SYLLABUS
FOR
V and VI semester B.E.

2026 – 2027

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, teamwork 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.

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B.E. in Electronics & Instrumentation Engineering

SCHEME OF TEACHING AND EXAMINATION FOR THE AY 2026-27

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/ TW	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	PCC	S5EI01	Digital Signal processing	EIE	42	0	0	48	3	50	50	100	3
2.	IPCC	S5EII02	Process Control Systems	EIE	42	0	28	50	3	50	50	100	4
3.	IPCC	S5EII03	Industrial Internet of Things	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	S5EIP	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	S5EIA0x	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

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering (B.E.) 2022-23 may please be referred to.

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first Week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the Degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of Degree.

Mini-project work: Mini Project is a laboratory-oriented/hands-on course that will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications etc. Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini-project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project. The CIE marks awarded for the Mini-project, shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

No SEE component for Mini-Project.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of Engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering a professional elective is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

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B.E. in Electronics & Instrumentation Engineering

SCHEME OF TEACHING AND EXAMINATION FOR THE AY 2026-27

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	S6EII03	Industrial Control and Automation	EIE	42	0	28	50	3	50	50	100	4
2.	IPCC	S6EII02	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	S6EIP	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.	NCMC	SHSEI08	Indian Knowledge System in Instrumentation	EIE	14	0	0	-	-	100	-	100	0
8.	MC	SHS06	Soft Skills	T&P	0	28	0	-	-	100	-	100	0
9.	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	S6EIPE25	Image Processing and Computer Vision
S6EIPE26	Deep Learning and Generative AI	S6EIPE27	Battery Management Systems
S6EIPE28	Robotics and Automation		

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National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first Week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the Degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of Degree.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of Engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering a professional elective is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses: Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum number of students' strength for offering an Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

Project Phase-I : Students have to discuss with the mentor /guide and with their help he/she has to complete the literature survey and prepare the report and finally define the problem statement for the project work.

5th Semester

DIGITAL SIGNAL 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:	S5EI01
Course Type:	PCC	Exam Hours:	3

Course objectives:

This course will enable students to:

1.	Understand discrete-time signal processing systems, Fourier representation of signals, and Z-transform techniques
2.	Study the Discrete Fourier Transform (DFT), its properties, efficient computation methods, and convolution techniques
3.	Learn the design and realization of FIR and IIR digital filters.

UNIT I

Introduction to Digital Signal Processing: Basic elements of a Digital Signal Processing system, advantages of digital over analog signal processing.

Fourier representation of signals: Introduction, Computation of DTFT, Frequency response of LTI systems.

Z-Transform: Introduction, Properties of ROC, inversion of Z-transform. Computation of Z-Transform and Inverse Z-Transform of signals, Properties of Z-transform.

9 Hours

UNIT II

Discrete Fourier transform: Introduction to DFT, properties of DFT, Computation of Circular convolution using graphical method, convolution of long sequences using overlap-save method, relationship between DFT and Z transforms.

Computation of DFT: Matrix method, Decimation-in-time radix-2 FFT and IFFT algorithms (4 point sequences).

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, 2nd 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.

Course Outcomes:	
Upon completion of this course the student will be able to:	
CO1	**Compute** DTFT and Z-Transform of sequences.
CO2	**Compute** the DFT and Convolution of sequences in time domain and frequency domain.
CO3	**Design** FIR filters for the given specifications.
CO4	**Design** IIR filters for the given specifications.
CO5	**Develop** the structures to realize the FIR and IIR filters and describe the functional units of DSP processor**.**

PROCESS CONTROL SYSTEMS

Contact Hours/Week:	3+0+2 (L+T+P)	Credits:	4
Total Lecture Hours:	42	CIE Marks:	50
Total Tutorial Hours:	00	SEE Marks:	50
Total Practical Hours:	28	Course Code:	S5EII02
Course Type:	IPCC	Exam Hours:	3

Course objectives:

This course will enable students to:

1.	Study the concepts of controller modes and design of analog controllers.
2.	Understand the operation of control loops, tuning methods, converters and valves used in process industry
3.	Study the concept of Computer-Aided process control and Process and Instrumentation drawing.

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, safety interlocks and its types.
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) **List of Experiments:** (2 Hours per week per batch) 13 Lab sessions + 1 Lab assessment (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	Modelling and analysis of control valve characteristics (linear, equal percentage and quick opening)
7	Analysis of servo and regulatory control performance
8	Development of motor control using the deadbeat algorithm.
9	Development of motor control using the Dahlin algorithm.
10	PID tuning using Ziegler Nichols method for water tank level and Flow rate using P & ID symbols.
Open Ended Experiments	
1	Design of cascade control for temperature process.
2	Design of feed forward control for disturbance rejection in control loop.

Course Outcomes:	
Upon completion of this course the student will be able to:	
CO1	**Analyze** the performance of different types of controller modes.
CO2	**Design** analog controllers for the given specifications.
CO3	**Apply** control system concepts to tune controllers. Analyze the operation of control valves and actuators.
CO4	**Design** digital control algorithms for process control applications.
CO5	**Develop** the process & instrumentation drawing (P&ID) for a given process.

