SYLLABUS

FOR

VII and VIII 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, team work and leadership qualities imbibing ethical values in their profession for the benefit of society.

Programme Outcomes (PO):

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

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

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

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

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

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

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

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

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

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

Programme specific Outcomes (PSO):

Student will be able to

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

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

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B.E. in Electronics & Instrumentation Engineering

SCHEME OF TEACHING AND EXAMINATION FOR THE AY 2026-27

VII and VIII Semester (Swappable VII and VIII Semester)

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching hrs./week				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Self-Study Component	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	IPCC	S7EII01	Real Time Operating Systems	EIE	42	0	28	50	3	50	50	100	4
2.	IPCC	S7EII02	Industrial Control and Automation	EIE	42	0	28	50	3	50	50	100	4
3.	PCC	S7EI01	Power Electronics	EIE	42	0	28	50	3	50	50	100	4
4.	PEC	S7EIPE3x	Professional Elective Course-III	EIE	42	0	0	48	3	50	50	100	3
5.	OEC	OExx	Open Elective Course-II	Any Dept.	42	0	0	48	3	50	50	100	3
6.	PROJ	S7EIP-II	Major Project Phase II	EIE	0	0	168	12	3	100	100	200	6
			Total		210	0	224	162	18	350	350	**700**	**24**
		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: **IPCC**: Integrated Professional Core Course, **PCC**: Professional Core Course; **PEC**: Professional Elective Course**; OEC:** Open Elective Course; **PROJ:** Project Phase –II;
L: Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation.

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

S7EIPE31	Instrumentation for Agriculture and Food processing industries	S7EIPE32	ASIC design
S7EIPE33	Aircraft Instrumentation	S7EIPE34	Artificial Neural Networks and Fuzzy logic
S7EIPE35	Digital Twin Technology	S7EIPE36	Security in IoT and Automation

Open Elective Course (OEC)

OE74	Industrial Control & Automation (Except EIE)		

Note: VII and VIII semesters of IV years of the program

1) Institutions can swap the VII and VIII Semester Schemes of Teaching and Examinations to accommodate research internships/ industry internships after the VI semester.
2) Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether the VII or VIII semesters is completed during the beginning of the IV year or the later part of IV years of the program.

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.

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 numbers of students' strength for offering 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 Work: The objective of the Project work is

i) To encourage independent learning and the innovative attitude of the students.

ii) To develop interactive attitude, communication skills, organization, time management, and presentation skills.

iii) To impart flexibility and adaptability.

iv) To inspire team working.

v) To expand intellectual capacity, credibility, judgment and intuition.

vi) To adhere to punctuality, setting and meeting deadlines.

vii) To install responsibilities to oneself and others.

viii) To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve in group discussion to present and exchange ideas.

CIE procedure for Project Work:

1) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

   The CIE marks awarded for the project work, shall be based on the evaluation of the project work 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.

2) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work 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.

SEE procedure for Project Work: SEE for project work will be conducted by the two examiners appointed by the University. The SEE marks awarded for the project work shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25.

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B.E. in Electronics & Instrumentation Engineering

SCHEME OF TEACHING AND EXAMINATION FOR THE AY 2026-27

VIII Semester (Swappable VII and VIII Semester)

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching hrs./week				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Self-Study Component	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	PEC	S8EIPE0x	Professional Elective (Online Courses)		42	0	0	48	3	50	50	100	3
2.	OEC	S8EIOE0x	Open Elective (Online Courses)		42	0	0	48	3	50	50	100	3
3.	INT	S8EIII	Internship (Industry/Research) (14-20 weeks)	EIE	0	0	280	20	3	100	100	200	10
			Total		**84**	**0**	**280**	**66**	**09**	**200**	**200**	**400**	**16**
		S8EIAAP	AICTE Activity Points (Applicable for both Regular and Lateral Entry students)	40 hours community service to be documented and produced for the examination									

Note: **PEC**: Professional Elective Course**; OEC:** Open Elective Course (Online); **INT:** Industry Internship / Research Internship / Rural Internship
L: Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation.

