



Government of Karnataka
DEPARTMENT OF COLLEGIATE and TECHNICAL EDUCATION

Program	Mechanical Engineering	Semester	5
Course Code	20ME51I	Type of Course	L:T:P (104: 52: 312)
Specialization	Automation and Robotics	Credits	24
CIE Marks	240	SEE Marks	160

Introduction:

Welcome to the curriculum for the Specialisation Pathway – **Automation and Robotics**. This specialisation course is taught in Bootcamp mode. Bootcamps are 12 weeks, intense learning sessions designed to prepare you for the practical world – ready for either industry or becoming an entrepreneur.

Automation is the process of use of automatic devices and controls in mechanized production line. It is applied to variety of systems in which there is a significant substitution of mechanical, electrical, or computerized action for human effort and intelligence. Automation technology has matured to a point where a number of other technologies have developed from it and have achieved a recognition and status of their own. Robotics is one of these technologies. Robots can work in hazardous conditions, such as poor lighting, toxic chemicals, or tight spaces. They are capable of lifting heavy loads without injury or tiring. Robots increase worker safety by preventing accidents. In addition to these, automated robotics makes production efficient, responsive, flexible and innovative which are key elements of staying competitive. Henceforth, is the Specialization pathway - **Automation and Robotics**

You will be assisted through the course, with development-based assessments to enable progressive learning. In this course, you'll learn how to Automate different activities in various applications and also incorporate Robots for required activities in an automation system.

Leading to the successful completion of this bootcamp, you shall be equipped to either do an **Internship** in an organisation working on **Automation and Robotics** or take up a **Project** in the related field. After the completion of your Diploma, you shall be ready to take up roles like Automation Engineer, Floor shop Manager, Production In-charge and also can become Entrepreneur in the related field and more.

This course will teach you about Designing an Automation system with or without Robots, Selection of the equipment's for an Automation and Robotics System, integrate SCADA and IoT in Automation system and more. Details of the curriculum is presented in the sections below

Pre-requisite

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

1st year -Engineering Mathematics, Communication Skills, Computer Aided Engineering Graphics, Statistics & Analysis, Basic IT Skills, Fundamentals of Electrical and Electronics Engineering, Project Management skills Engineering Materials and Mechanical Workshop

2nd year-Mechanics of Materials, Machine Tool Technology, Manufacturing Process, Fluid Power Engineering, Product Design and Development, Operations Management, CNC Machines and Elements of Industrial Automation. In this year of study, you shall be applying your 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 supplementally teaching and learning opportunities including good quality online courses available on platforms like Karnataka LMS, Infosys Springboard, NPTEL, Unacademy, SWAYAM, etc.

Course Outcomes: At the end of the Course, the student will be able to:

CO-01	Identify the possibilities of automation in a production system
CO-02	Select the Hardware components required for Automation and establish communication network by using industry standard protocol
CO-03	Develop, simulate, interface and Execute an Automation system for a given Application
CO-04	Develop, simulate, interface and Execute Robot Program for a specified process in an Automation system
CO- 05	Integrate HMI, SCADA and IIOT in an automation system

Detailed course plan

Week	C O	P O	Days	1 st session (9am to 1 pm)	L	T	P	2 nd session (1.30pm to 4.30pm)	L	T	P
1	1		1	Present an overview on Conventional Production process starting from procurement of raw materials to finished product and delivery to the customer			4	Virtual tour on modern industries such as automobile sector, aviation sector, Fast Moving Consumer Goods (FMCG) sector etc. Discuss Hierarchy of Industrial Automation, Industrial Automation pyramid. Present an Overview on the Levels of Automation- <ul style="list-style-type: none"> • Device level • Machine Level • Cell Level • Plant Level • Enterprise Level 	1		2
	1		2	<ul style="list-style-type: none"> • Understand Design Thinking as a problem-solving process. • Impact of design thinking on design, manufacturing and delivery • Describe the principles of Design Thinking • Discuss the feasibility of the operations that can be Automated in a Production system • Identify the operations that cannot be Automated in a Production system and requires human intervention 	2		2	Importance of Industrial automation in the Indian manufacturing industry Challenges and Limitations of industrial automations Present an Overview of Industry 4.0 and Challenges in implementation of Industry 4.0 in India	1		2

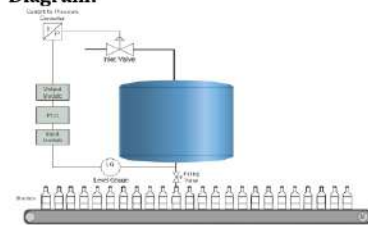
	1,2		3	Recap on Technologies adopted in Automation Demonstrate- <ul style="list-style-type: none"> Sensors Technology Drives and Actuators Relays and Switches PLC and Programming Communication Protocols 	1		3	Modern tools used for Industrial Automation- PAC, SCADA, HMI, DCS, AI, IIOT, etc Importance of IEC, ISO, NEMA, JIC and other standards used in automation.	2	1
	1,3		4	Programmable Automation Controllers (PACs)-Role of PACs in modern industries. Discuss Proportional Integral Derivative (PID)-Proportional Response, Integral Response, Derivative Response, Demonstrate Applications of PAC and PID	2		2	Programming with IEC 61131-3 Languages <ul style="list-style-type: none"> Ladder Diagrams Structural Text language Sequential function Chart Functional Block diagram Instruction List 	1	2
			5	Developmental Weekly Assessment				Assessment Review and corrective action		3
			6	Industry Class on Sensors and Actuators + Industry Assignment			5			
2	3		1	PEER Discussion on Industry Assignment		4		Recap and Practice PLC Ladder Diagram for Logic Gates, Timers, Counters	1	2
	3		2	Explain and Practice PLC Ladder Diagram for Compare, Jump and Subroutines	1		3	Explain and Practice PLC Ladder Diagram for Math Instructions and Shift Registers	1	2
	3		3	Explain and Practice PLC Program using Functional Block Diagram	1		3	Explain and Practice PLC Program using Functional Block Diagram	1	2
	3		4	Explain and Practice PLC Program using Structural Text language	1		3	Explain and Practice PLC Program using Structural Text language	1	2
			5	Developmental Weekly Assessment				Assessment Review and corrective action		3