INDUSTRIAL 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:	S5EII03
Course Type:	IPCC	Exam Hours:	3

Course objectives:

This course will enable students to:

1.	Learn the concepts of IoT levels and design Methodology of IoT systems.
2.	Understand the concepts of Industry 4.0 and Data analytics.
3.	Study the application Protocols of IoT and Edge computing.
4.	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 Home Automation.

Operational Technology and Information Technology: Overview of OT systems, Key Characteristics of OT, Components of Operational Technology, OT Protocol, Importance of Operational Technology & Applications of OT Understanding IT, Key Characteristics of IT Differences Between OT and IT.

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) **Edge Computing:** Edge computing architectures, models, and platforms. Comparison of edge computing with cloud computing.
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.
4	Pascal Ackerman	Industrial Cybersecurity: Efficiently secure critical infrastructure systems (Packt Publishing), 2nd Edition, 2017.

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) **List of Experiments:** (2 Hours per week per batch) 13 Lab sessions + 1 Lab assessment	
1	Develop a program on Raspberry Pi to upload temperature and humidity data to Thingspeak cloud.
2	Develop a program on Raspberry Pi to retrieve temperature and humidity data from Thingspeak cloud.
3	Develop a smart irrigation system using Raspberry Pi.
4	Develop an automatic Fan speed control system using Raspberry Pi.
5	Develop a smart lighting system using Raspberry Pi.
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	Interface Bluetooth with Raspberry Pi/Arduino and write a program to send sensor data to a smartphone using Bluetooth.
9	Develop a smart security system using Raspberry Pi and PIR sensor to detect human movement and generate an alert.
10	Develop a smart parking system using Raspberry Pi and ultrasonic sensor to detect vehicle presence and display parking status.

Open Ended Experiments	
1	Develop an RFID-based access control system using Raspberry Pi to identify authorized users and control access.
2	Interface an MQ-2 gas sensor with Raspberry Pi using MCP3008 ADC and develop a program to monitor gas/smoke level.

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** IoT Design methodologies and describe the characteristics of OT and IT.
CO3	**Describe** the concepts of IIoT and Industry 4.0.
CO4	**Apply** transport and application layer protocols to design IoT systems with edge computing.
CO5	**Analyze** cloud computing architectures, service models, deployment models, and their integration with IoT.

Signal Conditioning Circuits and Data Converters Lab

Contact Hours/Week:	0+0+2 (L+T+P)	Credits:	1
Total Lecture Hours:	00	CIE Marks:	50
Total Tutorial Hours:	00	SEE Marks:	50
Total Practical Hours:	28	Course Code:	S5EIL01
Course Type:	PCCL	Exam Hours:	3

Course objectives:	
This course will enable students to:	
1.	Learn the design of signal conditioning circuits
2.	Learn the design and operation of data converter circuits.

List of Experiments:	
(2 Hours per week per batch) 13 Lab sessions + 1 Lab assessment	
1.	Sample and Hold circuits
2.	Instrumentation Amplifier
3.	Phase locked loop
4.	Digital to Analog Converter (IC - Verification).
5.	4-bit R-2R ladder and Binary weighted DAC.
6.	Analog to Digital Converter (IC - Verification)
7.	Relay driving circuit
8.	Voltage to Frequency and Frequency to Voltage Convertor.
9.	Analog Multiplexer and De-Multiplexer based Data Acquisition System.
10.	Programmable gain amplifier.
Open Ended Experiments	
1.	Design signal Conditioning circuit for Strain Gauge using Instrumentation Amplifier.
2.	3-bit flash ADC.

Course outcomes:	
This course will enable students to:	
1.	**Design** signal conditioning circuits
2.	**Design** data converter circuits.

Professional Elective Course - 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:	PEC	Exam Hours:	3

Course objectives:

This course will enable students to:

1.	Study various compensation techniques used in control system
2.	Learn stability analysis of discrete time system
3.	Study state space model of electrical and mechanical systems
4.	Learn design concept of Optimal and Adaptive control systems
5.	Learn 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 LTI system.
CO2	**Analyze** the stability of discrete LTI systems.
CO3	**Formulate and analyze** state models for LTI systems.
CO4	**Analyze** and interpret controllability and observability of a continuous system.
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:	PEC	Exam Hours:	3

Course objectives:

This course will enable students to:

1.	Learn the architecture and addressing modes of ARM Cortex M3
2.	Learn peripheral interfacing and programming 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 BOOK		
1	Ming-Bo Lin	An Introduction to Cortex-M3-Based Embedded Systems: Cortex-M3 Assembly Language Programming, Create space 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:	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 BOOK		
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:	PEC	Exam Hours:	3

Course objectives:

This course will enable students to:

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** reasoning methodologies to solve problems in biomedical expert systems.
CO4	**Apply** Machine learning algorithms to develop computer aided diagnosis.
CO5	**Apply** AI approaches to analyze and create electronic health records (EHR) and clinical documentation.

