NAAN MUDHALVAN – POLYTECHNIC – ODD SEMESTER 2025-26

COURSE CURRICULUM

PLC PROGRAMMING AND APPLICATIONS

ABOUT THE COURSE

This course trains students in **practical skills related to PLC (Programmable Logic Controller) programming and HMI (Human-Machine Interface) design**. It focuses on essential concepts such as wiring, addressing, bit logic, structured programming, analog signal processing, and system integration using tools like SCADA.

COURSE NAME:	PLC Programming and Applications
TOTAL DURATION:	60 HRS
MODE OF DELIVERY	PHYSICAL CLASSROOM TRAINING AT RESPECTIVE COLLEGES
TRAINER TO STUDENT RATIO:	1:60
TOTAL MARKS:	70 (External) + 30 (Internal)

TABLE 1	
OVERALL COURSE OBJECTIVE	• Analyse the fundamentals of PLCs and their role in industrial automation, including hardware configuration and programming languages. • Develop and implement practical PLC applications involving wiring, addressing, and bit logic instructions. • Construct structured PLC programs using Function Blocks (FBs), Function Calls (FCs), and Data Blocks (DBs). • Design and operate HMI systems and SCADA solutions for real-time control and monitoring. • Integrate analogue signal processing and Industry 4.0 communication protocols for smart manufacturing applications.
LEARNING OUTCOME	• Configuration of PLC and I/O interface. • Program the PLC using bit logic, timer and controls. • Implement PLC Applications using Digital and Analog I/O. • Design SCADA systems and apply Industry 4.0 protocols for smart manufacturing.

TABLE 2: MODULE-WISE COURSE CONTENT AND OUTCOME				
SL.NO	**MODULE NAME**	**MODULE CONTENT**	**MODULE LEARNING OUTCOME**	**DURATION (HRS)**
1.	Introduction to PLC	- Introduction and Classification of Automation - Introduction to PLC and Programming Languages - PLC CPU & Hardware	Understand the basics of automation, PLC roles, classifications, and hardware components.	8 hours
2.	HMI Design Software	- PLC wiring and addressing - HMI Design software and different views - Commissioning of S7-1200: Practical tasks	Acquire practical skills in wiring, addressing, and using HMI design software for PLC commissioning tasks.	10 hours
3.	PLC Communication	- Bit logic instructions and hands-on practice - Structured Programming (FB, FC, DB) - Analog signal processing	Apply bit logic and structured programming techniques and process analog signals effectively through hands-on practice.	10 hours
4.	HMI Interfacing	- Introduction, Commissioning, and Interfacing of HMI - Interfacing PLC Programs with HMI using Tags - Alarms - Recipe - User Administration	Demonstrate the ability to interface PLC programs with HMI, configure alarms, manage recipes, and handle user administration.	8 hours
5.	Advanced PLC Communication	- Advanced PLC Communication using HMI Design software - Integrating PLC with	Develop advanced skills in PLC communication, SCADA system integration, and explore IoT protocols	9 hours

		SCADA Systems and IoT communication - Practical Applications and Case Studies	through practical examples.	

TABLE 3: OVERALL COURSE LEARNING OUTCOME ASSESSMENT CRITERIA AND USECASES		
LEARNING OUTCOME	**ASSESSMENT CRITERIA**	**USECASES**
Automation and PLC Programming	- Explain automation types and applications. - Identify PLC components and their functions.	**Use Case 1: Automation in Manufacturing** Scenario: A manufacturing company wants to automate its production line using PLCs. Task: Students must analyse the production process, classify automation levels, and identify the PLC components required for the system.
PLC wiring, addressing, and commissioning using HMI software.	- Demonstrate PLC wiring and addressing. - Perform basic commissioning of an S7-1200 PLC.	**Use Case 2: Wiring and Commissioning of Robotic Arm** Scenario: A robotics company needs to set up and commission a robotic arm for assembly tasks. Task: Students must wire the PLC, assign addresses, and use HMI design software to commission the robotic arm.
Implement bit logic, structured programming, and analog signal processing through practical tasks.	- Write and debug bit logic programs. - Use FB, FC, and DB effectively. - Process analog signals.	Use Case 3: Automated Water Pump Control Scenario: A water treatment facility requires automation for its pumping system to regulate flow and pressure. Task: Students must develop a PLC program using bit logic and structured programming and integrate analog sensors to monitor flow and pressure
Interface PLC programs with HMI to configure tags,	- Configure HMI tags and alarms. - Manage recipes and user roles in HMI.	**Use Case 4: HMI Setup for Chemical Processing** Scenario: A chemical plant requires an HMI system to