			6	Industry Class on PLC Programs practiced in Industry + Industry Assignment		5			
3	2		1	PEER Discussion on Industry Assignment	4		Explain and demonstrate how to establish communication network with PLC systems using industry standard communication protocols for data transfer <ul style="list-style-type: none">Serial CommunicationsASCII FunctionsParallel Communications	1	2
	2		2	Explain and demonstrate different types of networking architecture Explain OSI model of networking Networking hardware	2	2	Demonstrate TCP/IP Protocol Introduction to IP Address, Subnet Mask, Networking Devices, Network topology	2	2
	2		3	Demonstrate Industrial Automation Communication Protocols - RS232-422-485 standards	2	2	Demonstrate the Network standards, Modbus, CAN bus, ControlNet, Ethernet, Profibus, FIP I/O, Static and Dynamic Routing principle	2	2
	2		4	Demonstrate HART, DH-485 and Foundation fieldbus etc. Concepts of Wireless Networking	2	2	Latest trends in PLC communication protocols. Fundamental Parts and Characteristics of PLC communication Protocol Demonstrate Peer to Peer (PLC to PLC) & PLC to PC Communication protocols	1	2
			5	CIE 1- Written and practice test			Assessment Review and corrective action		3
			6	Industry Class on Communication Protocol practiced in industry + Industry Assignment		5			
4	5		1	PEER Discussion on Industry Assignment	4		<ul style="list-style-type: none">HMI (Human Machine Interface) - Types- Selection- Specifications PLC with colour Touch screen Human Machine Interface (HMI): <ul style="list-style-type: none">Colour Touch Screen HMI panels and specifications, various industry interfaces on HMI panels, features of HMI panels	1	2

5		2	Working with HMI software Tool <ul style="list-style-type: none"> • Configure PLC with HMI • Animation with graphical objects • Animate objects on an HMI screen to monitor motor status • Trend the data of a process parameter using a trend tool. • Create user groups and monitor screens with proper authentication. • Use security features to do tag logging and command execution 	2	2	<ul style="list-style-type: none"> • Practice HMI programming involving alarms, trends and bar graphs 	1	2
5		3	<ul style="list-style-type: none"> • Practice control of a Motor through HMI 				2	5
5		4	Supervisory data control and acquisition system (SCADA) <ul style="list-style-type: none"> • Concepts of SCADA systems • SCADA hardware <ol style="list-style-type: none"> Field level instrumentation and control devices RTU- Remote terminal unit Communication systems Master control station Data processing computer systems Creating and Editing tag Creating Graphs and bar charts, Alarm configuration, Trends (Real time and Historical), Report generation • SCADA Protocols • Application of SCADA 	4		Practice control of a Motor through SCADA software	1	2
		5	Developmental Weekly Assessment			Assessment Review and corrective action		3
		6	Industry Class on HMI and SCADA + Industry Assignment		5			
5	3	1	PEER Discussion on Industry Assignment	4		Problem Statement: Bottle filling has a constant speed of filling 20 bottles per minute. This speed	1	2

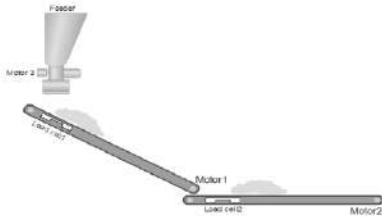
depends on level of the tank due to its head pressure. To maintain this speed, pressure head of the filling tank has to be maintained at a particular level. Implement this automation in PLC using Ladder Diagram programming language

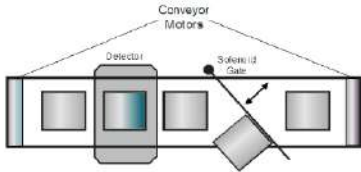
Diagram:

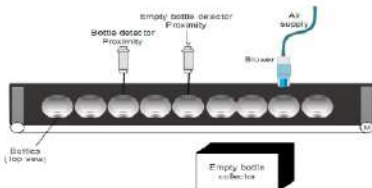


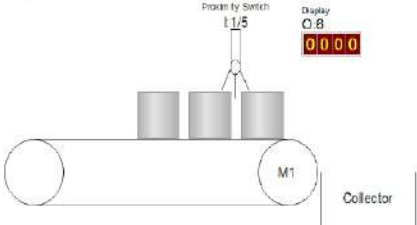
Condition: To continuously maintain constant Pressure in the tank

