Government of Karnataka

DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Program	**Electrical & Electronics Engineering**	**Semester**	**5**
Course Code	**20EE51I**	**Type of Course L:T:P**	**104 : 52 : 312**
Course Name	**Industrial Automation**	**Credits**	**24**
CIE Marks	**240**	**SEE Marks**	**160**

Introduction:

Automation in the industrial workplace provides the advantages of improving productivity and quality while reducing errors and waste, increasing safety, and adding flexibility to the manufacturing process. In the end, industrial automation yields increased safety, reliability, and profitability. This specialisation course is taught in Boot camp mode. Boot camp are 12 weeks, intense learning sessions designed to prepare the students for the practical world – ready for either industry or becoming an entrepreneur. Student will be assisted through the course, with development-based assessments to enable progressive learning. Industrial automation course introduces Programmable Logic Controllers (PLC), Field level Instrumentation and SCADA/HMI Systems used for Industrial Automation. The students will get appropriate knowledge and exposure to configuration of Industrial Controllers and development of application programs. Also covers Interfacing with SCADA/HMI systems used for remote monitoring & control of industrial process units and machines.

Leading to the successful completion of this boot camp, students shall be equipped to either do an internship in an organisation working on Automation and Robotics or do a capstone project in the related field. After the completion of Diploma, student shall be ready to take up roles like a Programmer, Supervisor and can rise up to the level of Manager, also can become Entrepreneur in the related field and more.

Pre-requisite

Before the start of this specialisation course, student shall have prerequisite knowledge gained in the first two years on the following subjects:

1st year – Engineering Mathematics, computer Aided Engineering Graphics, Fundamentals of Electrical and Electronics Engineering and Basics of Electrical power system, Communication Skills, Statistics & Analysis, Basic IT Skills, Project Management skills and Residential wiring.

2nd year- Transformers and Alternators, Transmission and Distribution, Switchgear and Protection, Analog and Digital electronics, Electrical motors, Power electronics, Fundamentals of Automation Technology and Computer Aided Electrical Drawing.

In the third year of study, student shall be applying previous years learning along with specialised field of study into projects and real-world applications.

Course Cohort Owner

A Course Cohort Owner is a faculty from the core discipline, who is fully responsible for one specialised field of study and the cohort of students who have chosen to study that specialised field of study.

Guidelines for Cohort Owner

1. Each Specialized field of study is restricted to a Cohort of 20 students which could include students from other relevant programs.
2. One faculty from the Core Discipline shall be the Cohort Owner, who for teaching and learning in allied disciplines can work with faculty from other disciplines or industry experts.
3. The course shall be delivered in boot camp mode spanning over 12 weeks of study, weekly developmental assessments and culminating in a mini capstone.
4. The industry session shall be addressed by industry subject experts (in contact mode/online / recorded video mode) in the discipline only.
5. The cohort owner shall be responsible to identify experts from the relevant field and organize industry session as per schedule.
6. Cohort owner shall plan and accompany the cohort for any industrial visits.
7. Cohort owner shall maintain and document industrial assignments, weekly assessments, practices and mini project.
8. The cohort owner shall coordinate with faculties across programs needed for their course to ensure seamless delivery as per time table
9. The cohort owner along with classroom sessions can augment or use supplementary teaching and learning opportunities including good quality online courses available on platforms like Karnataka LMS, Infosys Springboard, NPTEL, Unacademy, SWAYAM, etc.

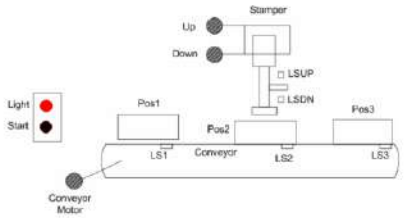
Course outcome:

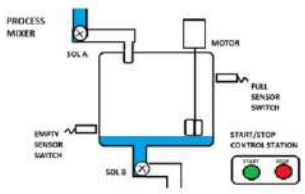
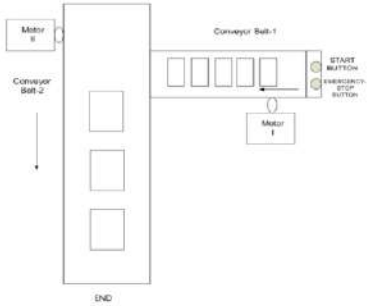
On successful completion of the course, the students will be able to:

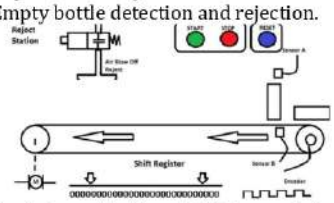
CO1	**Develop and test the PLC program for a given industrial application using simulation software.**
CO2	**Install, troubleshoot and maintain the PLC.**
CO3	**Interface VFD/servo motor with HMI and PLC to control various motor parameters.**
CO4	**Automate the given process and troubleshoot the system for its defects.**
CO5	**Interface SCADA /HMI with PLC and Control PLC from SCADA.**