alarms, recipes, and user administration.		monitor and control temperature and pressure during reactions. Task: Students must interface PLC programs with HMI, configure alarms for critical thresholds, and manage operator roles through user administration.
Integrate PLCs with SCADA and IoT protocols for smart manufacturing solutions.	- Design and implement advanced PLC communication. - Demonstrate SCADA system integration.	**Use Case 5: IoT-Enabled Predictive Maintenance** Scenario: A factory wants to integrate predictive maintenance using IoT protocols and SCADA for real-time monitoring. Task: Students must establish PLC-SCADA communication, implement IoT protocols, and design a system for monitoring machine health.

TABLE 4: LIST OF FINAL PROJECTS (20 PROJECTS THAT COMPREHENSIVELY COVER ALL THE LEARNING OUTCOME)	
SL.NO	**FINAL PROJECT** **(The Training Partner shall cover all the steps to complete a given project)**
1.	**Basic Conveyor Belt Control:** Task 1: Design a ladder diagram to start and stop a conveyor belt using a push button. Task 2: Implement a sensor to detect the presence of an item on the conveyor. Task 3: Stop the conveyor when the item reaches the end using a proximity sensor. Task 4: Add an emergency stop button for safety purposes. Task 5: Test the system for correct item detection and conveyor operation.
2.	**Traffic Light Control:** Task 1: Create a ladder diagram to control traffic lights for a 4-way intersection. Task 2: Implement timers to switch between red, yellow, and green lights. Task 3: Ensure green lights alternate for each direction with time delays. Task 4: Integrate pedestrian crossing signal control. Task 5: Test the system for proper traffic light switching and timing.
3.	**Water Pump Control:** Task 1: Design a ladder diagram to start and stop a water pump based on water level sensors.

	Task 2: Use high and low-level sensors to control the pump operation. Task 3: Set up an alarm if the water level is too high or low. Task 4: Add manual override control for pump operation. Task 5: Test the water level control system with varying sensor inputs
4.	**Temperature Monitoring System:** Task 1: Design a ladder diagram to monitor temperature with a sensor input. Task 2: Implement a control output to activate a cooling system when the temperature exceeds a set point. Task 3: Use an analog sensor for continuous temperature measurement. Task 4: Set up an alarm when the temperature exceeds the safety limit. Task 5: Test the system for correct temperature control and alarm activation.
5.	**Automatic Door System:** Task 1: Create a ladder diagram to open and close a sliding door using motion sensors. Task 2: Integrate a push button for manual door control. Task 3: Add a delay function for door closure after no motion is detected. Task 4: Set up a safety sensor to prevent door closing when an obstruction is detected. Task 5: Test the door system for proper operation and safety**.**
6.	**Simple Elevator Control:** Task 1: Design a ladder diagram to control an elevator with floor selection buttons. Task 2: Implement floor sensors to detect the elevator's position. Task 3: Add a door open/close control for each floor. Task 4: Integrate an overload sensor to prevent operation if the elevator is overloaded. Task 5: Test the elevator system for correct floor selection and door operation
7.	**Automatic Washing Machine:** Task 1: Create a ladder diagram to control the washing machine cycle using a start/stop button. Task 2: Implement timers for washing, rinsing, and spinning phases. Task 3: Use water level sensors to control water intake. Task 4: Add a door lock function during the wash cycle for safety. Task 5: Test the washing machine system for cycle completion and water control.
8.	**Level Control in Tank:** Task 1: Design a ladder diagram to maintain a constant water level in a tank. Task 2: Implement high and low-level sensors for tank monitoring. Task 3: Use a valve control to add or release water based on sensor input.