- i) For the above case, Discuss the suitable sensor technology, PLC, Drives, Communication Protocol and Related Hardware components
- ii) Select Hardware components from the Company catalogue and record their specifications in a DATA Sheet
- iii) Develop a PLC Ladder Program for the above case, simulate, interface with PLC and execute
- iv) Discuss the Applications of the above Case

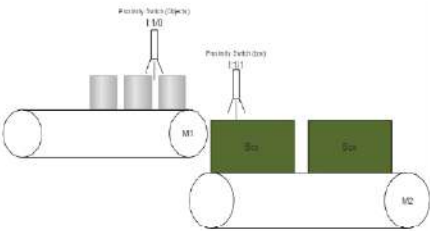
3	2	<p>Problem Statement: A feeder drops material on the conveyor which sends material for further process through one more conveyor. Conveyor must start automatically when material is dropped on it. Implement automation of this in PLC using Ladder Diagram programming language.</p> <p>Diagram:</p>  <p>Condition:</p> <ul style="list-style-type: none"> Feeder has a motor mounted to feed material on conveyor belts. Load cells are installed at the bottom of conveyor belts to detect if material is present on the conveyor belt. When material falls on conveyor belt 1, motor 1 should start, and when material is present on conveyor belt 2, motor 2 remain On. Switches can also be used sometimes to detect material's presence. But for more reliable operation, Load cells can be used as shown in the diagram above <p>a) For the above case, Discuss the suitable sensor technology, PLC, Drives, Communication Protocol and Related Hardware components</p> <p>b) Select Hardware components from the Company catalogue and record their specifications in a DATA Sheet</p>	2	5
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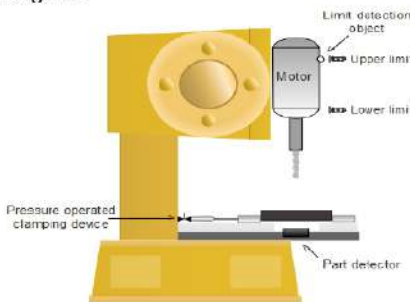
			<p>c) Develop a PLC Ladder Program for the above case, simulate, interface with PLC and execute</p> <p>d) Discuss the Applications of the above Case</p>		
3		3	<p>Problem Statement: Parts are moving on the conveyor from one process line to other with a constant speed. Out of 1000-part, one part is taken out for quality check. Implement automation of this in PLC using Ladder Diagram programming language.</p> <p>Diagram:</p>  <p>The diagram shows a horizontal conveyor belt with four rectangular parts on it. Above the belt, there is a 'Detector' unit and a 'Solenoid Gate' mechanism. The 'Conveyor Motors' are indicated at the top. The 'Solenoid Gate' is shown as a vertical bar that can move up and down, controlled by a solenoid.</p> <p>Condition:</p> <ul style="list-style-type: none"> To detect the parts, detector such as proximity switch, optical sensors or any other sensor is used. Connect output of this detector to Input Module of PLC which sets and resets image memory according to parts' detection. Give this detection, as an input to Up Counter which is incremented with each part's detection. Set counter preset value to 1000. Operate Solenoid for a few seconds until the part is diverted for quality check. <p>a) For the above case, Discuss the suitable sensor technology, PLC, Drives, Communication Protocol and Related Hardware components</p> <p>b) Select Hardware components from the Company catalogue and record their specifications in a DATA Sheet</p> <p>c) Develop a PLC Ladder Program for the above case, simulate, interface with PLC and execute</p> <p>d) Discuss the Applications of the above Case</p>	2	5

3	4	<p>Problem Statement: After filling process, bottles are moved on the conveyor belt for packing process. Detect if any empty bottle is left on the conveyor and remove it from the conveyor. Implement automation of this in PLC using Ladder Diagram programming language.</p> <p>Diagram:</p>  <p>Condition:</p> <ul style="list-style-type: none"> Proximity sensors are used to detect bottles. One proximity is calibrated such that it detects all the bottles passing on the conveyor. And other proximity is used such that it detects only empty bottle. Use Bit Shift Register to shift a bit which is set when an empty bottle is detected. Use a Pneumatic Cylinder or blower to throw an empty bottle out of the conveyor <p>a) For the above case, Discuss the suitable sensor technology, PLC, Drives, Communication Protocol and Related Hardware components</p> <p>b) Select Hardware components from the Company catalogue and record their specifications in a DATA Sheet</p> <p>c) Develop a PLC Ladder Program for the above case, simulate, interface with PLC and execute</p> <p>d) Discuss the Applications of the above Case</p>	2	5	
5	<p>CIE 2- Written and practice test</p>			<p>Assessment Review and corrective action</p>	3

			6	Industry Class on Automation in Industry + Industry Assignment		5			
6	3		1		4		<p>Problem Statement: Parts are moved on the conveyor. Count the number of parts collected at the end of the conveyor and display it on the display in PLC using Ladder Diagram programming language.</p> <p>Diagram:</p>  <p>Condition:</p> <ul style="list-style-type: none"> • Mount Proximity Switch to detect the parts. • Use output of proximity to counter as an input to increment data. • Convert this number into appropriate numerical and show number of parts collected. • Use Inductive or Capacitive Proximity switches are Depending on Metal or Non-Metal • Mount this sensor according to the size of parts present on the conveyor and width of conveyor so that this sensor can detect parts easily. • CUP is used to increment the number of parts collected. 	1	2
				PEER Discussion on Industry Assignment					