MINI PROJECT

Contact Hours/Week:	0+0+4 (L+T+P)	Credits:	2
Total Lecture Hours:	0	CIE Marks:	50
Total Tutorial Hours:	0	SEE Marks:	50
Total Practical Hours:	56	Course Code:	S5EIP
Course Type:	Project	Exam Hours:	3

Course objectives: This course will enable students to:	
1.	**Study and identify** a relevant engineering problem through a systematic literature survey and understanding of contemporary technologies.
2.	**Learn to define and formulate** clear engineering objectives by exploring current challenges and identifying gaps in existing solutions.
3.	**Learn to develop project planning skills** by preparing effective schedules, conducting budget analysis, and distributing responsibilities within a team.
4	**Explore sustainable and ethical engineering practices** by considering environmental, health, safety, legal, and cultural aspects in the proposed solutions.
5	**Apply and integrate foundational knowledge** from mathematics, science, engineering, and management to address real-world problems.
6	**Learn to choose and use modern engineering tools and technologies** effectively for implementing practical solutions.
7	**Analyze, design, and validate engineering solutions** through simulation, prototyping, and experimentation using appropriate methodologies.
8	**Develop technical writing skills** by preparing detailed reports, research papers, and documentation in a professional format.
9	**Enhance oral communication abilities** through presentations and demonstrations of the project work.
10	**Study and practice ethical conduct and safety standards** relevant to engineering projects and professional environments.
11	**Learn to function effectively in team environments**, demonstrating leadership, collaboration, and project management capabilities.

Course Outcomes:	
Upon completion of this course the student will be able to:	
CO1	To identify a problem through literature survey and knowledge of contemporary engineering technology
CO2	To consolidate the literature search to identify issues/gaps and formulate the engineering problem
CO3	To prepare project schedule for the identified design methodology and engage in budget analysis, and share responsibility for every member in the team.
CO4	To provide sustainable engineering solution considering health, safety, legal, cultural issues and also demonstrate concern for environment
CO5	To identify and apply the mathematical concepts, science concepts, engineering and management concepts necessary to implement the identified engineering problem
CO6	To select the engineering tools/components required to implement the proposed solution for the identified engineering problem
CO7	To analyze, design, and implement optimal design solution, interpret results of experiments and draw valid conclusion
CO8	To demonstrate effective written communication through the project report, the one-page poster presentation, and preparation of the video about the project and the four page IEEE/Springer/ paper format of the work
CO9	To engage in effective oral communication through power point presentation and demonstration of the project work.
CO10	To demonstrate compliance to the prescribed standards/ safety norms and abide by the norms of professional ethics.
CO11	To perform in the team, contribute to the team and mentor/lead the team

RESEARCH METHODOLOGY AND IPR

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:	SHS04
Course Type:	AEC	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Differentiate between alternative research methods and formulate a research problem from a broader context.
2.	Prepare a literature review, data collection plan, and analyze the obtained data.
3.	Develop a research methodology and interpret the key elements of the report.
4.	Demonstrate the basic concepts of Intellectual Property Rights (IPR) and the procedure of obtaining Patents, Copyrights, and Trademarks.
5.	Analyze new developments in IPR and the impact of information technology on IP management.

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:

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:		
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 (L+T+P)	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:	MC	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 and 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 Course – 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:	AEC	Exam Hours:	3

Course objective:

This course will enable students to:

1	Analyze and design digital integrated circuits using Renesas microcontroller.

List of Experiments:

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

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.
9	Design and develop a serial communication system using UART interfaced to the Renesas microcontroller to transmit sensor data and receive control commands through a serial terminal.
10	Design and develop an interrupt-driven event counter using a push-button interfaced to the Renesas microcontroller, and display the number of button presses on an LCD.

Open Ended Experiments	
1	Design and develop an automatic street light system using the Renesas microcontroller to sense ambient light and control an LED lamp automatically.
2	Design and develop an automatic fan controller using the Renesas microcontroller to sense temperature and control fan speed based on predefined temperature levels.

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:	AEC	Exam Hours:	3

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

List of Experiments:	
(2 Hours per week per batch) 13 Lab sessions + 1 Lab assessment	
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
9.	Design and simulation of a CMOS Ring Oscillator.
10.	Design and simulate a 4:1 CMOS multiplexer using EDA tools.

Open Ended Experiments	
1.	Design and simulate an application-oriented digital circuit using CMOS technology and EDA tools.
2.	Design and simulate a 2:1 CMOS multiplexer using EDA tools.

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:	AEC	Exam Hours:	3

Course objective:

This course will enable students to:

1	Study machine learning concepts and algorithms using python.

List of Experiments:

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

1.	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.
2.	Implement and demonstrate the candidate-elimination algorithm to output a description of the set of all hypotheses consistent with the training examples
3.	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.
4.	Build an artificial neural network by implementing the back propagation algorithm and test the same using appropriate datasets.
5.	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.
6.	Develop Naïve Bayesian classifier model to perform document classification. Calculate the accuracy, precision, and recall for the data set.
7.	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.
8.	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.
9.	Develop a program to implement k-nearest neighbour algorithm to classify the iris data set. Print both correct and wrong predictions.
10.	Implement the non-parametric locally weighted regression algorithm to fit data points. (Select Appropriate Data)

Open Ended Experiments	
1.	Develop a machine learning model to predict student academic performance using relevant academic and demographic attributes. Compare the performance of two suitable machine learning algorithms and evaluate their prediction accuracy.
2.	Develop a machine learning model for detecting spam emails/messages using text features. Preprocess the text data, extract suitable features, classify the messages as spam or legitimate, and evaluate the model using accuracy, precision, recall, and F1-score.