Professional Elective (Online Courses)			
MOOC8PE	Biomedical Instrumentation	MOOC8PE	Introduction To Industry 4.0 And Industrial Internet Of Things
MOOC8PE	Digital Image Processing.	MOOC8PE	Sensors and Actuators
MOOC8PE	Control Engineering for Robotics	MOOC8PE	The MOS Transistor Modeling
MOOC8PE	Electrical Measurement and Electronic Instruments	MOOC8PE	Microsensors and Nanosensors
Open Elective (Online Courses)			
MOOC8OE	Web-designing and multimedia Technology	MOOC8OE	Deep Learning
MOOC8OE	Introduction to Cyber Security	MOOC8OE	Cryptography and Network Security
MOOC8OE	Optical Fiber Sensors	MOOC8OE	Memory Device Technology for AI/ML Computing
MOOC8OE	Semiconductor device modeling and Simulation	MOOC8OE	Electronic Systems for Cancer Diagnosis
MOOC8OE	Low Voltage CMOS Circuit Operation	MOOC8OE	Computer Vision

Note: VII and VIII semesters of IV years of the program

1) Institutions can swap the VII and VIII Semester Schemes of Teaching and Examinations to accommodate research internships/ industry internships after the VI semester.
2) Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether the VII or VIII semesters is completed during the beginning of the IV year or the later part of IV years of the program.

Elucidation:
At the beginning of IV years of the program i.e., after VI semester, VII semester classwork and VIII semester Research Internship /Industrial Internship / Rural Internship shall be permitted to be operated simultaneously by the University so that students have ample opportunity for an internship. In other words, a good percentage of the class shall attend VII semester classwork and a similar percentage of others shall attend to Research Internship or Industrial Internship or Rural Internship.
Research/Industrial /Rural Internship shall be carried out at an Industry, NGO, MSME, Innovation center, Incubation center, Start-up, center of Excellence (CoE), Study Centre established in the parent institute and /or at reputed research organizations/institutes.

The mandatory Research internship /Industry internship / Rural Internship is for 14 to 20 Weeks. The internship shall be considered as a head of passing and shall be considered for the award of a Degree. Those, who do not take up/complete the internship shall be declared to fail and shall have to complete it during the subsequent University examination after satisfying the internship requirements.

Research internship: A research internship is intended to offer the flavor of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research.

Industry internship: Is an extended period of work experience undertaken by students to supplement their Degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints.

Rural Internship: Rural development internship is an initiative of Unnat Bharat Abhiyan Cell, RGIT in association with AICTE to involve students of all departments studying in different academic years for exploring various opportunities in techno-social fields, to connect and work with Rural India for their upliftment.

The faculty coordinator or mentor has to monitor the student's internship progress and interact with them to guide for the successful completion of the internship.

The students are permitted to carry out the internship anywhere in India or abroad. University shall not bear any expenses incurred in respect of the internship.

With the consent of the internal guide and Principal of the Institution, students shall be allowed to carry out the internship at their hometown (within or outside the state or abroad), provided favorable facilities are available for the internship and the student remains regularly in contact with the internal guide. University shall not bear any cost involved in carrying out the internship by students. However, students can receive any financial assistance extended by the organization.

Professional Elective /Open Elective Course: These are ONLINE courses suggested by the respective Board of Studies. Details of these courses shall be made available for students on the VTU web portal.

7th Semester

REAL TIME OPERATING SYSTEMS

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:	S7EII01
Course Type:	IPCC	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Study the real-time operating systems concepts in embedded applications.
2	Study resources required to design real time systems.
3	Learn various real time embedded system components and debugging methods.

UNIT I

Introduction to operating systems: Operating systems structure: simple structure, layered approach, Micro kernels, modules
Introduction to Real Time Systems, Embedded Systems.
Real Time System Resources: Resource Analysis, Real-Time Service Utility, Real-Time OS, Thread Safe Reentrant Functions.
Process: Necessary and Sufficient feasibility condition, Preemptive Fixed-Priority Policy
Scheduling algorithms: FCFS, Priority and Round Robin scheduling

9 Hours

UNIT II

Process: Rate Monotonic, Deadline Monotonic scheduling, Dynamic priority policies.
I/O Resources: Worst-case Execution time, Intermediate I/O, Execution efficiency, I/O Architecture.
Memory: Physical hierarchy, Capacity and allocation, Shared Memory, ECC Memory, Flash file systems.

