hough transform: Introduction, Global processing via Graph theoretic Techniques Thresholding: Foundation, Role of illumination, Basic Global thresholding, Basic Adaptive thresholding, Optimal global and adaptive thresholding Region-based segmentation: Basic Formulation, Region growing, Region splitting & merging.
8 Hours

TEXT BOOKS		
1	Rafael C. Gonzalez & Richard E. Woods	Digital Image Processing, 4th Edition. Pearson Education, 2018

REFERENCE BOOKS		
1	Anil K. Jain	Fundamentals of Digital Image Processing, 1st Edition, Pearson Education India, 2015.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Identify the relationships between pixels in the neighborhood and select suitable color model for an application
CO2	Identify and apply suitable enhancement techniques for a given image in the spatial domain.
CO3	Analyze and select suitable image enhancement techniques in frequency domain and perform dilation and erosion operation on binary images
CO4	Analyze and apply image compression techniques for 1D data.
CO5	Select and apply suitable segmentation technique for images.

PROCESS AUTOMATION LABORATORY

Contact Hours/Week:	0+0+2 (L+T+P)	Credits:	1
Total Lecture Hours:	0	CIE Marks:	50
Total Tutorial Hours:	0	SEE Marks:	50
Total Practical Hours:	28	Course Code:	S6EIL01
Course Type:	Practical (PCCL)	Exam Hours:	3

Course objective:	
This course will enable students to:	
	Study, develop and implement various applications using P/PI/PD/PID mode for various controller

(2 Hours per week per batch) 13 Lab sessions + 1 Lab assessment **List of Experiments:**	
1.	Optimum response of the flow controller using P/PI/PD/PID mode.
2.	Optimum response of the level controller using P/PI/PD/PID mode.
3.	Optimum response of the pressure controller using P/PI/PD/PID mode.
4.	Optimum response of the temperature controller using P/PI/PD/PID mode.
5.	Tuning of PID Controller using Zeigler Nichols method for temperature control.
6.	Control valve characteristics.
7.	Multipurpose Process System
8.	Heat Exchanger-Temperature Control using PID
Open ended Experiments	
9.	Optimum response of hybrid process control in P/PI/PD/PID mode using DCS with IoT.

Course Outcomes:	
Upon completion of the course the student will be able to:	
CO1	Analyze the optimum response of Flow, Level, Pressure and Temperature controllers using P/PI/PD/PID mode
CO2	Analyze the optimum response of control valve characteristics
CO3	Analyze and fine-tune PID parameters for improved system performance and stability