Detailed Course Plan

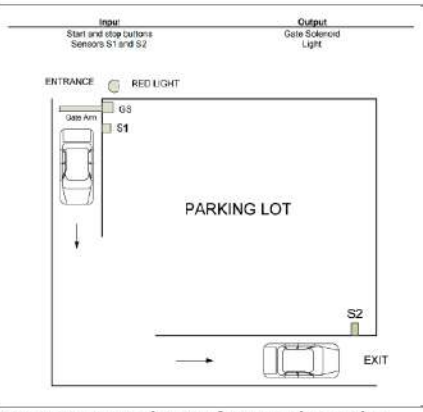
Week	CO	PO	Days	1st session (9 am to 1 pm)	L	T	P	2ND session (1.30 pm to4.30 pm)	L	T	P
1	1	3	1	**Introduction to industrial automation:** Video on automation • Why automation is required? • Examples to understand industrial automation • Motivation for Industrial Automation • Levels of Industrial Automation Process • Types of automation. • What can be automated and what cannot be automated?	3		1	• Introduction to process automation • Familiarizing with process control system Video demonstration: • Demonstrate the various automation processes.	1		2
	1	3	2	• Familiarizing and learning open loop and close loop systems with examples. • Demonstrate a closed-loop feedback system with a different applications • Demonstrate the different components used in process control. • Demonstrate how the process control system works.	2		2	Video Demonstration on • Automation of the beverage industry • Automation of motor stator production. • Automation of Transformer core • The Role of PLCs in manufacturing • PLC application stories			3
	1	2,3,4	3	**Advance PLC instructions** Bit Logic Instructions: Standard Contacts, Immediate Contacts, NOT Instruction, Positive and Negative Transition Instructions, Output, Output Immediate, Set and Reset, Set Immediate and Reset Immediate • Normally Open	2		2	**Develop a LAD (Ladder diagram) to control the stamp system.** **Identify and select sensors ,switches and actuators required to implement the sytem.** An automatic stamp system shown in Figure 2 works as follows: When start switch is turned on, system gets ready to run. When the operator puts a box at the beginning of the conveyor (on LS1) the motor runs and conveyor moves. Upon			3

				• Normally Close • NOT logic • Coil • Set Coil • Reset Coil • Negative Edge • Positive Edge Demonstration of instructions Explain the five steps to PLC Program development • Define the task. • Define the inputs and outputs. • Develop a logical sequence of operation. • Develop the PLC program. • Test the program.				reaching the midpoint of the conveyor (on LS2) the conveyor motor stops. Then the stamp comes down and puts the stamp on the box. When this process is finished, the stamp goes up and conveyor moves again to the other end of the conveyor. After box reaches to end of the conveyor (on LS3), the motor stops. The system waits for the box to get and the box to be placed at the beginning of the conveyor. If start switch is turned off, the system cannot run even if there is a box on conveyor. The light on the start box indicates that the system is active whereas UP and Down lights indicate that the stamp is UP and DOWN position respectively.  			
	1	2,3,4	4	• To study the operation of different types of timers. • Timer Instructions: On-Delay Timer, Retentive On-Delay Timer, Off-Delay Timer • Counters: Count Up Counter, Count Down Counter, Count Up/Down Counter **Develop and Test a LAD (Ladder diagram)/ Functional Block Diagram(FBD) using simulation software, for the process mixer.**	2		2	**Develop and Test a LAD (Ladder diagram)/ Functional Block Diagram (FBD) for the given system using simulation software.** **Identify and select sensors ,switches and actuators required to implement the sytem.** The system to be controlled by PLC consists of two belts. If the Start button is pressed, Conveyor Belt-1 will begin to run. After 5 seconds Conveyor Belt-2 will be active. After the whole system runs			3

				Identify and select sensors, switches and actuators required to implement the sytem. A normally open start and normally closed stop pushbuttons are used to start and stop the process. When the start button is pressed, solenoid A energizes to start filling the tank. As the tank fills, the empty level sensor switch closes. When the tank is full, the full-level sensor switch closes. Solenoid A is de-energized. The mixer motor starts and runs for 3 minutes to mix the liquid. When the agitate motor stops, solenoid B is energized to empty the tank. When the tank is completely empty, the empty sensor switch opens to de-energize solenoid B. The start button is pressed to repeat the sequence. 				For 15 seconds, Conveyor Belt-1 will stop. Then Conveyor Belt-2 continues to move for 5 seconds And then it will stop, too. Also the system can be reset by the emergency-stop button at any time. 			
			5	**Developmental Assessment**	-	-	-	**Assessment Review and corrective action**			3
			6	**Industry Class+ Assignment** **PLC programming**	**2**		**3**				
2	1	2,3,4	1	**Peer discussion on Industrial assignment**		4		Shift register Instructions Practice of Instructions	1		2

			2	Develop and Test a **LAD/FBD** for the given system using simulation software. Identify and select sensors, switches and actuators required to implement the sytem. Empty bottle detection and rejection.  A start pushbutton (NO) is used to start the conveyor and a stop pushbutton (NC) is used to stop. Sensor B detects a product on the conveyor belt and sensor A will detect if it is too large and needs to be rejected. The product is tracked along the conveyor belt and when under the reject station the Reject Blow Off will expel the bad product. The product is randomly placed on the conveyor belt, so an incremental encoder is used to track the conveyor movement. The reset pushbutton (NO) will signal that all of the product on the conveyor has been removed between the sensors and reject blow-off.	1		3	Develop and test a **LAD /FBD** using simulation software to sort three different types of jobs. **identify sensors, switches and actuators required to implement the sytem.** 			3
	1	2,3	3	**Program Control Instructions:** Jump Instructions, Subroutine Instructions, Calling a Subroutine With Parameters. **Comparison Instructions in PLC Programming.** Equal (EQU) Instruction	2		2	**Automatic Bottle Filling System using PLC.** Develop and Test a LAD for this system using simulation software. Identify and select sensors ,switches and actuators required to implement the sytem.			3

				Not Equal (NEQ) Instruction Less than (LES) Instruction Less Than or Equal (LEQ) Instruction. Greater Than (GRT) Instruction. Greater than or Equal (GEQ) Instruction. Limit Test (LIM) Instruction.							
	1	2,3,4	4	**Math Instructions:** Multiply Integer to Double Integer and Divide Integer with Remainder, Multiply Integer to Double Integer and Divide Integer with Remainder, Increment and Decrement Instructions. MOV and Masked MOVE instructions Practice of Instructions	2		2	**Develop LAD/ Functional Block Diagram (FBD) for the parking lot controller by using math instructions. Do not use counter instructions?** **Identify and select sensors ,switches and actuators required to implement the sytem.** The parking lot which has a capacity of 100 cars is to be controlled by a PLC system. The sensor S1 and S2 are used to count the car at the entrance and exit. If the number of the cars reaches to 100, red light is lit and the gate arm is closed. The arm stays closed until one or more parking space is available in the lot. The gate arm is controlled by activating/deactivating the gate solenoid (GS).			3