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

INDUSTRIAL CONTROL AND AUTOMATION

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:	S6EII03
Course Type:	IPCC	Exam Hours:	3

Course objectives:

This course will enable students to:

1.	Learn the fundamental components of programmable Logic Controllers (PLCs) and study the ladder logic for various industrial automation applications.
2.	Study the principles of SCADA and Distributed Control Systems(DCS)

UNIT I

Introduction to programmable logic controllers:

PLC hardware components: Input status file, output status file, I/O Units addressing, analog I/O units, PLC memory.

Input Units: Discrete AC input Unit, DC input units, Sourcing and sinking units.

Output Units: Discrete output units, solid state output unit switching, TTL output units, relay output Units

Introduction to PLC programming: PLC programming language, procedure for creating ladder diagram, ladder logic diagram, structure of the ladder program, graphical symbol for Boolean instructions and function.

8+5 Hours

UNIT II

Timer instructions: Mechanical timing relay, timer instruction, ON delay and OFF delay and retentive timer instructions, cascading timers, developing ladder diagram for analytical problems.

Counter instructions: PLC counter up and down instructions, cascading counters, combining counters and timers, developing ladder diagram for analytical problems.

8+5 Hours

UNIT III
Comparison, data handling and sequencer instructions: Comparison instructions, data handling instructions, sequencer instructions, programming sequence output instructions, developing ladder diagram with analytical treatment. **Program flow instructions**: Subroutines - jump to subroutine instruction, subroutine file, conditioned return in subroutine, nested subroutines, jump to label instruction – multiple jumps to same label, rung operation within a jump zone, immediate input with mask instruction, refresh instruction, master control reset instruction.
8+5 Hours

UNIT IV
Math instructions: Addition instruction, subtraction instruction, multiplication instruction, division instruction, other word-level math instructions, file arithmetic operations. **Shift register instructions**: Shift registers and word shift registers
8+5 Hours

UNIT V
SCADA: Introduction and brief history of SCADA - Fundamental principles of modern SCADA systems, Remote terminal units, Specialized SCADA protocols. **DCS:** Overview of a distributed control system, DCS software configuration, DCS communication, advantages and features of DCS. Use of DCS in pulp and paper. IOT based communication
8+6 Hours

TEXT BOOKS		
1	Frank D.Petruzella.	Programmable Logic Controllers, TATA McGRAW-HILL 6th Edition 2022.
2	Gary Dunning.	Introduction to Programmable logic Controllers, Delmar, 3rd Edition, 2006

REFERENCE BOOKS		
1	Bela G. Liptak	Process control: Instrument Engineers Handbook, Butterworth-Heinemann Publisher, 3rd Edition, 2013.
2	JR Hackworth	Programmable Logic Controllers, Pearson Education, 2003.

List of experiments: (Only for CIE) (2 Hours per week per batch) 13 Lab sessions + 1 Lab assessment	
1	Ladder logic for logic gates.
2	Ladder logic for Boolean equation.
3	Ladder logic using timers 1) On delay timer 2) Off delay timer 3) Retentive timer for Pump Filling process.
4	Ladder logic using UP and Down counter for counting the number of objects passed on conveyor system.
5	Ladder logic to measure RPM of a Motor.
6	Ladder logic for sequential motor control.
7	Ladder logic for automatic liquid mixing application.
8	Ladder logic for conveyor control system.
9	Ladder logic for traffic light controller.
10	Ladder logic for car parking system.
Open ended Experiments	
1	Develop ladder logic for automatic star-delta starting of a three-phase induction motor.
2	Develop ladder logic for elevator control system.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	**Identify** the basic components of PLC and develop ladder logic for given Boolean expression.
CO2	**Develop** ladder logic to control industrial process using PLC timer, counter instruction.
CO3	**Develop** ladder logic to control industrial process using comparison, data handling, sequencer and program flow instructions.
CO4	**Develop** ladder logic to control industrial process using math and shift instructions by combining the other instruction set.
CO5	**Analyze** the principles of SCADA, RTU and DCS & interpret the functionality of various elements of DCS.

DIGITAL VLSI DESIGN

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:	S6EII02
Course Type:	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, sequential and memory circuits.

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. Introduction to FinFETs and its advantages over buried gates. Nano meter technologies.

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, Ratioed logic, Pass Transistor Logic, Transmission Gate logic, Interconnect & Wire Delay: RC delay models, Elmore delay, Crosstalk effects.

9 Hours

UNIT III
Designing Combinational Logic gates in CMOS: Introduction, Static CMOS Design style: Complementary CMOS, 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
Timing Fundamentals: Setup & hold timing equations, Timing paths (combinational + sequential), clock skew, jitter & uncertainty, Introduction to timing violations, Timing closure of setup/hold basics. **Dynamic Latches and Registers:** Dynamic Transmission gate edge triggered 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. **Semiconductor Memories:** Introduction, Memory Classification, Memory Architecture and Building Blocks, Dynamic Random Access Memory (DRAM): 1T and 3T DRAM Cell operation, Static Random Access Memory (SRAM): 6T SRAM, Read only Memories, Non-Volatile Read Write Memories, Memory Peripheral Circuitry: Address Decoders, Sense Amplifiers.
8 Hours

TEXT BOOK		
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.
3	J. Bhasker and Rakesh Chadha.	"Static Timing Analysis for Nanometer Designs A Practical Approach", 2009, Springer edition.

DIGITAL VLSI DESIGN Lab: (Only for CIE) **List of Experiments:** (2 Hours per week per batch) 13 Lab sessions + 1 Lab assessment 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 Dynamic D-registers.
10	Layout of static invertor
Open Ended Experiment	
1	Design and Analysis of Static CMOS Master slave D-register.