8 Hours

UNIT III
Multi-resource Services: Blocking, Deadlock and livestock, Critical sections to protect shared resources, priority inversion. **Soft Real-Time Services:** Missed Deadlines, QOS, Alternatives to rate monotonic policy, mixed hard and soft real-time services. **Embedded System Components:** Embedded system components of Real time stereo vision system monitoring.
8 Hours

UNIT IV
Firmware Components: The three firmware components, RTOS system software mechanisms, Software application components. **Debugging Components:** Exceptions, assert, Checking return codes. Single-step debugging, kernel scheduler traces, Test access ports, Trace ports, Power-On self-test and diagnostics, External test equipment, Application-level debugging. **Performance Tuning:** Basic concepts of drill-down tuning, hardware – supported profiling and tracing, Building performance monitoring into software, Path length, Efficiency Call frequency, Fundamental optimizations.
8 Hours

UNIT V
High availability and Reliability Design: Reliability and Availability, Similarities and differences, Reliability, Reliable software, Available software, Design tradeoffs, Hierarchical applications for Fail-safe design. **Process and Threads:** Process and thread creations, Programs related to semaphores, message queue, shared buffer applications involving inter task/thread communication.
9 Hours

TEXT BOOKS		
1	Sam Siewert	"Real-Time Embedded Systems and Components" Cengage Learning India Edition, 2016.
2	Myke Predko	"Programming and Customizing the PIC microcontroller" 3rd Ed, TMH, 2008.

REFERENCE BOOKS		
1	Jhon Wiley	"Programming for Embedded Systems" Dreamtech Software Team, Jhon Wiley, India Pvt. Ltd, 2008.
2	Abraham S ilberschatz, Peter Baer Galvin, Greg Gagne	Operating system concepts, Wiley India, 9th Edition, 2013.
3	Pof Prof. Rajib Mall	NPTEL course Real Time Systems, IIT Kharagpur,

List of experiments: (Only for CIE) (2 Hours per week per batch) 13 Lab sessions + 1 Lab assessment	
1	Creation of Process
2	Creation of Threads
3	Priority Assignment
4	Rate Monotonic scheduling
5	Deadline monotonic scheduling.
6	Deadlock prevention.
7	Missed deadline in soft real time services.
8	Semaphore implementation.
9	Message Queue.
10	Priority Inversion
Open Ended Experiments	
1	Simulation of Temperature control system using freeRTOS.
2	Simulation of priority assignment using freeRTOS.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	**Describe** the fundamental concepts of real-time operating systems.
CO2	**Apply** scheduling algorithms and analyze the system resources required to build RTOS.
CO3	**Analyze** the Multi-service resources required for RTOS and deadlock prevention methods.
CO4	**Analyze** various performance tuning techniques
CO5	**Develop** C programs for multithreaded applications using suitable techniques.

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:	S7EII02
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.

9+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.

9+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.

POWER ELECTRONICS

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:	S7EI01
Course Type:	PCC	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Study the construction and operation of various power devices.
2.	Study the design of various converter for industrial applications

UNIT I

THYRISTORS: Introduction to thyristor family, structure of SCR and modes of operation, SCR turn-on and turn-off characteristics, snubber circuits and Problems, Triggering circuits (R and RC) and Problems, Commutation circuits for SCR (natural and complimentary commutation) and Problems, thyristor types (construction and operation of TRIAC and DIAC only).

9 Hours

UNIT II

SINGLE PHASE AC-DC CONVERTER: Introduction, principle of phase controlled converter operation, single phase half wave, semi converter and fully controlled converters with R-L loads and freewheeling diodes, problems.

9 Hours

UNIT III

DC TO DC CONVERTER: Step-down and step-up chopper, chopper classifications, analysis of Buck, Boost regulator and impulse commutated chopper, problems.

8Hours

UNIT IV

INVERTERS: Introduction, principle of operation, single phase bridge inverters, voltage control of single phase inverters: Sinusoidal PWM modified sinusoidal PWM, current source inverter, Problems. Multilevel Inverters –Diode clamped inverters.

8 Hours

UNIT V
AC TO AC CONVERTERS: Introduction, principle of On-off control, principle of phase control, Single phase AC voltage controllers with resistive load, problems, introduction to single phase cycloconverters, problems, Modes of operation, Circulating current mode and Non-Circulating mode.
8 Hours

TEXT BOOK		
1	M. H. Rashid	Power Electronics, 3rd edition, PHI / Pearson publisher, 2017, 4th Edition.

REFERENCE BOOKS		
1	P.C. Sen	Modern Power Electronics, S.Chand, 2000, 2nd Edition.
2	NedMohan, T.M Undeland & W.P Robbin,	Power Electronics: Converters, Application and Design, 2006, John Wiley and sons, Wiley India edition

List of experiments: (Only for CIE) (2 Hours per week per batch) 13 Lab sessions + 1 Lab assessment	
1	Single phase half wave controlled rectifier with R and RL load
2	Single phase Full wave controlled rectifier with R and RL load
3	Single phase Full wave semi converter with RL load and free wheeling diode
4	DC to DC buck converter with R load
5	Single phase half bridge inverter with R and RL load
6	Single phase full bridge inverter with R and RL load
7	Single phase half wave AC voltage controller with R and RL load
8	Single phase full wave AC voltage controller with R and RL load
9	Three phase inverter -180° with RL load
10	Buck –Boost converter with R Load.
Open Ended Experiments	
1	Single-Phase Cycloconverter with R load
2	Three phase Full wave controlled rectifier with R load

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	**Describe** the characteristics of power semiconductor devices, design and compare different triggering methods.
CO2	**Design** controlled rectifier for industrial applications.
CO3	**Design** DC to DC converter for control applications.
CO4	**Design** inverter for industrial applications.
CO5	**Design** AC-AC converters for industrial applications.