	Task 4: Add an alarm if the water level exceeds the safe range. Task 5: Test the system for accurate water level maintenance**.**
9.	**Basic Alarm System:** Task 1: Create a ladder diagram to monitor a sensor for fault detection. Task 2: Set up an alarm to activate when a fault is detected. Task 3: Add a reset button to deactivate the alarm. Task 4: Integrate a delay function for the alarm response. Task 5: Test the alarm system with simulated faults.
10.	**Bottle Filling System:** Task 1: Design a PLC program to control a bottle filling process using sensors. Task 2: Implement a level sensor to stop the filling process once the bottle is full. Task 3: Add a conveyor system to move bottles to and from the filling station. Task 4: Integrate a valve control for the liquid flow. Task 5: Test the filling system for accurate bottle filling and sensor operation.
11.	**Automated Sorting System:** Task 1: Create a PLC program to sort items on a conveyor belt using optical sensors. Task 2: Set up pneumatic actuators to divert items to different chutes. Task 3: Implement a control for different sorting criteria (size, color, etc.). Task 4: Add a stop function to halt the system in case of an error. Task 5: Test the sorting system for proper item detection and sorting.
12.	**Elevator with Multiple Floors:** Task 1: Design a PLC ladder diagram to control an elevator with multiple floors. Task 2: Implement floor selection buttons and position sensors. Task 3: Integrate door open/close control for each floor. Task 4: Add an emergency stop button to halt the elevator. Task 5: Test the elevator system for correct operation on all floors.
13.	**Air Conditioning System Control:** Task 1: Create a PLC program to control an air conditioning system based on temperature sensors. Task 2: Implement a control output to turn the AC on or off based on the temperature setpoint. Task 3: Add a timer to limit the duration of the air conditioning cycle. Task 4: Integrate a humidity sensor to control air quality. Task 5: Test the system for temperature and humidity control.
14.	**Automated Greenhouse System:** Task 1: Design a PLC program to control the environment in a greenhouse (temperature, humidity). Task 2: Implement sensors to measure temperature and humidity levels. Task 3: Use actuators to control fans and heating systems.

	Task 4: Set up an alarm if environmental conditions fall outside the desired range. Task 5: Test the greenhouse system for proper environmental control.
15.	**Smart Lighting System:** Task 1: Create a PLC program to control lighting based on motion detection. Task 2: Integrate a timer to turn lights off after a set period of no motion. Task 3: Use a light sensor to adjust lighting levels according to ambient light. Task 4: Implement manual override switches for user control. Task 5: Test the lighting system for motion detection and automatic dimming
16.	**Advanced Bottle Capping System:** Task 1: Design a PLC program to control a bottle capping machine. Task 2: Use a sensor to detect if the bottle is properly positioned for capping. Task 3: Control the capping mechanism based on sensor feedback. Task 4: Add a reject mechanism for misaligned bottles. Task 5: Test the system for correct capping and rejection.
17.	**Robotic Arm Control:** Task 1: Create a PLC program to control the movements of a robotic arm. Task 2: Implement position sensors to track the arm's location. Task 3: Integrate motor controls for different arm movements (rotate, lift, etc.). Task 4: Add an emergency stop function for safety. Task 5: Test the robotic arm's accuracy and safety functions.
18.	**Automated Packaging System:** Task 1: Design a PLC program to automate the packaging process using a conveyor system. Task 2: Control the flow of products onto a packaging station using sensors. Task 3: Integrate a sealing mechanism to close packages automatically. Task 4: Add a quality control station to check package integrity. Task 5: Test the system for correct packaging and sealing.
19.	**Automated Parking System:** Task 1: Create a PLC program to control an automated parking system. Task 2: Implement sensors to detect available parking spaces. Task 3: Use a conveyor or automated guided vehicle (AGV) to park cars. Task 4: Integrate a payment system and exit control. Task 5: Test the system for parking accuracy and space management
20.	**Smart Factory Automation:** Task 1: Design a PLC program for a smart factory automation system with multiple production lines.

	Task 2: Integrate sensors to monitor machine status and product quality. Task 3: Implement automatic material handling using conveyors and AGVs. Task 4: Add a data logging system for production and maintenance reports. Task 5: Test the entire automation system for seamless integration and operation.

TABLE 5: COURSE ASSESSMENT RUBRICS (TOTAL MARKS: 70)

ASSESSMENT CRITERIA	DESCRIBE THE CRITERIA OF THE BELOW CATEGORY PERFORMANCE			TOTAL MARKS
	FAIR	GOOD	EXCELLENT	
1. Demonstrate PLC wiring and addressing	Wiring and addressing are partially correct	Wiring is correct but addressing is incomplete	Wiring and addressing are complete and error-free	15
2. Perform commissioning tasks using S7-1200.	Partial commissioning with errors	Commissioning is mostly correct but lacks validation	Commissioning is complete, validated, and documented	15
3. Write and debug bit logic programs.	Basic program with limited functionality	Mostly functional program with minor debugging issues	Fully functional program, debugged, and optimized	15
4. Configure HMI tags and alarms.	Few tags/alarms configured with errors	Most tags/alarms configured correctly	All tags/alarms configured perfectly with example	15
5. Design and implement advanced PLC communication	Limited communication design with errors	Effective communication design with minor gaps	Advanced communication with SCADA and IoT integration	10
Total				**70**