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

Professional Elective Course - 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:	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 BOOK		
1	Willard H.W Merritt, L.L Dean J A Settie FA	Instrumental Methods of Analysis, 10th Edition, 2015.

REFERENCE BOOK		
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 instruments 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:	PEC	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Learn the model structures for System Identification
2.	Study the parameters of the input-output model.
3.	Study 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 BOOK		
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** and describe the model structure of linear systems
CO2	**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:	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 and management.
2.	Study Serial and parallel communication standards and commonly used industrial protocols.
3.	Learn industrial process communication protocols.

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.

Layer of Protection Analysis (LOPA) and brief case studies of industrial accidents (e.g., Bhopal Gas Tragedy).

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. **PROFINET Architecture, Communication Types in PROFINET,** Industrial Safety Monitoring Using PROFIBUS Networks, Smart Safety Sensors, Cybersecurity Challenges in PROFIBUS-.

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	**Analyze** hazardous areas, materials and safety methods.
CO2	**Analyze** process safety risks and Safety Management Systems.
CO3	**Select** appropriate communication protocols for Industrial control applications.
CO4	**Identify** and describe hybrid protocol for remote process data transmission.
CO5	**Identify** and describe the different protocols for remote process data transmission.

IMAGE PROCESSING AND COMPUTER VISION

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:	S6EIPE25
Course Type:	PEC	Exam Hours:	3

Course objectives:

This course will enable students to:

1	Study fundamentals of Image Processing
2	Study various image feature descriptor.
3	Study deep convolutional neural network for classification and segmentation.

UNIT I

Digital Image Fundamentals: Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Image Sampling and Quantization, Some Basic Relationships between Pixels, connected component analysis. IMAGE ENHANCEMENT: Background, Histogram processing – Histogram equalization, Histogram matching (specification)

8 Hours

UNIT II

Linear Filters and Segmentation: Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Filters as Templates, Segmentation: Fundamentals, Point, Line and Edge Detection, Hough transform, Thresholding

9 Hours

UNIT III

Image Descriptors and Features: Boundary descriptors, Region feature descritors, Principal Component as Feature descriptor, Object Boundary and Shape Representations, Histogram of Oriented Gradients, Scale Invariant Feature Transform.

8 Hours

UNIT IV
Image Descriptors and Features: Boundary descriptors, Region feature descritors, Principal Component as Feature descriptor, Object Boundary and Shape Representations, Histogram of Oriented Gradients, Scale Invariant Feature Transform.
8 Hours

UNIT V
Deep Learning for Computer Vision: CNN Architectures – Convolution, Pooling Layers, Back propagation in CNN. Object Classification-VGGNET, RESNET, ALEXNET, DENSENET, EFFICIENT NET. Image Segmentation-UNet, SegNet.
9 Hours

TEXT BOOKS		
1	Rafael C. Gonzalez and Richard E. Woods	"Digital Image Processing", Pearson Education, 2018.
2	David A ForsythJean Ponce	"Computer Vision – A Modern Approach", PHI Learning, 2009.
3	Richard Hartley, Andrew Zisserman	"Multiple View Geometry in Computer Vision," Cambridge University Press, 2004
4	Ian Goodfellow, Yoshua Bengio, Aaron Courville,	"Deep Learning", 2016.

REFERENCE BOOK		
1	E. R. Davies	"Computer and Machine Vision – Theory, Algorithms and Practicalities," Elsevier (Academic Press), 2013

Course Outcomes: Upon completion of the course the student will be able to:	
CO1	**Analyze** fundamental image processing techniques required for computer vision.
CO2	**Apply** suitable techniques to enhance an image and extract regions of interest for analysis.
CO3	**Analyze** Morphological processing and compression techniques for image data.
CO4	**Analyze** various techniques for image feature extraction.
CO5	**Apply** deep learning models for object classification and segmentation.

DEEP LEARNING AND GENERATIVE AI

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:	S6EIPE26
Course Type:	PEC	Exam Hours:	3

Course objectives:	
This course will enable students to:	
1.	Learn the fundamental concepts of Deep Learning
2.	Study the various issues in the design of Generative AI and its applications.

UNIT I
Introduction to Deep Learning: Overview of AI, ML, and DL; Relationship between AI, ML, and DL; Applications and challenges of deep learning. Neural Network Basics: Perceptrons, activation functions (sigmoid, tanh, ReLU), loss functions, forward pass computation. Learning Process: Introduction to gradient descent, stochastic gradient descent, and backpropagation (conceptual understanding). Regularization and Optimization: Overfitting, dropout, early stopping, weight initialization, batch normalization.
9 Hours

UNIT II
Deep Learning Architectures: Feedforward networks, Convolutional Neural Networks (concepts of convolution, pooling, feature maps) for vision tasks. Sequence Models: Introduction to RNNs, LSTMs, GRUs, and their applications in sequential data. Transfer Learning: Pre-trained models and fine-tuning.
8 Hours

UNIT III
Introduction to Generative AI: Definition, importance, and differences from traditional AI; Discriminative vs Generative models; Applications in text, images, audio, and video. Latent Space Representation: Concept of latent vectors, sampling, and decoding. Variational Autoencoders (VAEs): Architecture, encoder–decoder process, applications in image generation.
8 Hours