Professional Elective Course - III

INSTRUMENTATION FOR AGRICULTURE AND FOOD PROCESSING INDUSTRIES

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:	S7EIPE31
Course Type:	PEC	Exam Hours:	3

Course objectives: This course will enable students to:	
1.	Study various sensors required for soil testing
2.	Learn instrumentation for green house monitoring
3.	Learn Instrumentation techniques for Food processing and quality analysis

UNIT I

Introduction: Necessity of instrumentation and control for food processing and agriculture sensor requirement, remote sensing, biosensors in Agriculture, standards for food quality.
Soil science and sensors: pH, conductivity, resistivity, temperature, soil moisture and salinity, ion concentration, measurements, methods of soil analysis. Instrumentation for environmental conditioning of seed germination and growth.

9 Hours

UNIT II

Green houses and Instrumentation: Ventilation, cooling and heating wind speed, temperature and humidity, rain gauge, carbon dioxide enrichment measurement and control. Leaf area, length, evapo-transpiration, temperature, wetness and respiration measurement and data logging. Electromagnetic, radiation, photosynthesis, infrared and CV, bio sensor methods in agriculture. Agro meteorological instrumentation weather stations.

9 Hours

UNIT III
Food Processing: Flow diagram of sugar plant, sensors and instrumentation set-up, Flow diagram of fermenter and control (Batch process), Oil extraction plant and instrumentation set-up, Pesticides manufacturing process and control, Flow diagram of Diary and confectionary industry and instrumentation set-up and Juice extraction control set-up.
8 Hours

UNIT IV
Instrumentation for food quality assurance: Instrumental measurements and sensory parameters. Inline measurement for the control of food processing operations: color measurements of food, food composition analysis using infrared, microwave measurements of product variables, pressure and temperature measurement in food process control, level and flow measurement in food process control, ultrasonic instrumentation in the food industry. Instrumental techniques in the quality control, Food Safety and Standard Authority of India (FSSAI) specifications.
8 Hours

UNIT V
Food Industry instrumentation: Instrumentation in Brewing, Level control, Temperature and pressure monitoring in Canning industry, principle of roasting, roasting equipment. Pasteurization: purpose, microorganisms and their reaction to temperature and other influences. Methods of heating, design and mode of operation of heating equipment, plate heat exchanger in Baking industry. Application of SCADA and PLC in the packaging industry.
8 Hours

TEXT BOOKS		
1	Erika Kress-Rogers, Christopher J.B. Brimelow	Instrumentation and Sensors for the Food Industry, Woodhead Publishing, 2001
2	Manabendra Bhuyan	Measurement and control in food processing, CRC/Taylor & Francis Publications, 2007
3	Singh and Sahay	Agricultural Process Engineering, Vikas Publishing House, New Delhi.2014.

REFERENCE BOOKS		
1	Desrosier N.W	Technology of food preservation, CBS Publisher and Distributor, New Delhi, 4th Edition, 2016.
2	P.J. Fellows	Food Processing Technology, Principles and Practice, Woodhead Publishing, 3rd Edition, 2009.
3	Semioh Otles	Methods of analysis of food components and additives, CRC Press, Taylor and Francis group, 2nd Edition, 2012.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	**Describe** the importance of instrumentation in agriculture and food processing and identify a suitable sensor to measure soil parameters.
CO2	**Analyze** various parameters to be controlled in Green house monitoring.
CO3	**Develop** flow diagrams for food processing techniques.
CO4	**Describe** the quality standards and instrumentation for food processing.
CO5	**Describe** instrumentation and control techniques for food processing applications.

ASIC DESIGN

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:	S7EIPE32
Course Type:	PEC	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Learn the design of various ASIC configurations,
2.	Learn the operation of Programmable ASIC memories and I/O Cells.
3.	Study Physical design flow for Digital IC Design

UNIT I

Introduction: Types of ASIC Design, ASIC Design Flow, FPGA design Flow, Programmable logic device, ASIC cell libraries.