											
			5	**Developmental Assessment**	-	-		**Assessment Review and corrective action**			
			6	**Industry Class + Assignment (PLC programming)**	**2**		**3**				
3	2	4	1	**Peer discussion on Industrial assignment.**		4		**Making and wiring of PLC based control panel** The Evolution of PLCs in Industrial Automation. • Identify different types of PLCs • Identify different brands of PLCs • Comparison of different brands of PLCs • Selection of PLC for given industrial application	1		2

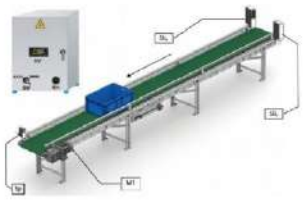
	2	4	2	**Elements of logic panel:** DIN rail for equipment, mounting, Cable channel. Terminal for wire connection, VFD, PLC, Power supply, SMPS. Relay, Contactor, Fan, Connectors, Input outputs module, Power sockets, Transformer, HMI, Selector switch, Push button, Indicating lamp, etc.	**1**		3	• Safety measures for PLC installations in control panels. • Demonstrate all tools that are required for making the PLC control panel.			3
	2	4	3	To cut DIN rail as per our requirements and fixed in the control panel	1		**3**	To Mount different devices on DIN rail			3
	2	4	4	• To connect all equipment by different types of cables. • Check all connections before powering on the control panel multimeter.	1		**3**	Demonstration of SMPS and their connections			3
			5	**CIE 1– Written and practice test**	**-**	**-**	**-**	**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment (PLC control panel)**	**2**		**3**				
4	2	4	1	**Peer discussion on Industrial assignment**		4		**Installation, Troubleshooting and maintenance of PLC** • Safety precautions when installing PLC systems. • Power requirements and safety circuitry • Power requirements: Common AC Source. Isolation Transformers. Safety circuitry: Emergency Stops, Master control relay (MCR) and safety control relay (SCR), Emergency Power Disconnect.	1		2

	2	4	2	• I/o installation, wiring, and precautions • I/o module installation, • Wiring considerations: wire size, wire and terminal labelling. Wire bundling. Wire bundling • Wiring procedures • Special i/o connection precaution:	1		3	**PLC START-UP AND CHECKING PROCEDURES:** Static input wiring check, static output wiring check, dynamic system checkout			3
	2	4	3	• PLC system maintenance: preventive maintenance: guidelines for preventive measures: spare parts, replacement of I/O modules. • Common Causes of Programmable Logic Controller Failure • Classification of Faults in a PLC System. • Trouble shooting of Hardware faults	1		3	Troubleshooting the PLC system: • Troubleshooting ground loops • Diagnostic indicators • Troubleshooting plc inputs • Troubleshooting plc outputs • Troubleshooting the CPU • Troubleshooting Specific Components of the PLC System • Power Supply Trouble shooting • Troubleshooting PLC Program Errors • Troubleshooting the Working Environment of a PLC			3
	2	4	4	**Types of software faults** Access various troubleshooting resources provided in the software to diagnose the faults with the PLC system.	1		3	Access various troubleshooting resources provided in the software to diagnose the faults with the PLC system.			3
			5	**Developmental Assessment**		-		**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment (Trouble shooting of PLC)**			3				
Week	**C O**	**P O**	**Days**	**1st session (9am to 1 pm)**	**L**	**T**	**P**	**2ND session (1.30pm to 4.30pm)**	**L**	**T**	**P**
5	3	1	1	**Peer discussion on Industrial assignment**		4		**VFD** • Familiarizing AC motor speed is controlled using the voltage or frequency.	2		1

							• Familiarizing constant flux density. And AC induction motors.				
	3	4	2	• Building blocks of VFDs, specifications, types and working principles. • Torque/current Vs frequency characteristics. • Sizing of VFD • VFD with motor control panel, modules of VFD. • Industrial and domestic applications of VFDs. • Selection of VFD for a given application.	2		2	Wire and test VFD with motor control panel			3
	3	4	3	• Test the communication port, cable and module of VFD. • Connect and Commission the given VFD • Configure and run the motor with factory settings. • Troubleshooting of VFD.	1		3	**Mounting of Variable Frequency Drive** To operate Variable Frequency Drive. Set and control the speed of motor by VFD.			3
	3	4	4	**Diagnose the simulated faults and explore the remedial measures of AC drives.** • Connection of Variable Frequency Drive with PLC and motor	1		3	**Motor Speed Control using VFD and PLC**			3
			5	**CIE 2– Written and practice test**	-	-		**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment (Industrial application of VFD)**	**2**		**3**				
6	3	1	1	**Peer discussion on Industrial assignment**		4		**Servo motors:** • Fundamentals of Servo motors and motion control applications. • Servo motors, specifications	1		2

								• servo drives and AC Drives, principle of operation and its applications in motion control, precision measurements etc. • Demonstration of servo motor applications.			
	3	4	2	**Wire and test Servo drive.** Connect and Commission the given servo Drive. • Servo drive for electric mobility application Unguided vehicle(UGV) • Servo drive for robotic applications	1		3	Configure and run the motor with factory settings.			3
	3	4	3	• Diagnose the simulated faults and explore the remedial measures of servo drives.	1		3	• Various communication standards and protocols used in Drives. • Communication cables and adapters. • Various Fault diagnosis in the communication modules.	1		2
	3	4	4	• Connect the Drive with a computer, configure and establish communication. • Configure the drive for various applications using the software. • Troubleshooting of Servo drive.	1		3	• Monitor various motor parameters using the given drive software.			3
			5	**Developmental Assessment**	-	-		**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment (Industrial application of servomotor)**	**2**		**3**				
Week	**C O**	**P O**	**Days**	**1st session (9am to 1 pm)**	**L**	**T**	**P**	**2ND session (1.30pm to 4.30pm)**	**L**	**T**	**P**
7	5	4	**1**	**Peer discussion on Industrial assignment**		4		**PLC with colour Touch screen Human Machine Interface (HMI):**	1		2