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			<ul style="list-style-type: none"> Mount these switches such that switches detect assigned object only. For example, mount Square detector proximity such that it neither detects Rectangular blocks nor Balls. Load counter values in registers for different objects. And load this value as soon as a particular type of object is detected. <p>a) For the above case, Discuss the suitable sensor technology, PLC, Drives, Communication Protocol and Related Hardware components</p> <p>b) Select Hardware components from the Company catalogue and record their specifications in a DATA Sheet</p> <p>c) Develop a PLC Ladder Program for the above case, simulate, interface with PLC and execute</p> <p>d) Discuss the Applications of the above Case</p>		
3		3	<p>Problem Statement: Objects are moving on a conveyor belt 1. When an empty box is detected, conveyor belt starts and 5pcs are packed in a box. When box is filled, it is carried to the storage area via conveyor belt 2. Implement automation of this process in PLC using Ladder Diagram programming language.</p> <p>Diagram:</p>  <p>Condition:</p>	2	5

		<ul style="list-style-type: none">• Use proximity switches to detect moving objects on the conveyor belt 1 and to detect an empty box on conveyor belt 2.• Use counter to count number of objects to be packed.• Use timer such that when 5pcs are detected, conveyor runs for a while and stops when 5th object is finally collected in the box. Assume time by calculating conveyor belt speed.• When number of parts to be packed are detected timer is activated. When timer is over, it stops the conveyor until next empty box is detected.• Assuming time taken by the last 5th object is 2secs to be collected. <p>a) For the above case, Discuss the suitable sensor technology, PLC, Drives, Communication Protocol and Related Hardware components</p> <p>b) Select Hardware components from the Company catalogue and record their specifications in a DATA Sheet</p> <p>c) Develop a PLC Ladder Program for the above case, simulate, interface with PLC and execute</p> <p>d) Discuss the Applications of the above Case</p>		
3	4	<p>Problem Statement: Whenever a part is placed on the drilling table, pneumatic clamper clamps the part and drilling process is done. On completing the drilling process, the clamper releases the part by releasing pressure. When another part is detected, the process is repeated. Implement this in PLC using Ladder Diagram programming language</p> <p>Diagram:</p>  <p>Condition:</p>	2	5

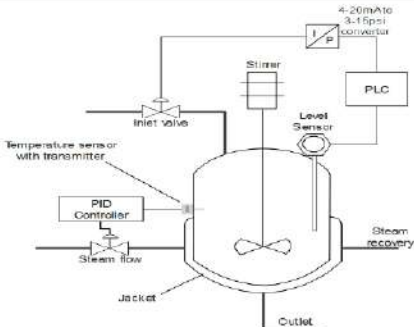
- Set lower and upper limit of a motor to stop and start the drilling process. This is done for precise drilling and to obtain uniformity.
- Pressure operated clamping device is used to hold the objects firmly. This is operated by air supply which is provided when an object is detected.
- Limit detection object is placed on the motor to detect upper and lower limit by the switches.

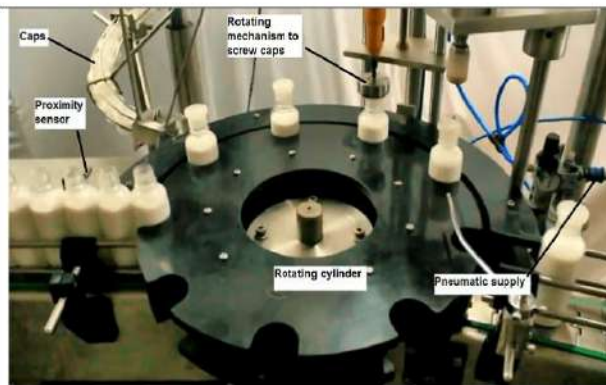
a) For the above case, Discuss the suitable sensor technology, PLC, Drives, Communication Protocol and Related Hardware components

b) Select Hardware components from the Company catalogue and record their specifications in a DATA Sheet

c) Develop a PLC Ladder Program for the above case, simulate, interface with PLC and execute

d) Discuss the Applications of the above Case in other machines

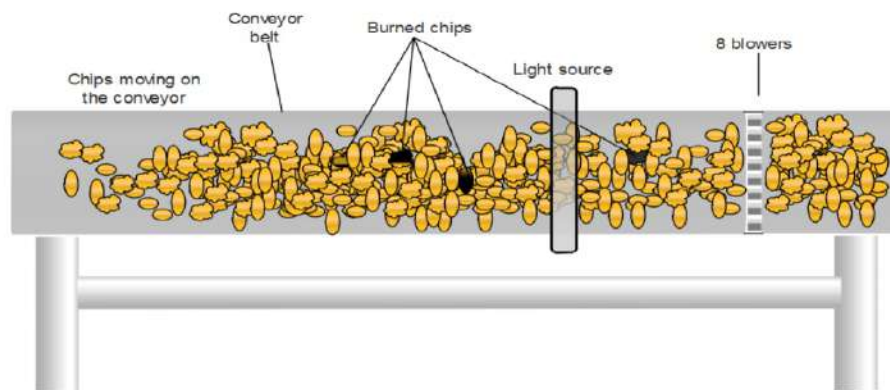
7						 <p>Condition:</p> <ul style="list-style-type: none">Three parameters are controlled in this reactor. Temperature, Flow and Level of the tankUse PID Controller <p>For the Above case, Develop a PLC program</p>		
3		2	<p>Problem Statement: Water bottles are moved on a conveyor for capping. Screw caps are screwed to close the opening end of the bottle using rotating mechanism. Implement this in PLC using Ladder Diagram programming language</p> <p>Diagram:</p>			2	5	