9 Hours

UNIT II

Data Logic Cells: Data Path Elements, Adders, Multiplier, Arithmetic Operator, I/O cell. **ASIC Library Design**: Logical effort: practicing delay, logical area and logical efficiency logical paths, multi stage cells, optimum delay, optimum no. of stages, library cell design.

9 Hours

UNIT III

Low-Level Design Entry: Schematic Entry, **Programmable ASIC**: Anti-fuse, Static RAM, EPROM and EEPROM Technology, FPGA, Programmable ASIC logic cells, ASIC I/O cells, Programmable ASIC Interconnects.

8 Hours

UNIT IV
A Brief Introduction to Low Level Design Language: introduction to EDIF, PLA Tools and CFI designs representation. Half gate ASIC. Introduction to Synthesis and Simulation. **ASIC Construction:** Physical Design, CAD Tools, System Partitioning, Estimate ASIC size, FPGA Partitioning and its Methods.
8 Hours

UNIT V
Floor Planning and Placement and Routing: Physical Design, System Partitioning, Estimating ASIC size, partitioning methods. Floor planning tools, I/O and power planning, clock planning, placement algorithms. Global Routing, Local Routing, Detail Routing, Special Routing, Circuit Extraction and DRC.
8 Hours

TEXT BOOKS		
1	M.J.S .Smith	"Application - Specific Integrated Circuits" – Pearson Education, 2003.
2	Jose E.France, YannisTsividis	"Design of Analog-Digital VLSI Circuits for Telecommunication and signal processing", 2nd Edition, Prentice Hall, 1993.

REFERENCE BOOKS		
1	MalcolmR.Haskard; Lan. C. May	"Analog VLSI Design – NMOS and CMOS", Prentice Hall, 1998.
2	Mohammed Ismail and Terri Fiez	"Analog VLSI Signal and Information Processing", McGraw Hill, 1994.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	**Apply** appropriate ASIC configuration for particular application.
CO2	**Apply** appropriate techniques to optimize data path and arithmetic components.
CO3	**select** Programmable ASIC memories as per design requirements
CO4	**Describe** the synthesis process of ASICs.
CO5	**Describe** physical design process flow.

AIRCRAFT 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:	S7EIPE33
Course Type:	PEC	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Learn various measuring and display instruments used in Aircraft.
2.	Study working principles of gyroscopes and fuel quantity indicating system.
3.	Study Engine power and control instruments of an Aircraft.

UNIT I

Aircraft instruments: Introduction, instrument grouping, instrument display, quantitative and qualitative displays, director displays, cockpit layout, standard atmosphere, basic air data system, pitot static probe, heating circuit arrangements.

9 Hours

UNIT II

Air data instruments: Air speed indicator, square law characteristics, match/air speed indicator, altimeters, effects of atmospheric temperatures, vertical air speed indicators, air temperature indicator, air data alternating system, match warning system, altitude alert system.

9 Hours

UNIT III
Gyroscopic flight instruments: Gyroscope and its properties, determining direction of precession, limitations of gyroscopes, operating gyroscopic instruments, gyro horizons, erection systems for gyro horizons, errors due to acceleration and turning, direction indicator, turn and bank indicator.
8 Hours

UNIT IV
Fuel quantity indicating systems: Capacitance type system, indicating system, effects of fuel temperature changes, measurement of fuel quantity by weight, construction of probes, and location of probes.
8 Hours

UNIT V
Engine power and control instruments: RPM measurement, generator and indicating system, tacho probe and indicator system, torque monitoring, exhaust gas temperature, engine pressure ratio measurement, fuel flow measurement, integrated flow meter system.
8 Hours

TEXT BOOK		
1	EHJ Pallet Longman.	Aircraft Instruments, Pearson, 2nd Edition, 2009.

REFERENCE BOOKS		
1	S Nagabhushan	Aircraft Instrumentation and System, IK International, 2013
2	C A Williams.	Aircraft Instruments, Golgotia Publications, New Delhi. 2007

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	**Explain** the parameters to be analyzed in Aircraft.
CO2	**Describe** the principle and operation of indicators used in Aircraft.
CO3	**Describe** the principle and operation of gyroscope used in Aircraft
CO4	**Analyze** the technique of measuring fuel quantity and its Indication
CO5	**Describe** the working of engine power and control instruments.

ARTIFICIAL NEURAL NETWORKS AND FUZZY LOGIC

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:	S7EIPE34
Course Type:	PEC	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Study the mathematical foundations of artificial neural networks and fuzzy logic systems.
2.	Learn different artificial neural network architectures and fuzzy logic.