								• Colour Touch Screen HMI panels and specifications, various industry interfaces on HMI panels, features of HMI panels			
	5	4	2	Working with HMI software Tool • Configure PLC with HMI • Animation with graphical objects • Troubleshooting of communication problems with drive/PLC • Set up and configure HMI with PLC and Perform supervisory control to turn on/off output field devices **-1**	2		2	Set up and configure HMI with PLC and Perform supervisory control to turn on/off output field devices -2			3
	5	4	3	• Animate objects on a HMI screen to monitor motor status. • Trend the data of a process parameter using a trend tool.	1		3	• Create user groups and monitor screens with proper authentication. • Use security features to do tag logging and command execution.			3
	5	4	4	• Control the servo motor from PLC on a network for various operations such as acceleration, and deceleration. • Configure a servo Drive from the given PLC and Control the motor speed for fixed steps for indexing operations and integrate the given PLC, SCADA/HMI and VFD systems to automate the given process. **-1**	1		3	Configure a servo Drive from the given PLC and Control the motor speed for fixed steps for indexing operations and integrate the given PLC, SCADA/HMI and VFD systems to automate the given process. -2			3
			5	**CIE 3 Written and practice test**				**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment (Integrate HMI with PLC)**	**2**		**3**				
8	4	1	1	**Peer discussion on Industrial assignment.**		4		**Introduction to basic pneumatic components**	2		**1**

	4	4	2	**Wire, program and automate a working model Applications. :** Wiring and identifying the sensors and valves in the batch process reactor plant and programming it for mixing of the two ingredients-1 OR Design, construct, install, configure, test and demonstrate the operation of an industrial conveyor of empty boxes -1  Description of operation: • If there is no box to convey, the device is off; • If a box is detected by Sb, the conveyor is turned on and the speed of the treadmill must be reached in 5 seconds; • The box is conveyed at a speed of 25 cm/s in auto mode; • Speed can be regulated by user in manual mode with a potentiometer and displayed on the front door of the control box;	1		3	**Wire, program and automate a working model Applications. :** Wiring and identifying the sensors and valves in the batch process reactor plant and programming it for mixing of the two ingredients-2 OR Design, construct, install, configure, test and demonstrate the operation of an industrial conveyor of empty boxes -2			3

				• The conveyor is turned off if the box finished its course on the treadmill detected by sensor Sp AND no new box has been inserted for 10 seconds; Description of contents • M1 is a three-phase asynchronous motor 230 V / 400 V, 0, 18 kW; • Sp is a photo-electric sensor, diffuse system, 24 VDC, negative; • Sb is a photo-electric sensor, thru-beam, (Sbe = Emitter; Sbr = Receiver) 24 VDC, negative • SW is a selector switches with 2 NO contacts and standard or long handle. • RH is a potentiometer to regulate speed in manual mode; • Speed driver is a SCHNEIDER Altivar ATV12 H018 M3; • HV is a digital display of the speed.							
	4	4	3	**Wire, program and automate a working model Applications**: Automatic sorting station.-1	1		3	**Wire, program and automate a working model Applications :** Automatic sorting station.-2			3
	4	4	4	**Wire, program and automate a working model Applications. :** PLC based Automatic Packaging System-1.	1		3	**Wire, program and automate a working model Applications. :** PLC based Automatic Packaging System-2.			3
			5	**Developmental Assessment**				**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment (Automating industrial process)**	**2**		**3**				

9	4	1	1	Weekly Assignment review	-	4	-	**Introduction to IOT** • Main components used in IoT • Ways of building IoT: • Characteristics of IoT: • Modern Applications: Demonstrate application of **IoT**	2		1
	4	1	2	• Communication devices in IoT • Needs for setting up IoT environment for basic applications • Choosing a platform for IoT development • AWS IoT: (Amazon Web Services) • Microsoft Azure IoT: • Choosing IoT hardware processor: • Arduino -Set up – procedure, Advantages: • Raspberry Pi - Set up – procedure, Advantages: • Need to use Bluetooth beacons	2		2	• Introduction to NODE MCU ESP8266 (WIFI module) • Automate a system to control appliances from anywhere through the internet.	1		3
	4	1,4	3	IoT-based Smart Energy Meter using NodeMCU ESP8266	1		3	• What is Raspberry pi and why is it important for IoT • IoT-based Smart Energy Meter using Rasberry PI			3
	4	4	4	• IoT-Based Home Appliances Control with Adafruit IO and Raspberry Pi	1		3	• **Applying IoT technologies in the Electric Power Industry** • **IIoT in Industrial Automation** The essentials of an Industrial IoT solution	1		2

				• IoT-based Home Automation using Blynk App and Raspberry PI				• Practical Industrial IoT examples for daily use			
	4		5	**CIE 4 Written and practice test**	-	-	-	**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment (Automating industrial process)**	**2**		**3**				

Week	C O	P O	Days	1st session (9am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
10	5	4	1	**Peer discussion on Industrial assignment**		**4**		**Interconnect PLC systems with different industry standard communication protocols for data transfer.** • Need for Industrial networking • brief history • Different types of networking architecture • Topology	3		
	5	1	2	• OSI model of networking • Networking hardware **Network standards** • Modbus, • CAN bus, • ControlNet, • Ethernet, • Profibus • FIP I/O, etc	4			**Proprietary Network standards and protocols:** Master Slave Configurations.	3		
	5	4	3	• Communication Driver software and Communication hardware modules • Network / communication driver software install and settings for PLC and SCADA.			4	• Remote Terminal Units. . • Scheme of Remote I/O	3		