UNIT IV
Generative Adversarial Networks (GANs): Generator and discriminator architecture, loss functions, training challenges (mode collapse), variants (DCGAN, CycleGAN, StyleGAN). Diffusion Models: Concept, training process, and applications (Stable Diffusion). Large Language Models (LLMs): Introduction to transformer architecture, GPT, BERT
8 Hours

UNIT V
Applications: Introduction to ChatGPT, Overview of Large Language Models, Output Formats Generated By ChatGPT, Use Cases for ChatGPT, Differences Between ChatGPT and Web Search, AI-assisted text generation, image synthesis, code generation, and creative design.
9 Hours

TEXT BOOKS		
1	Ian Goodfellow, Yoshua Bengio, Aaron Courville	Deep Learning, MIT Press, 2016
2	François Chollet	Deep Learning with Python, Manning Publications, 2021.
3	David Foster	Generative Deep Learning, O'Reilly Media, 2019.

REFERENCE BOOKS		
1	Denis Rothman	Transformers for Natural Language Processing, Packt Publishing, 2021.
2	Ben Auffarth	Generative AI with LangChain Packt Publishing Ltd. 1st Edition, 2023

Web Resources:	
1	Hugging Face Documentation – https://huggingface.co/docs
2	OpenAI Documentation - https://platform.openai.com/docs

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	**Explain** the fundamental concepts of AI, describe neural network components, and apply regularization and optimization techniques to simple models.
CO2	**Design** and implement feedforward, convolutional, and sequence-based deep learning models, and apply transfer learning to vision and sequential data tasks.
CO3	**Analyze** latent space representations, and implement basic VAE architectures for generative tasks.
CO4	**Develop** GAN and diffusion model architectures, identify common training challenges, and explain the fundamentals of transformer-based LLMs.
CO5	**Demonstrate** the use of ChatGPT and other LLMs for text, code, and image generation, and evaluate their applications and limitations in real-world problem-solving.

BATTERY MANAGEMENT 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:	S6EIPE27
Course Type:	PEC	Exam Hours:	3

Course objectives:	
This course will enable students to:	
1.	Understand battery characteristics, modeling techniques, and state estimation methods used in Battery Management Systems (BMS).
2.	Learn BMS solutions for battery monitoring, protection, balancing, thermal management, and fault diagnosis in electric vehicle and energy storage applications

UNIT I

Battery Fundamentals & Modeling:

Introduction to Energy Storage & Lithium-Ion Batteries: Role of energy storage in EVs and the grid, Basic electrochemistry, oxidation-reduction, Faraday's laws, cell chemistry comparisons (NMC, LFP, NCA, Li-Ion, Li-Po, NiMH, lead-acid), Key terminology: Capacity, C-rate, Nominal Voltage, Cycle Life.

Battery Testing & Characterization: Open-Circuit Voltage (OCV) vs. State of Charge (SOC), Charging protocols (CC-CV), Pulse testing (HPPC) and dynamic current profiles,

Battery Modeling: Empirical vs. Electrochemical models (Overview), Equivalent Circuit Models (ECM): Rint, Thevenin, and RC networks, Hysteresis in battery modelling,

Parameter Identification: Extracting ECM parameters from lab data, Recursive Least Squares (RLS) and real-time parameter estimation.

9 Hours

UNIT II
State Estimation Algorithms: State of Charge (SOC) Estimation - Part 1: Definition of SOC. Voltage translation (OCV-SOC lookup) and Coulomb Counting (Ampere-hour integration), Error accumulation and sensor noise analysis. **State of Charge (SOC) Estimation - Part 2**: Introduction to state observers, The Linear Kalman Filter (KF) and Extended Kalman Filter (EKF) for SOC estimation. **State of Health (SOH) Estimation**: Battery degradation mechanisms (SEI layer growth, lithium plating). Capacity fade vs. Power fade (resistance increase), Data-driven and model-based SOH estimation techniques.
9 Hours

UNIT III
Cell Balancing Systems: Causes of cell imbalance in series/parallel packs, Passive balancing (Bleed resistors, topology, control logic), Active balancing (Switched capacitor, inductive, flyback converters). **Thermal Management**: Heat generation in batteries (Joule heating, entropic heat), Air, liquid, and phase-change material (PCM) cooling, Thermal runaway mechanisms and propagation prevention. **BMS Hardware Architecture**: Master-Slave vs. Centralized topologies, Analog Front End (AFE) ICs for voltage and temperature multiplexing. Current measurement (Shunts vs. Hall-effect sensors). High-voltage isolation, contactors, and pre-charge circuits. **BMS Software Architecture & Functional Safety**: Embedded software design for BMS (RTOS, State Machines). Fault detection, diagnostics, and isolation, Overview of automotive functional safety (ISO 26262, ASIL ratings for BMS).
8 Hours

UNIT IV
Pack Design & System Integration: Series/Parallel configurations and welding techniques, Packaging, structural considerations, and crash safety, Communication protocols (CAN bus, LIN, SPI), **Emerging Trends in Battery Management:** Fast-charging algorithms, Second-life batteries and Grid-tied energy storage, Solid-state batteries and next-gen chemistries (Na-ion, Li-S, Li-metal), AI/ML in predictive battery management, Failure modes and safety hazards: thermal runaway cascade, venting, fire, Regulatory standards: UN 38.3, IEC 62133, ISO 26262 (functional safety)
8 Hours