UNIT I

Introduction: Introduction to Artificial Intelligence and Machine Learning. **Basics of Artificial Neural Networks**: Trends in computing, Pattern and Data, Pattern recognition tasks. Basic methods of pattern recognition, Basics of Artificial Neural Networks, Biological Neural Network, Models of neuron: McCulloch-Pitts (MP) Model, Perceptron, Adaline, topology, supervised and unsupervised learning, Basic learning laws, Realization of logic functions using MP neuron.

9 Hours

UNIT II

Functional units of ANN & Single layer perceptron: Basic ANN Models (architectures) for Pattern recognition task**,** Pattern recognition tasks by feed-forward, feed-back and competitive learning Neural networks. Feed-forward neural network: Linear associative network, Analysis of pattern classification networks, Linear separability, Perceptron convergence theorem.

9 Hours

UNIT III
Multi-Layer perceptron: Linear Inseparability**:** Hard problems, Multilayer feed forward neural network (MLFFNN): Back propagation learning, Drawbacks of back propagation algorithm, Heuristics to improve the performance of Back propagation learning discussion on error back propagation, Convolution neural network (CNN).
8 Hours

UNIT IV
Introduction to Fuzzy Logic, Classical sets and Fuzzy sets. Introduction to Fuzzy Logic, Classical sets (crisp sets) - Operations on Classical sets, Properties of Classical sets, Function of Mapping of Classical sets. Fuzzy sets – Fuzzy set operations, Properties of fuzzy sets. Simple Problems **Classical Relations and Fuzzy Relations** – Introduction, Cartesian Product of Relation, Classical Relation, Fuzzy Relation, Tolerance and Equivalence Relations, Non-interactive Fuzzy sets, Simple Problems.
8 Hours

UNIT V
Membership Functions – Introduction, Features of the Membership functions, Fuzzification, Methods of Membership Value Assignments, Simple Problems **Defuzzification**- Introduction, Lamba-cuts for Fuzzy sets (Alpha-Cuts), Lamba-Cuts for Fuzzy Relation, Defuzzification Methods. **Fuzzy Logic Control (FLC) Systems** – Introduction, Control System Design, Architecture and Operation of FLC system, FLC system Models, Application of FLC systems.
8 Hours

TEXT BOOKS		
1	B.Yegnanarayana,	Artificial Neural Networks. Pill, New Delhi PHI Learning Pvt. Ltd., 2010.
2	Timothy J. Ross,	"Fuzzy logic with engineering applications", McGraw Hill International Edition, 2004

REFERENCE BOOKS		
1	J.M. Zurada,	Introduction to Artificial Neural Systems, Jaico Publications, 2007
2	Satish Kumar	Neural Networks A Classroom Approach -, McGraw Hill Education (India) Pvt. Ltd, 2nd Edition 2017.
3	Simon Haykin	Neural Networks for Pattern Recognition, Pearson Education Limited, 2008

Course Outcomes:	
Upon completion of this course the student will be able to:	
CO1	**Describe** machine intelligence and differentiate supervised and unsupervised machine learning
CO2	**Analyze** learning methods for neural networks.
CO3	**Develop** Neural network models.
CO4	**Describe** the fundamentals of fuzzy logic, Classical Relations and Fuzzy Relations.
CO5	**Develop** fuzzy logic concepts for building automated systems.

DIGITAL TWIN TECHNOLOGY

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:	S7EIPE35
Course Type:	PEC	Exam Hours:	3

Course objectives: This course will enable students to:	
1.	Learn the principles, data frame works and applications needed to design and implement Digital Twin system in process and healthcare industry.
2.	Study security performance and integration challenges in Digital Twin through threat modelling simulation and strategic design.

UNIT I

Fundamentals of Digital Twins: Introduction to Digital Twins: Overview of Digital Twins Historical context and evolution; Digital Twins maturity models; Significance in digital transformation and modern industries.

Digital Twin Frameworks: Introduction to different; Digital Twin frameworks; Industry-specific applications; Problem identification and digital transformation roadmap; Case studies

Types of digital twin-Based on Product and Process-Based on Functionality-Based on Maturity. Development considerations,

Physical based Approaches: Principles and applications; Examples and case studies.

8 Hours

UNIT II

Digital Twin data Types and threat modelling:

Digital Twin Data Types and Management Geometric, behavioural data; Historical, Synthetic and real-time data.

Data driven Methods: Data acquisition, preprocessing and analytics.