**Condition:**

- To sense the bottle, proximity sensor is used.
 - Used a timer to stop the cylinder motor for 2secs to screw caps.
 - Used one more timer to run the motor for 1sec to rotate the cylinder.
 - Bit Shift register is also used to perform this operation.
 - Count the number of steps capping machine is placed from the sensor and set bit position to operate capping machine accordingly.
 - In this example as you can see, bottle is 7 steps away from the proximity switch, so if Bit register B3:0 is used, then capping machine should be operated when B3:0/0 is shifted to B3:0/6.
 - Two inputs are given to this Capping machine, electric supply to run motor and pneumatic supply to push machine down cap ram.
- a) For the above case, Discuss the suitable sensor technology, PLC, Drives, Communication Protocol and Related Hardware components
 - b) Select Hardware components from the Company catalogue and record their specifications in a DATA Sheet
 - c) Develop a PLC Ladder Program for the above case, simulate, interface with PLC and execute
 - d) Discuss the Applications of the above case

3	3	<p>Problem Statement: Two tanks have same products filled. Draining from these depends on the requirement from the storage tank. Implement automation in this Drainage tank using with PLC using Ladder Diagram programming language</p> <p>Diagram:</p> <p>Condition:</p> <ul style="list-style-type: none"> • Level gauge is used to measure level of the storage tank continuously • Level gauge is connected with Level Transmitter which converts corresponding level output in 4-20mA equivalent. • Analog I/O Modules are chosen to deal with Analog signals. • Pumps are used to drain material from both the tanks at the same time. • Two low level switches are used to detect low level of tanks 1 and 2 which turns Pumps OFF when low level is reached. • Height of storage tank is 5meters that is 500cm and the level which is to be maintained is 470cm. <p>a) For the above case, Discuss the suitable sensor technology, PLC, Drives, Communication Protocol and Related Hardware components</p> <p>b) Select Hardware components from the Company catalogue and record their specifications in a DATA Sheet</p> <p>c) Develop a PLC Ladder Program for the above case, simulate, interface with PLC and execute</p>	2	5
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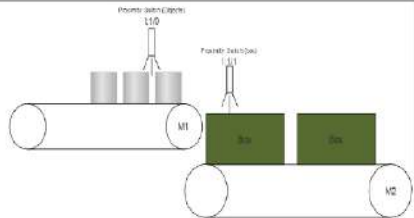
				d) Discuss the Applications of the above Case		
	3		4	Problem Statement: Potato chips are made and ready to be packed. But before that, it goes through a conveyor in which final quality check is done, burnt chips are detected and removed from the process line. Implement this in PLC using Ladder Diagram programming language	2	5

Diagram:**Condition:**

- To detect burned chips, light source and sensors are used.
- Light source is used so light detectors such as Light Dependent Resistors are used to detect the burned chips.
- Blowers are used to throw burned chips away from the conveyor when detected.
- There are total number of 8 blowers. Number of blowers to be used depends on the width of a conveyor belt.
- Time measurement of an event to take place can be used here to measure what time burned chips take to reach from light source to blowers when detected.
- Set this time as pre-set of a timer to operate particular blower.
- There are 8 blowers, so 8 light detecting circuits must be used in order to operate all blowers.
- Let us assume we are using Light Dependent Resistor. To use this resistor, threshold has to be set that is darkest color to be passed as a good quality product. If chips are darker than the desired level, light source detects it and activates corresponding circuit.
- So, output of this circuit is normally high and to activate blower, normally low logic has to be set while programming or we can even invert output from LDR circuit.

				Develop a PLC Ladder Program for the above case						
			5	CIE 3- Written and practice test				Assessment Review and corrective action		3
			6	Industry Class on Automation in process industry + Industry Assignment			5			
8	4		1	PEER Discussion on Industry Assignment		4		Concepts of Industrial Robots, Applications of Robotics, Types of robots, Configurations of robots – Articulated Robot, Polar configuration, SCARA, Cartesian Co-ordinate Robot, Delta Robot, Key Components of Robot.	3	
	4		2	Demonstrate Wrist configuration, Work Volume Degree of Freedom- Forward and Back, Up and Down, Left and Right, Pitch, Yaw, Roll, Joint Notation & Type of joints in robot- Linear Joint (L Joint), Orthogonal Joint (O Joint), Rotational Joint (R Joint), Twisting Joint (T Joint), Revolving Joint (V Joint)	2		2	End Effectors- Grippers, Tools, Types of grippers, Factors to be considered for Selecting a Gripper, Robotic Drives- Electric Drive, Pneumatic Drive, Hydraulic Drive	3	
	4		3	Demonstrate Robot Control systems- • Point- to Point control Systems • Continuous Path Control • Intelligent control • Controller Components • System Control	1		3	Present a Robotic Coordinate system using a robot • Joint co-ordinate system • Rectangular co-ordinate system • User or object coordinate system • Tool coordinate system. Steps to define user co-ordinate system. • Defining X, Y, Z co-ordinate system • Verifying co-ordinate system by multiple motion movements.	1	2
	4		4	Jogging Practice on robot with different coordinate systems					2	5
			5	Developmental Weekly Assessment				Assessment Review and corrective action		3
			6	Industry Class on interfacing of Robots with peripheral devices + Industry Assignment			5			
9	4		1	PEER Discussion on Industry Assignment				Introduction about Simulation software. Creating new model in Simulation Software.	1	2