	5	4	4	Demonstrate Industrial Automation Communication Protocols - RS232-422-485 standards			4	Demonstrate HART and MODBUS, PROFIBUS, DH-485 and Foundation fieldbus etc.				3
			5	**Developmental Assessment**				**Assessment Review and corrective action**				3
			6	**Industry Class + Assignment (Industry standard communication standards)**	**2**		**3**					
Week	**C O**	**P O**	**Days**	**1st session (9am to 1 pm)**	**L**	**T**	**P**	**2ND session (1.30pm to 4.30pm)**	**L**	**T**	**P**	
11	5	1	1	**Peer discussion on Industrial assignment**		4		**Supervisory data control and acquisition system (SCADA)** **Introduction to SCADA:** • What is SCADA? • SCADA SYSTEMS • Evolution of SCADA • Objective of SCADA. • Benefits of SCADA • Functions of SCADA: • SCADA APPLICATIONS • Usage of SCADA • Real-Time Monitoring and Control using SCADA	3			
	5	4	2	**SCADA HARDWARE:** • SCADA Hardware Functions, • Remote Terminal Units (RTU): RTU Hardware: A typical single-board RTU. • Hardware functionality in an RTU, RTU Software functions • Basic operation: RTU Standards. • Difference between PLC and RTU • Features of SCADA	2		2	**SOFTWARE AND PROTOCOLS.** • DNP3 Protocol: Important Features of DNP3. • IEC60870 PROTOCOL The two widely used protocols for SCADA Applications : • HDLC (High-Level Data Link Control) • MODBUS The widely-used open software for SCADA systems : • Citect and Wonderware.			3	

				• Configuration for SCADA environment and applications. • SCADA Software Introduction.							
	5	4	3	• Simple Digital System implementation in SCADA software. • Simple analog System implementation in SCADA software	1		3	Create SCADA Animation in SCADA software			3
	5	4	4	Conveyor Animation Example in SCADA	1		3	Visibility Concept in SCADA			3
		4	**5**	**CIE 5 Written and practice test**	-	-		**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment**	**2**		**3**				
Week	**CO**	**PO**	**Days**	**1st session (9am to 1 pm)**	**L**	**T**	**P**	**2ND session (1.30pm to 4.30pm)**	**L**	**T**	**P**
12	5	4	1	**Peer discussion on Industrial assignment**		4		• Interfacing of SCADA with PLC • Master Terminal Unit (MTU) • Remote Terminal Unit (RTU)	1		2
	5	4	2	**Control PLC from SCADA** • PLC ladder logic to control variable frequency drive (VFD) for motor speed control with speed selection from Field Local Panel or SCADA graphics.-1	1		3	**Control PLC from SCADA** PLC ladder logic to control variable frequency drive (VFD) for motor speed control with speed selection from Field Local Panel or SCADA graphics-2			3
	5	4	3	Digital Alarms Interfacing with PLC	1		3	Analog Alarms Virtual Simulation			3
	5	4	4	Analog Alarms Interfacing with PLC Basic Report Generation-1	1		3	Analog Alarms Interfacing with PLC Basic Report Generation-2			3
			5	**Developmental Assessment**				**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment (Application of SCADA in automation)**	**2**		**3**				

Week	CO	PO	Days	1st session (9am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
13	1,2, 3,4, 5	2,3, 4		**Internship** a) Secondary research on various industries and their operations to identify at least 3 companies along with the areas of work interest and develop an internship plan that clearly highlights expectations from the industry during the internship. b) Design and develop a cover letter for an internship request to all 3 identified companies and the resume to be submitted to potential companies. c) Prepare for an internship interview to highlight your interests, areas of study, career aspirations and personnel competence – including the areas of learning you expect to learn during the internship		4		**Project** a) Identification of the problem statement (from at least 3 known problems) the students would like to work as part of the project – either as provided by faculty or as identified by the student. Document the impact the project will have from a technical, social and business perspective. b) Design and develop the project solution or methodology to be used to solve at least one of the problems identified. Prepare a project plan that will include a schedule, WBS, Budget and known risks along with strategies to mitigate them to ensure the project achieves the desired outcome.			3

Reference:

Sl. No.	Description
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2	Introduction to PLC by Gary Dunning, Cengage Learning.
3	Mechatronics: W.Bolton
4	Control of Machines- S.K. Bhattacharya & Brijinder Singh, New Age International Publishers
5	https://foodsafetytech.com/column/automation-benefits-food-beverage-industry/
6	PLC Handbook https://cdn.automationdirect.com/static/eBooks/PLC%20Handbook.pdf
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8	https://support.industry.siemens.com/cs/document/109782616/logo!-soft-comfort-v8-demo?dti=0&lc=en-WW
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10	Programming a daily timer on LOGO PLC: https://www.youtube.com/watch?v=Rl2VIBUVr-0
11	Siemens Logo 8 Pump Start & Stop Control With Set Pressure: https://www.youtube.com/watch?v=gf0ZwrVvn_4
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30	https://www.reliance-scada.com/en/download/reliance4/reliance4-example-projects
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37	https://realpars.com/connect-vfd-to-plc/
38	https://forumautomation.com/t/plc-selection-criterias/4383
39	https://www.plctechnician.com/news-blog/evolution-plcs
40	SCADA applications in manufacturing | SCADA process control systems: https://www.youtube.com/watch?v=f0bw2DE-cos&list=RDCMUCFnjTv9lIHl0Pk6u_i8CJWQ&index=6
41	SCADA colour mixing recipe management: https://www.youtube.com/watch?v=S6giv9rIRNA&list=RDCMUCFnjTv9lIHl0Pk6u_i8CJWQ&index=13
42	Introduction to SCADA System | Supervisory Control and Data Acquisition System: https://www.youtube.com/watch?v=86uY3TQq2Yk https://nptel.ac.in/courses/108106022