Data Analytics and Insights: Descriptive analysis; Diagnostic analysis; Predictive analysis; Prescriptive analysis; Data-driven decision-making, Case studies illustrating data-driven approaches.

Hybrid Approaches: Integrating physical and data-driven elements; Advantages and challenges

UNIT II
Concepts of Threat Modelling: Security challenges and risks associated with digital twins, Importance of security in digital twin implementations.
9 Hours

UNIT III
Threat Modelling methodologies: Common threat modelling methodologies (eg STRIDE), Steps involved in threat modelling: identifying assets, vulnerabilities, threats, and mitigations. Case study on basic threat modelling for simple digital twin components. Introduction to MITRE ATT&CK Framework: structure: tactics, techniques, and procedures (TTPs). Navigating the MITRE ATT&CK matrix. Mapping digital twin components to ATT&CK tactics and techniques. Identifying potential threats to digital twins using ATT&CK. Analyzing attack paths within a digital twin environment. Developing security recommendations and mitigations based on ATT&CK. Practical exercises: threat modelling specific digital twin scenarios using ATT&CK.
9 Hours

UNIT IV
Digital Twins in Process industry and Healthcare: Digital Twin in Process industry: Basics of Process Industry, Trends in the process industry, control system requirements in a process industry, Digital Twins of a plant, Digital Thread in Process Industry. Digital Twin in Healthcare: Introduction to healthcare and bioengineering applications of digital twins. The bioprocess and its potential, industrial-scale bioreactors and biomanufacturing, hospital administration in industry 4.0, epidermic control prediction, and cloud computing for radiotherapy systems are covered. Investigating digital twin applications in areas like patient monitoring, surgical planning, and drug development.
8 Hours

UNIT V
Critical Functional and Non-functional Components: Realtime Modelling and Simulation: Dynamic modelling; Simulation techniques; Feedback loops and control systems. Preparing for Challenges: Anticipating challenges in digital twin implementation; Scalability, and integration with legacy systems; Metrics and performance measurement in the success of Digital Twins; Ethical considerations; Strategies for overcoming challenges.
8 Hours

Text Books:		
1	Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang	"Digital Twin Driven Smart Manufacturing", Elsevier Science. United States, 2019.
2	Tony UcedaVelez & Marco M. Morana	Risk-Centric Threat Modeling: Process for Attack Simulation and Threat Analysis, John Wiley & Sons Inc, 2015.

REFERENCE BOOK		
1	Shyam Varan Nath, Pieter van Schalkwyk, Dan Isaacs	"Building Industrial Digital Twins Design, Develop, and Deploy Digital Twin Solutions for Real-world Industries Using Azure Digital Twins", Packt Publishing, 2021.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	**Describe** the concept, structure, and lifecycle of Digital Twin development and apply the frameworks to solve real world industry problems.
CO2	**Identify** the data types of Digital Twins based on application and complexity and assess security in Digital Twin.
CO3	**Identify** the threats and develop security mitigations for Digital Twin environments.
CO4	**Apply** Digital Twin concepts in process and health care industries to enhance operational efficiency.
CO5	**Apply** real-time modeling and simulation concepts and formulates strategies to overcome challenges in Digital Twin deployment.

SECURITY IN IOT AND AUTOMATION

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:	S7EIPE36
Course Type:	PEC	Exam Hours:	3

Course objectives:
This course will enable students to:

1.	Study the concept and Security and challenges in SCADA and IoT
2.	Understand the Security standards and Risk management in industrial automation.

UNIT I

Security Fundamentals: Confidentiality, Integrity, Availability (CIA Triad)**,** Threat modelling and risk assessment**,** Authentication, authorization, encryption**,** secure boot and firmware validation.

IoT Application Architecture: Security Concerns of IoT, Security Recommendations, *Solutions among Different Industries:* Healthcare, Manufacturing (Industry 4.0), Energy and Utilities. *IoT Application Architectures in Focus:* Cloud-centric architectures, Edge and fog computing architectures, Hybrid architectures.

8 Hours

UNIT II

Network Security in IoT: Secure network architecture design**,** Firewalls, IDS/IPS, and segmentation**,** VPNs and Zero Trust networks**,** Secure OTA (Over-the-Air) updates.

Hardware Security in IoT: Overview of Cyberattacks in IoT, Distributed Denial of Service, Hardware Security, Hardware Security v/s Hardware Trust, Embedded System Hardware, Data Layers.