						Importing different types of robots Identify the position variation in robots Perform Robot axis movements		
	4		2	Practice simple robot program using simulation software			2	5
	4		3	Practice simple robot program using simulation software			2	5
	4		4	Practice simple robot program using simulation software			2	5
			5	CIE 4- Written and practice test		Assessment Review and corrective action		3
			6	Industry Class on Robot Programming + Industry Assignment		5		
10	4		1	PEER Discussion on Industry Assignment	4	Develop a simple welding Robot program and simulate using suitable software.	1	2
	4		2	Develop a simple welding Robot program and simulate using suitable software			2	5
	4		3	Interface the above welding program with a Physical Robot Consider all required parameters and Tools and Execute the same. Perform Quality check			2	5
	4		4	Interface the above welding program with a Physical Robot Consider all required parameters and Tools and Execute the same.			2	5
			5	Developmental Weekly Assessment		Assessment Review and corrective action		3
			6	Industry Class on Robots in Welding + Industry Assignment		5		
11	4		1	PEER Discussion on Industry Assignment	4	Problem Statement: Objects are moving on a conveyor belt 1. When an empty box is detected, conveyor belt starts and 5pcs are packed in a box. When box is filled, it is carried to the storage area via conveyor belt 2. Integrate a robot with the system to pick the filled box from conveyor belt 2 and place it on a fork lift truck	1	2

							 <p>Develop and execute an Automated system for the above condition</p>		
	4		2	Develop and execute the above Automated system				2	5
	4		3	Develop and execute the above Automated system				2	5
			4	Develop and execute the above Automated system				2	5
			5	CIE 5- Written and practice test			Assessment Review and corrective action		3
			6	Industry Class on Robot for PICK and PLACE + Industry Assignment		5			
12	5		1	PEER Discussion on Industry Assignment	4		<ul style="list-style-type: none"> • Concepts of IIOT- How it works • How IIoT is Improving Operational Effectiveness Transforming Legacy Systems, Greater Energy Efficiency, Data Analytics Get Smarter, Cobots Bring Connected Support to Human workers, Digital Twins are Gaining Traction Among Enterprises 	1	2
	5		2	<ul style="list-style-type: none"> • Convergence of Operation Technology and Information Technology • Technologies which bring Convergence of OT and IT <ul style="list-style-type: none"> ➤ No code Application ➤ Digital Twins ➤ Augmented Reality ➤ Edge computing 	4		BENEFITS OF IIOT <ul style="list-style-type: none"> • Improving Inventory Management • Simplified process control • Cloud-Based Inventory Systems • Gain Supply Chain Visibility • Improves Product Design & Quality Controls 		3

							<ul style="list-style-type: none"> Real-Time Insights Provide Greater Business Agility Location Tracking Offers Surprising Cost Savings Reduced Downtime and Repair Costs via Predictive Maintenance, Safety and Compliance 			
	5		3	<ul style="list-style-type: none"> Risks and Challenges Associated with IIOT Security considerations for IIOT <ul style="list-style-type: none"> Cybersecurity challenge Potential Human Impact Murky Regulatory Guidance Data Management Interoperability challenges Cyber hacking IP Leakage Production Sabotage 	4		<ul style="list-style-type: none"> Concept of Artificial Intelligence (AI) Bringing the power of AI to the IOT <ul style="list-style-type: none"> Edge computing Collaborative robots (COBOTS) Digital twins Autonomous Delivery robots Selecting right IIOT platform and Partner 	3		
	5		4	<ul style="list-style-type: none"> Case study - IIoT with other emerging technologies 		4	<ul style="list-style-type: none"> Case study - IIoT with other emerging technologies 			3
	5		5	Developmental Weekly Assessment			Assessment Review and corrective action			3
	5		6	Industry Class on SCADA and IIOT in Automation + Industry Assignment		5				
13			1	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			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.			40 HRS

				personnel competence - including the areas of learning you expect to learn during internship	c) 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.	
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References:

- 1 Programmable logic Controllers by W. BOLTON
- 2 Digital electronics By FLYOD
- 3 Exploring PLC with applications By PRADEEP KUMAR SRIVATSAVA
- 4 Automation, Production systems and Computer integrated Manufacturing By MIKELL GROOVER
- 5 Sensors Hand book-SABRIE SOLOMAN-MC-GRAW HILL publications
- 6 Hand book of Modern Sensors, Physics, Designs and Applications- JACOB FRADEN-Springer Publications
- 7 Electric Motors and Drives BY AUSTIN HUGHES and BILL DRURY
- 8 Automating Manufacturing Systems with PLC by Hugh Jack
- 9 Thomas Braunl, Embedded Robotics: Mobile Robot Design and Application with Embedded Systems, 2nd ed., Springer, 2006.
- 10 John M. Holland, Designing Autonomous Mobil Robots: Inside the Mind of an Intelligent Machine, Newnes, 2003.
- 11 Springer Handbook of Automation by Shimon Y. N
- 12 Industrial Robotics technology, programming and Application by Mikelle P Groover
- 13 SCADA: Supervisory Control and Data Acquisition, Fourth Edition by A_Boyer
- 14 PLCs & SCADA - Theory and Practice First Edition, Kindle Edition by Rajesh Mehra and Vikrant Vij
- 15 The Internet of things by Samuel Greengard