UNIT V
Advanced Battery Management Systems and Estimation Techniques: Battery Management System (BMS) Functions and Architecture, Battery State Variables and Their Importance, State of Charge (SOC) Estimation Methods: Coulomb Counting Method, Open Circuit Voltage (OCV) Method, Model-Based SOC Estimation Equivalent Circuit Models (ECM) for BMS: Rint Model, Thevenin Model Multi-RC Network Models. Kalman Filter Based Battery State Estimation: Linear Kalman Filter (KF) Extended Kalman Filter (EKF), Unscented Kalman Filter (UKF) – Overview State of Energy (SOE) Estimation: State of Power (SOP) Estimation, State of Health (SOH) Estimation Using Model-Based Approaches, Battery Fault Detection and Diagnostics: Sensor Faults, Cell Faults Internal Short Circuit Detection. Practical BMS Implementation Challenges:Sensor Accuracy, Computational Requirements, Real-Time Embedded Implementation Case Studies of EV Battery Management Systems
8 Hours

TEXT BOOK		
1	Gregory L. Plett (Artech House).	Battery Management Systems, Volume I & II

REFERENCE BOOKS		
1	Christopher D. Rahn and Chao-Yang Wang	Battery Systems Engineering, Wiley, 2013.
2	Davide Andrea	Battery Management Systems for Large Lithium Battery Packs, Artech House, 2010.

E-Resources	
1	https://mocha-java.uccs.edu/BMS1/?utm_source=chatgpt.com
2	https://www.mathworks.com/solutions/battery-management-system.html
3	https://www.mathworks.com/solutions/electrification.html
4	https://nptel.ac.in?utm_source
5	https://www.pybamm.org
6	https://batteryuniversity.com
7	https://www.batterydesign.net

Course Outcomes:	
Upon completion of this course the student will be able to:	
CO1	**Analyze** battery characteristics, testing methods, and equivalent circuit models for energy storage systems.
CO2	**Analyze** SOC and SOH estimation techniques for battery state monitoring and performance evaluation.
CO3	**Analyze** battery balancing methods, thermal management techniques, and BMS architectures for safe and reliable battery operation.
CO4	**Analyze** battery pack integration, communication protocols, safety standards, and emerging battery technologies.
CO5	**Design** advanced battery management solutions incorporating state estimation and fault diagnostic algorithms.

ROBOTICS AND AUTOMATION

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3
Total Lecture Hours:	42	CIE Marks:	50
Total Tutorial Hours:	00	SEE Marks:	50
Total Practical Hours:	00	Course Code:	S6EIPE28
Course Type:	PEC	Exam Hours:	3

Course objective:

This course will enable students to:

1.	Study the basic mechanics, movements, and control systems of industrial robots.
2.	Learn to design automated workcells using advanced AI and human-robot collaboration.

UNIT I

Introduction to Robotics: Definition and history of robotics, Classification and anatomy of robots, Robot configurations - Cartesian, cylindrical, spherical, SCARA and articulated, Specifications and work envelope.

Drive Systems and Feedback Devices: Hydraulic, pneumatic and electric drive systems - selection criteria, Position and velocity feedback devices: encoders, resolvers and tacho-generators.

Fundamentals of Automation: Types of automation - fixed, programmable and flexible, Elements of an automated system, Automation strategies and economic justification.

9 Hours

UNIT II

Forward Kinematics: Representation of position and orientation, Homogeneous transformation matrices, Denavit-Hartenberg (DH) convention and its application to serial manipulators.

Inverse Kinematics: Closed-form and geometric solutions for two and three link manipulators, Workspace analysis, Multiplicity of solutions and singular configurations.

Velocity Kinematics: The manipulator Jacobian, Differential motion and static force relationships, Kinematic singularities.

8 Hours

UNIT III

Robot Dynamics: Lagrange-Euler formulation of manipulator dynamics, Equations of motion for a two-link manipulator, Effect of gravity, inertia and Coriolis terms.

Robot Control: Joint space and Cartesian space trajectory planning, PID control of a robotic joint, Elements of control system architecture for manipulators.

Embedded Control and Sensor-Actuator Interfacing: Microcontroller/microprocessor architecture for robot control, Interfacing of encoders, limit switches and proximity sensors, Driver circuits for DC, stepper and servo motors.

8 Hours

UNIT IV

Robotic Automation: Concept and principles of robotic automation, Automated robotic workcells, Robot-based material handling, Robotic assembly systems, Automated inspection, Integration of robots with sensors and machines.

Flexible and Reconfigurable Automation: Flexible automation, Flexible Manufacturing Systems (FMS), Reconfigurable robotic systems, Robot cell layout and workflow, Robot–machine coordination, Production flexibility and scalability

Robot Integration and Safety: Robotic system integration, End-of-line automation, Tool and work-object calibration, Robot safety and risk assessment, Safety zones, interlocks and emergency stops, Human–robot collaborative workcells

9 Hours

UNIT V

Artificial Intelligence in Robotics: Introduction to AI-based robotics, Intelligent robot architecture, AI-based decision making, Applications of AI in robotics

Intelligent Human–Robot Interaction : Collaborative robots (Cobots), Human–robot collaboration, AI-enabled voice and gesture interaction

Emerging AI Technologies in Robotics: Reinforcement learning for robotics, Digital twins for robotics, Vision-Language-Action (VLA) models, Edge AI for robotics, Soft robotics.