43	https://bin95.com/industrial-training-videos/ab-plc-dh485-rs232-usb.htm
44	https://www.geeksforgeeks.org/introduction-to-internet-of-things-iot-set-1/
45	**Introduction to IOT** **a.**https://infyspringboard.onwingspan.com/web/en/viewer/video/lex_auth_012812710727385088146 73_shared?collectionId=lex_auth_01309442655 35569922151_shared&collectionType=Course **b.**https://www.geeksforgeeks.org/internet-things-iot-2/
46	Introduction to NODE MCU ESP8266 (WIFI module) https://www.nodemcu.com/index_en.html Automation system to control appliances from anywhere through the internet. https://easyelectronicsproject.com/esp32-projects/esp8266-mqtt-home-automation-system/
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48	What is Raspberry pi and why is it important for IoT https://analyticsindiamag.com/raspberry-pie-important-iot/ IoT based Smart Energy Meter using Rasberry pi https://circuitdigest.com/microcontroller-projects/iot-based-raspberry-pi-smart-energy-meter
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52	https://instrumentationtools.com/problem-on-plc-hmi-vfd-and-motor-circuit/
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54	https://instrumentationtools.com/hardware-troubleshooting-steps-for-plc-automation-systems/#h-how-to-troubleshoot-the-plc-hardware-faults
55	https://www.electricityforum.com/iep/electric-motors-and-drives/vfd-sizing https://www.focusondrives.com/how-do-you-size-a-vfd/

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57	VFD www.newark.com › agilent › TroubleshootingVFD cdn.logic-control.com › media › abb https://www.pesquality.com/blog/general-troubleshooting-of-vfd-problems https://instrumentationtools.com/how-to-control-vfd-with-plc/
58	https://www.ato.com/servo-drive-troubleshooting https://gesrepair.com/servo-motor-drive-troubleshooting-guide/
59	https://instrumentationtools.com/fieldbus-profibus-hart-protocols/

CIE and SEE Assessment Methodologies

CIE Assessment	Assessment Mode	Duration In hours	Max Marks
Week 3	CIE 1– Written and practice test	4	30
Week 5	CIE 2– Written and practice test	4	30
Week 7	CIE 3– Written and practice test	4	30
Week 9	CIE 4– Written and practice test	4	30
Week 11	CIE 5– Written and practice test	4	30
	On line Course work (Minimum 10 hours online course with certification from (SWAYAM/NPTEL/Infosys Springboard)		40
	Profile building for Internship / Submission of Synopsys for project work		20
Portfolio evaluation (Based on industrial assignments and weekly developmental assessment) *			30
TOTAL CIE MARKS (A)			**240**
SEE 1 - Theory exam (QP from BTE) Conducted for 100 marks 3 hrs duration reduced to 60 marks		**3**	**60**
SEE 2 – Practical		**3**	**100**
TOTAL SEE MARKS (B)			**160**
TOTAL MARKS (A+B)			**400**

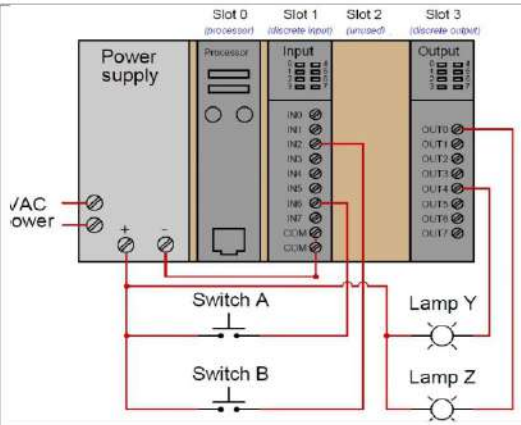
* The industrial assignment shall be based on peer-to-peer assessment for a total of 10 marks (on a scale of 1 to 10) and in the event of a group assignment the marks awarded will be the same for the entire group, the developmental assessment will be for a total of 20 marks and based on MCQ/case study/demonstration and such other assignment methods

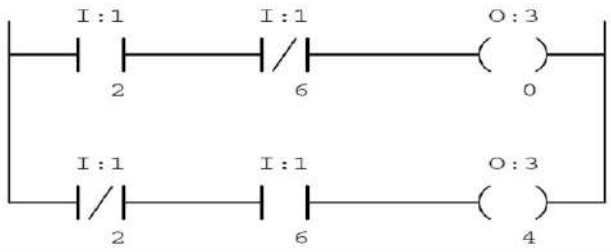
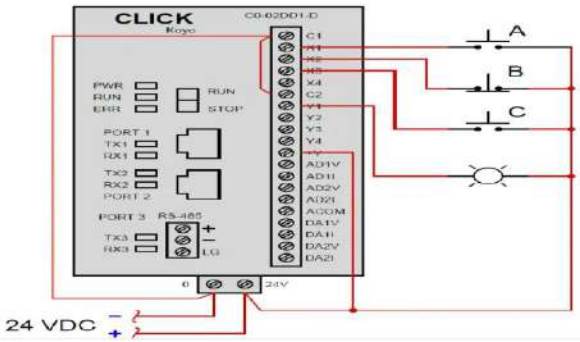
Assessment framework for CIE (1 to 5)

Note : Theory to be conducted for 1 hour and practice for 3 hours, total duration of exam – 4 hours

Programme	**Electrical & Electronics Engineering**	**Semester**	**V**
Course	**Industrial Automation**	**Max Marks**	**30**
Course Code	**20EE51I**	**Duration**	**4 hours**
Name of the course coordinator			

Note: Answer one full question from each section.