9 Hours

UNIT III

Security in SCADA Systems: Cyber threats to SCADA and IoT Systems, Challenges to Secure SCADA systems in IoT-Cloud Environments, Protecting SCADA, IIoT and IoT Systems, Best practices for securing IoT-Cloud based SCADA systems, Unique challenges in ICS environments, Intrusion detection in control systems, Patch management and anomaly detection.

9 Hours

UNIT IV
IoT Security Standards and Risk management for industrial automation: IoT Security Standards Protocols, GSMA: Global System for Mobile Communications, One M2M & Io, GDPR, HIPAA, ISO 27001, ISA/IEC 62443, US NIST Cybersecurity Framework, Device certification and compliance. **Risk Management for Industrial Automation:** Risk management, ANSI/ISA-62443-2-1 (99.02.01)-2009 cyber security, Risk analysis, Addressing risk, NIST SP 800-39 Integrated enterprise risk management, Threats.
8 Hours

UNIT V
Cloud and Edge Security: Cloud platforms in IoT**,** Identity and Access Management (IAM)**,** Secure APIs and data storage**,** Edge computing risks and mitigations **Secure Development Practices:** Secure coding for embedded systems**,** Hardware security modules (HSMs)**,** Secure DevOps (DevSecOps) in IoT projects**,** Threat modeling for IoT applications. **Emerging Approaches to Industrial Automation Security:** Internet of Things, Open platform communications unified architecture, Security and privacy, Big data analytics and the industrial Internet of Things, Cybersecurity, Critical Infrastructure security, Software-defined elements.
8 Hours

Text Books:		
1	Brij B. Gupta	A Beginner's Guide to Internet of Things Security: Attacks, Applications, Authentication Fundamentals and Security
2	Swarup Bhunia & Mark Tehranipoor	Hardware Security: A Hands-On Learning Approach, 2019.
3	Tyson Macaulay & Bryan Singer	Cybersecurity for Industrial Control Systems: SCADA, DCS, PLC, HMI, and SIS

REFERENCE BOOKS		
1	Vipin Bahety	IoT Security Issues" (Springer)
2	Perry Lea (Packt)	IoT and Edge Computing for Architects

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	**Articulate** the importance of security in IoT applications, highlighting its significance in various industrial sectors.
CO2	**Analyse** Cyberattacks on IoT Hardware
CO3	**Analyze** and assess the security frameworks and vulnerabilities within SCADA
CO4	**Apply** industry-recognized security standards and frameworks to safeguard IoT systems in industrial automation environments.
CO5	**Analyze** security challenges in edge and cloud computing architectures, and develop strategies to mitigate risks.

Open Elective Courses (OEC)

INDUSTRIAL CONTROL AND AUTOMATION

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:	OE74
Course Type:	OEC	Exam Hours:	3

Course objectives:

This course will enable students to:

1	Study the basic components of PLC and learn to develop ladder logic for industrial applications.
2	Study the principle of SCADA, RTU and elements of 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 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: Counter instructions, PLC counter up and down instructions, cascading counters, combining counters and timers, developing ladder diagram for analytical problems.

9 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.
9 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 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 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.

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	**Identify** principles of SCADA, RTU and elements of DCS & interpret the functionality of various elements of DCS.

8th Semester

INTERNSHIP

Contact Hours/Week:	0+0+20 (L+T+P)	Credits:	10
Total Lecture Hours:	0	CIE Marks:	100
Total Tutorial Hours:	0	SEE Marks:	100
Total Practical Hours:	280	Course Code:	S8EIII
Course Type:	Internship	Exam Hours:	3

Course objectives: This course will enable students to:	
1	To expose technical students to the industrial environment thereby creating competent professionals.
2	To provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required.
3	To enable students to apply the technical knowledge learnt in the classroom in real industrial situations.
4	To empower them in writing technical reports.
5	To expose students to the engineer's responsibilities and ethics
6	To promote academic, professional and/or personal development.
7	To expose the students to future employers.
8	To make them understand the social, economic and administrative considerations that influences the working environment of industrial organizations.
9	To make them understand the psychology of the workers and their habits, attitudes and approach to problem solving.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Formulate the given engineering problem and review literature.
CO2	Design a methodology using engineering knowledge and analytical abilities.
CO3	Implement the methodology and propose a meaningful solution by using problem solving skills considering health, safety issues.
CO4	Gain practical/research knowledge to existing classroom knowledge, such as new tools or skills ort and oral presentation.
CO5	Effectively communicate the solution through report writing
CO6	Demonstrate time management, punctuality and life-long learning skills.
CO7	Expand the professional network and explore career options.
CO8	Demonstrate individual and team work, ethics required for success in a professional work environment