16 Getting Started with Internet of Things by Cuno Pfister

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

CIE 2- Model Question Paper

Programme	Mechanical Engineering	Semester	V		
Course	Automation and Robotics	Max Marks	30		
Course Code	20ME51I	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.a)	The cutting area is an important section in the float glass production line, which includes many productions control equipment, such as longitudinal cutting, transverse cutting, conveying roller table, etc. The main control part of the whole system is PLC, and the monitoring will be undertaken by HMI. Is it required to use both HMI and PLC, As opposed to just a PLC in this Production line? Justify your statement.	L4	5		03
b)	In any manufacturing plant, motor plays a vital role. Controlling the speed of the motor according to the prerequisite is a requirement in any plant. If any problem occurs in a process which cannot be tackled by the operator, then error should be checked by the programmer. It is not compulsory that programmers should be present at the place to solve the issue. Henceforth, how do you Remotely control the speed of the Motor using HMI.	L3	5		07
2.a)	In a manufacturing plant, 3 different machines are to be controlled from a single location with real time information. Specific production data are to be gathered from ERP system. Similarly, equipment data and sensor information are also required for cloud-based analytics resulting in predictive maintenance. Discuss the hardware and Protocols of SCADA and suggest suitable solution to the case with justification	L4	5		04

b)	An oil industry is constantly having issues on Oil leakage. Constant monitoring was required to detect this issue and resolve to prevent accidents. Henceforth, the company decided to introduce Alarms. Device a method to detect Gas Leakage and to strike an Alarm on detection using HMI alarm.	L3	5		06
Section-2 (Practical) - 20 marks					
3)	One open tank is installed in the water plant in which liquid level is to be controlled. Develop a PLC Ladder Program for the following condition: a) When Level High is detected, outlet flow is allowed and inlet flow is blocked b) When Level Low is detected, Outlet flow is blocked and inlet flow is allowed until high level is achieved Also, Simulate the above case. Suggest PLC and protocols for the above case	L4	3		20
4)	In a Process industry, filled bottles are moved on the conveyor belt for packaging process. Device a PLC Ladder Diagram program to a) Pick one bottle after every 500 bottles for inspection. Simulate, interface with PLC and execute the above case.	L4	3		20

Note : Theory questions shall be aligned to practical questions

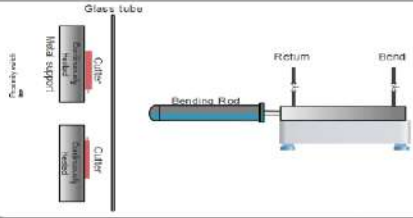
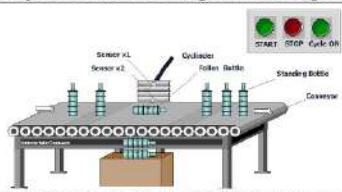
Scheme of Evaluation for Practical question- Section 2

Sl. No	Description	Marks: 20
1	Analyze the given Problem Statement	02
2	Selecting suitable sensor technology, PLC, Drives for the above case,	05
3	Develop and simulate PLC Ladder Program for the above case	05
4	Suggest/Interface with PLC and execute using suitable communication protocols	05
5	Execution of the same program for different boundary conditions	03
	Total	20

Assessment framework for SEE 1 (Theory)

Programme : Mechanical Engineering			Semester: V	
Course : Automation and Robotics			Max Marks: 100 Marks	
Course Code : 20ME51I			Duration: 3 Hrs	
Instruction to the Candidate: Answer one full question from each section.				
Q.No	Question	CL (L3/L4)	CO	Marks
Section-1				
1.a)	When a product is manufactured, there is always a start line and a finish line. The start line is where the raw materials enter the factory, and the finish line is where the final product is complete and ready to be shipped. A process turns the raw materials into the final finished product between the start and finish lines. This process can happen either manually or automatically. How does the automation affect the manufacturing? Can Automation be introduced at all levels? Justify your statement with examples	L4	1	10
b)	Virtually all industrial devices and processes are governed by standards to various degrees. Why are these standards important? Discuss standards established by IEC and ISO and their applications	L3		10
2.a)	Over many years, Sainsbury company was operating with the same supply chain and the IT system. These systems were outdated. Since they were created long before. So, the new firms in the market had started to overtake Sainsbury in terms of the market share since they had the recent technologies in supply chain. Hence, Sainsbury company decided to go for Automation. Provide an overview to Sainsbury company about various technologies and tools that are available for Automation. Suggest the best technology and tool that the company can adopt with justification	L4		10
b)	The modern and globalized world cannot exist without standards which are supporting cooperation, trade, health, safety, and economic growth etc. In fact, standards exist in almost all aspects of modern life. Highlight the importance of Automation Standards? List some Automation standards used and the role played by them?	L3		10
Section-2				