Qn.No	**Question**	**CL L3/L4**	**CO**	**PO**	**Marks**
	Section-1 (Theory) – 10 marks				
1.	 PLC connected to a pair of pushbutton switches and light bulbs as shown in this illustration: Examine the following relay ladder logic (RLL) program determining the necessary switch statuses to energize lamp Y, and the necessary switch statuses to energize switch Z:	L4	1	2	10

					
2.	Suppose we have a PLC connected to three pushbutton switches as shown in this illustration:  Sketch a Ladder Diagram program for this PLC to energize the lamp if the following input conditions are met: • Switch A pressed • Switch B pressed • Switch C unpressed		1	2	10
Section-2 (Practical) - 20 marks					
3.	Write the PLC circuit for the following condition, simulate and execute.	L3	1	4	20

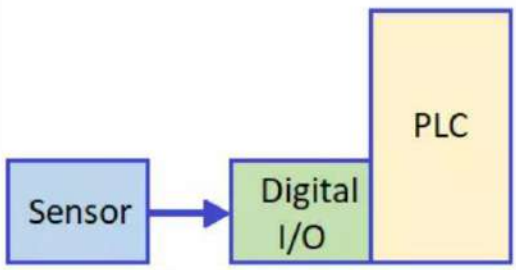
	When PB1 is pressed feed unit advance & motor runs for 5 secs only if the job is present and clamped then return back. After delay of 3 secs cycle repeats until PB4 is pressed. Each operation can also be operated manually by individual push buttons Parameter: PB3 press everything off. Cycle should repeat if PB1 press again after completion of one cycle				

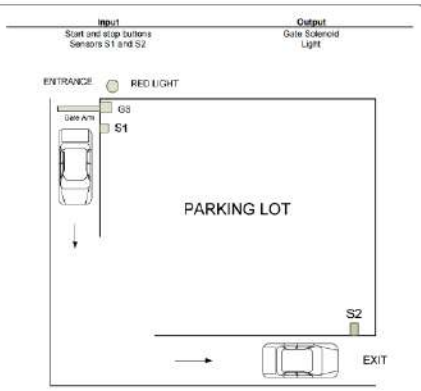
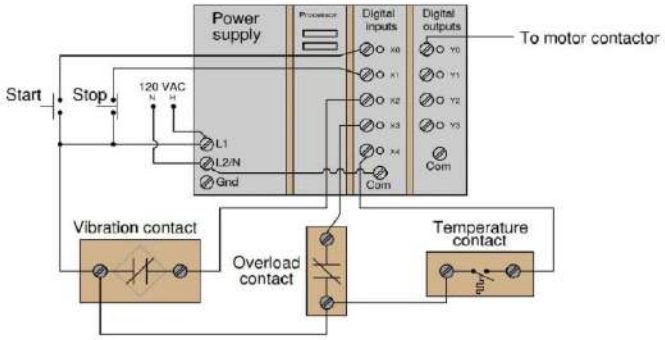
Note : Theory questions shall be aligned to practical questions

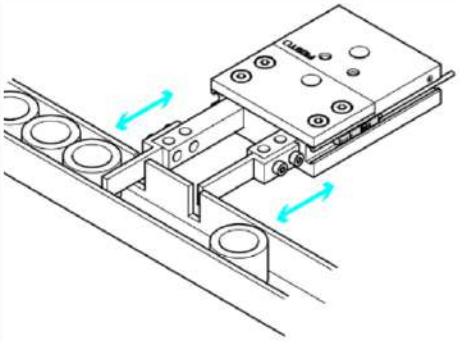
Assessment framework for SEE 1 (Theory)

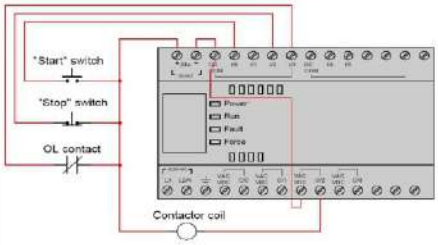
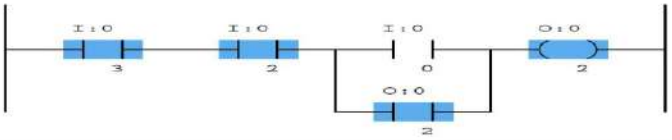
Programme	:	**Electrical & Electronics Engineering**			
Semester	:	**V**			
Course	:	**Industrial automation**	**Max Marks**	:	**100**
Course Code	:	**20EE51I**	**Duration**	:	**3 Hrs**

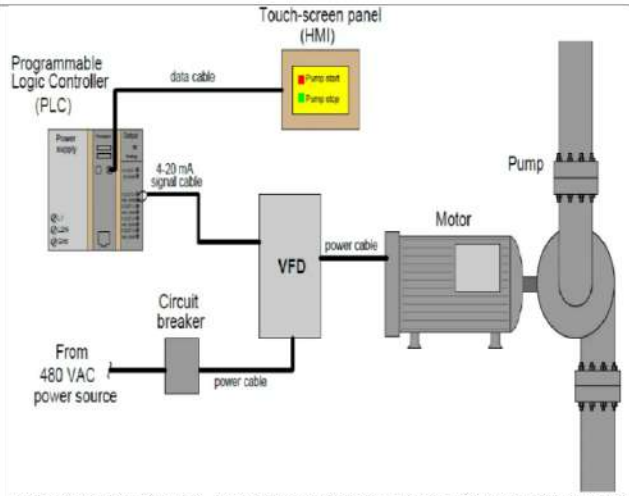
Instruction to the Candidate: Answer one full question from each section.

Q.No	Question	CL	CO	Marks
	Section-1			
1.a)	Write the PLC circuit for the following condition When PB1 is pressed L1 gets ON after 10sec L1 off L2 ON there after 15 sec L2 OFF L3 ON, blinks with delay of 1sec for 10 times then gets OFF Parameter: PB3 press everything off. Cycle should repeat if PB1 press again after completion of one cycle.	L4	1	10
b)	 Pick an appropriate sensor for the circuit shown below and justify the selection.	L3		5
c)	**Select sensors ,switches and actuators required to implement the sytem.** The parking lot which has a capacity of 200 cars is to be controlled by a PLC system. The sensor S1 and S2 are used to count the car at the entrance and exit. If the number of the cars reaches to 200, red light is lit and the gate arm is closed. The arm stays closed until one or more parking space is available in the lot. The gate arm is controlled by activating/deactivating the gate solenoid (GS).	L3		5

				
2.a)	 This PLC is being used to start and stop an electric motor, and also to shut it down automatically if any of three "shutdown" conditions occur: Excessive vibration Overcurrent (overload heater contact) High winding temperature	L4		10