9 Hours

TEXT BOOKS		
1	Saeed B. Niku	Introduction to Robotics: Analysis, Control, Applications, 3rd Edition, Wiley, 2020.
2	Francis X. Govers	Artificial Intelligence for Robotics, 2nd Edition, Packt Publishing, 2024.

REFERENCE BOOKS		
1	John J. Craig	Introduction to Robotics: Mechanics and Control, 4th Edition, Pearson, 2018.
2	Mark W. Spong, Seth Hutchinson and M. Vidyasagar	Robot Modeling and Control, 1st Edition, Wiley, 2005.
3	Peter Corke, Witold Jachimczyk and Remo Pillat	*Robotics, Vision and Control: Fundamental Algorithms in Python, 3rd Edition, Springer, 2023.*
4	Bruno Siciliano and Oussama Khatib (Eds.),	*Springer Handbook of Robotics*, 2nd Edition, Springer.

Course Outcomes:	
Upon completion of the course the student will be able to:	
CO1	**Identify** the fundamental concepts, configurations, drive systems, feedback devices and automation principles of robotic systems.
CO2	Analyze the forward and inverse kinematics of robotic manipulators using the DH convention.
CO3	**Analyze** robot dynamics, control architectures and sensor–actuator interfacing techniques for robotic systems.
CO4	Analyze robotic automation concepts involving robotic workcells, flexible and reconfigurable automation, robot–machine coordination, and safety considerations.
CO5	**Apply** artificial intelligence techniques and emerging technologies for intelligent, collaborative and autonomous robotic systems.

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:	PCCL	Exam Hours:	3

Course objective:

This course will enable students to:

1	Study tuning method using Ziegler nichols technique to achieve optimum response of different controllers.
2	Study the control valve characteristics

List of Experiments:

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

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.	PLC based Bottle Filling System
9	PLC based Car Parking System
10	PLC based Elevator System
Open Ended Experiments	
1.	PLC based Drilling system
2.	Heat Exchanger temperature control using PID

Course Outcomes:

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

CO1	**Apply** ziegler nichols method and 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

Indian Knowledge System in Instrumentation Engineering

Contact Hours/ Week:	1+0+0 (L+T+P)	Credits:	0
Total Lecture Hours:	14	CIE Marks:	100
Total Tutorial Hours:	0	SEE Marks:	0
Total Practical Hours:	0	Course Code:	SHSEI08
Course Type:	NCMC	Exam Hours:	0

Course objectives:
This course will enable students to:

1. Understand the fundamentals of the Indian Knowledge System (IKS) and its contributions to science, technology, and instrumentation.

UNIT I

Introduction to Indian Knowledge System and Engineering Heritage: Overview of the Indian Knowledge System (IKS), Evolution of science and technology in ancient India, Contributions of Vedas, Upanishads, and scientific literature, Contributions of Indian scholars to mathematics, astronomy, metallurgy, medicine, and engineering, Ancient educational systems and knowledge dissemination, Relevance of IKS in modern engineering education.

Traditional Measurement Systems and Instrumentation: Ancient Indian units of measurement (length, mass, time, volume), Measurement techniques in Vedic and medieval India, Time measurement using sundials and water clocks, Astronomical instruments and observatories (Jantar Mantar).

5 Hours

UNIT II

Instrumentation in Healthcare: Insights for Biomedical Engineering: Principles of diagnosis in Ayurveda, Pulse diagnosis (Nadi Pariksha), Traditional physiological measurements, Modern biomedical sensors inspired by traditional diagnostics, Cognitive Science: Applications in cognitive science, neuroscience, and human-machine interaction, Enhancing creativity, critical thinking, and mindfulness in engineering education.

Indian Astronomy and Its Engineering Applications: Use of ancient astronomical methods in modern space science, satellite engineering and navigation systems.

5 Hours

UNIT III
Instrumentation in Agriculture: Precision agriculture based on indigenous farming practices, Environmental monitoring using IoT and sensor technology, **Indigenous Technologies and Smart Instrumentation:** Traditional water management systems, Instrumentation for irrigation and water conservation, Indigenous metallurgy and materials for sensor applications, Smart sensing using IoT, Sustainable instrumentation systems, Digital Twin concepts for heritage conservation.
5 Hours

TEXT BOOKS		
1	B. Mahadevan, Vinayak Rajat Bhat, and Nagendra Pavana R. N.,	Introduction to Indian Knowledge System: Concepts and Applications, PHI Learning, 2022.
2	Bansal G	Indian knowledge system: Integrating heritage with engineering. Deep Science Publishing, 2025.
3	Kapil Kapoor and Michel Danino (Eds.)	Indian Knowledge Systems, Indian Institute of Advanced Study, 2005

REFERENCE BOOK		
1	AICTE	Indian Knowledge System (IKS) Course Material, AICTE, New Delhi, 2021.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Explain the fundamental concepts of the Indian Knowledge System (IKS) and its contributions to science and instrumentation.
CO2	Explain the role of traditional Indian knowledge in healthcare, astronomy, and environmental monitoring with reference to modern engineering practices.
CO3	Apply the principles of the Indian Knowledge System to identify sustainable and technology-driven solutions using smart instrumentation, IoT, and digital technologies.