3.a)	An industrial control network is a system of interconnected equipment used to monitor and control physical equipment in industrial environments. Interconnection is achieved by adopting suitable automation protocols. Compare the protocols used in Automation based on their Application, Strengths and limitations.	L4	2	10
b)	Sensors can be found in almost everything we use on a day-to-day basis. According to the National Science Foundation, "incorporating new sensor technologies, manufacturers can bring new capabilities to their products while improving performance and efficiency. Discuss the sensor technologies used in automation with examples and application.	L3		10
4.a)	The development of newer technologies such as cloud computing, internet of things and cyber-physical systems has brought a new revolution to the manufacturing industry. Communication among devices is one of the key goals of Industry 4.0. One way of achieving this is by using PLC communication protocols. Discuss the features of these PLC communication protocols and their usage in the existing systems with a comparative analysis?	L4		10
b)	A local food and beverage company was working with Horizon Solutions on automation to upgrade projects for one of their key manufacturing facilities. One of the machines looked at upgrading was connected to a conveyor on the packing line. This machine merged three conveyor lines. Also, before packing, one among the lot had to pushed for inspection which is performed by actuators. Discuss different actuators available with their strength and limitations. Suggest a suitable actuator for the above case with justification.	L3		10
Section- 3				
5.a)	A beverage industry has to fill its bottle with beverages at a constant speed of filling 30 bottles per minute. This speed depends on level of the tank due to its head pressure. To maintain this speed, pressure head of the filling tank has to be maintained at a particular head. Suggest a) A Suitable sensor technology, PLC, Drives, Communication Protocol b) A PLC Ladder Program for the above case	L3	3	10
b)	Heated glass tubes are passing in a process line having a particular length which are to be bent. To manufacture fluorescent bulbs, these tubes are to be bent in U-Shape as shown in the diagram. Analyse the diagram and automate this process using Ladder Diagram programming language.	L4		10

				
6.a)	Heating of the liquid in the tank is to be performed. To heat this liquid, steam flow is controlled. If the temperature is detected less than the set point, increase the steam flow and vice-versa. Select a Suitable sensor technology, PLC, Drives, Communication Protocol Implement automation of this process in PLC using Ladder Diagram programming language.	L3		10
b)	 Analyse the above diagram. Automate the above process in PLC using Ladder Diagram Programming language	L4		10
Section-4				
7.a)	Picking and placing parts or assemblies is often a simple, repetitive, and monotonous task in most industrial manufacturing processes. Especially when it comes to moving large, small, or hard-to-handle parts, automating this function on the factory line with high-speed pick and place robots can provide many benefits to manufacturers. To utilise these benefits, the company has asked programmers to device a Pick and place robot program which will not only provide solution to their problem but also is cost effective. Write a program for the above case assuming the required criteria.	L4	4	10
b)	Inertia Switch company got the full benefits of automation by using effective Grippers in Robots. Discuss different Robot Grippers and Highlight the criteria considered in selection of right type of Robot grippers.	L3		10
8.a)	Pick and place robots used for inspection applications are equipped with advanced vision systems to pick up objects, detect variation and remove defective parts or items by placing them in a designated location. Device a Pick and place robot program for the above case. Assume the required criteria.	L4		10
b)	Develop a program to command a PUMA robot to unload a cylindrical part of 10 mm diameter from machine 1 positioned at point P1 and load the part on machine 2 positioned at P2. The speed of robot	L3		10

	motion is 40 in/s. However, because of safety precautions, the speed is reduced to 10 in/s while moving to a machine for an unloading or loading operation.			
Section-5				
9.a)	One of the key requirements for effective predictive maintenance is a vast quantity of historical and real-time data of machine operations. In the industry 3.0 era, when computers began running traditionally manual operations, this required regular collection and recording of operational data. This was a cumbersome task for the maintenance team. Does the convergence of OT and IT emerge as a solution to this problem? Justify. What is this convergence called? What are the risks and security challenges faced by this convergence?	L3	5	10
b)	Jeff Thornton, product manager at Red Lion Controls pointed five key facets of HMI technology that are changing the common perceptions of HMI. One among them is the protocol. Compare the HMI protocols available and suggest the best one with justification.	L4		10
10.a)	HMI Panel software uses virtual components called Objects. Meters and Graphs are part of these objects. These help in producing simple, human machine interfaces. Using HMI, how is the level of liquid in a container indicated in the form of Bar graphs.	L3		10
b)	With the fourth industrial revolution, Industry 4.0, the Internet of Things has become the hot topic for numerous latest technological development efforts. Although they are merely a subset of modern technologies that are used to improve business processes still, they have their benefits and hence is spreading its wings over the enterprise. Does the introduction of IIOT improve the operational effectiveness? Justify considering all parameters.	L4		10

Scheme of Evaluation for SEE 2

Sl. No	Description	Marks: 100
Problem statement	<p>Condition: A company is involved in supplying mineral water. They need to continuously meet the customer demand. Hence, have decide to Automate their entire unit. Following conditions were provided by the company</p> <ol style="list-style-type: none"> Bottles are to be filled at a constant speed of 30 bottles per min to meet the Demand. The bottles are to be capped and lifted from the conveyor belt and shifted to the packaging process. 200 bottles are to be packed in one carton during packaging. The cartons are to be labelled with the company's Tag. <p>Device a fully Automated system with Robots which will satisfy the company's requirement.</p>	
1	Analyze the given Problem Statement	10
2	Selecting suitable sensor technology for the above case,	10

3	Selecting suitable PLC for the above case	10
4	Selecting suitable Drives for the above case,	10
5	Develop and simulate PLC Ladder Program for the above case	20
6	Interface with PLC and execute using suitable communication protocols	30
7	Execution of the same program for different boundary conditions	10
Total		100