	The status of each shutdown contact is as follows: Vibration contact: closed when okay, opens when vibration becomes excessive Overload contact: closed when okay, opens when overloaded Temperature contact: open when okay, closes when hot Draw a PLC ladder-logic program to start and stop this motor.			
b)	 Work pieces are transported to a processing unit on a conveyor belt. The work pieces have to be separated upstream of the processing unit. The separating cylinder's end positions are monitored using magnetic proximity switches. 1. Select a suitable proximity switch for monitoring the end position of a cylinder. 2. Explain terminology from the field of proximity switch technology. 3. Determine whether or not a solenoid valve can be directly actuated by a proximity switch.	L4		10
	Section-2			
3.a)	Testing of PLC yielded following results. Find likely fault in the PLC 1. Diagnostic indicators are not showing RED 2. Power supply is OK 3. Field input , outputs and I/O modules Check Ok 4. Program in the PLC memory matches with the master program and all the working environmental conditions are as recommended by the PLC manufacturer. 5. PLC system still doesn't come up even with proper powering	L4	2	10

b)	 Suppose we have an PLC connected to a pair of pushbutton switches and contactor controlling power to an electric motor as shown in this illustration: This motor control system has a problem, though: the motor refuses to start when the "Start" pushbutton is pressed. Examine the "live" display of the ladder logic program inside this PLC to determine what the problem is: 	L4		10
4.a)	Suggest troubleshooting procedures and corrective actions for PLC system for the following faults 1. All LEDs are off 2. ERROR LED is flashing https://www.plctutorialpoint.com/plc-fault-finding-troubleshooting/	L4		10
b)	Suggest troubleshooting procedures and corrective actions for PLC system for the following fault. No abnormality is found with the PLC CPU, its power supply, the I/O modules, and corresponding field I/O devices PLC system is still not working.	L4		10
	Section- 3			
5.a)	Why the VFD operated Motor produces more Torque than across the line?	L3	3	5
b)	Suggest possible solutions for following faults/issues in VFD 1. VFD starts but will not run	L3		15

	2. No display 3. Under voltage fault 4. Motor overload fault 5. Overcurrent Fault			
6.a)	 Unfortunately, though, there is something wrong with this system. The pump does not run, regardless of what the operator commands using the touch-screen panel. When you examine the VFD faceplate, you see a few LED indicators lit, but nothing either confirming or denying that power is reaching the motor. Supposing the only test equipment available to you is a digital multimeter (DMM), what diagnostic tests could you perform to identify the location and nature of the system fault?	L4		10
b)	Suggest troubleshooting Procedures and Corrective Actions for servo drive for the following faults 1. The servo motor runs faster in one direction than the other 2. Servo motor stalls 3. The LED light is green, but the servo motor doesn't move 4. When the servo motor rotates, the LED light flashes 5. Servo Motor Shuts Off After Reaching High or Full Speed	L4		10

	Section-4			
7	To automate a sorting station 1. Write the process algorithm (step by step procedure/ instructions) 2. Block diagram of system/process diagram 3. Schematic diagram of logic circuit /PLC ladder diagram/ Functional block diagram /Structured list/ instruction list Selection of proper sensors , motors, switches , valves other accessories with specifications	L4	4	20
8	To automate a packaging system 1. Write the process algorithm (step by step procedure/ instructions) 2. Block diagram of system/process diagram 3. Schematic diagram of logic circuit /PLC ladder diagram/ Functional block diagram /Structured list/ instruction list Selection of proper sensors , motors, switches , valves other accessories with specifications	L4		20
	Section-5			
9.a)	Explain part of the SCADA system which initiates all most all communications and interface with operator.	L3	5	5
b)	Explain the scenarios where 1. Profibus is preferred over Modbus 2. Modbus is preferred over Profibus	L3		10
c)	Can we replace PLC with RTU? Justify your answer.	L3		5
10.a)	Where HART protocol is used. Why is it called as Hybrid protocol? Compare its data rate and range with other protocols			10
b)	Are alarms indispensable in SCADA systems? Justify your answer.	L3		10

Scheme of Evaluation for SEE 2

Sl. No	Description	Marks
	Automate given process	
1	Process algorithm (step by step procedure/ instructions) with Block diagram of system / process diagram	10
2	Schematic diagram of logic Circuit /PLC ladder diagram/ Functional block diagram /Structured list/ instruction list	20
3	PLC Input / Output List	05
4	Power distribution scheme	05
5	Selection of proper sensors, motors, switches, valves other accessories with specifications	10
6	Selection of PLC /HMI with proper specifications	05
7	Proper Input/output connections to PLC	10
8	Simulation of ladder diagram	10
9	Professional practice 1. Safety Electrical power supply and circuit integrity with proper insulation with no bare wires and loose connections, pneumatic , mechanical connections integrity firm , no leaks 2. Usage of proper tools and equipment usage Usage of right tools and methods for electrical connections. Mounted hardware and circuit board properly. No damage to tools and equipment	05
10	Testing and Troubleshooting of automated system	10
11	Results (of fully automated)	10
	Total	**100**

Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
1	PLC Systems with digital I/P, O/P modules and software	12/24v Dc/relay 6 Digital Inputs , 4 Digital Outputs, ethernet card standard micro Sd card integrated webserver	5
2	PLC Systems with analog I/P, O/P modules and software	12/24v Dc/relay 6 Digital Inputs , 4 Digital Outputs, ethernet card standard micro Sd card integrated webserver	2
	HMI with software	7 inch panel, 24 V DC	5
3	Pneumatic kit	Valves , air compressor (minimum capacity) and accessories	1
4	Conveyor belt assembly	Prototype	2
5	PLC control panel	With mounting arrangement for PLC power supply pushbutton switch etc.	2
6	VFD	2HP	2
7	Servo Motor	1.5 Kw	2
8	Raspberry PI Board		5