

**INDUSTRIAL AUTOMATION**

**EE / EEE**

**SEMESTER – FIFTH**

***These important questions have been prepared using your previous exam papers (PYQs), verified concepts, and additional reference from trusted online academic sources. For deeper understanding, please refer your class notes as well.***

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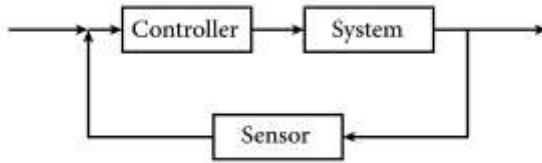
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**Part A: HIGH & LONG IMPORTANT QUESTIONS**

**Unit 1: Introduction to Automation & Control Systems**

1. Define Industrial Automation. Explain in detail the necessity and primary advantages (such as increased productivity, quality improvement, enhanced safety, and flexibility) of automation in modern industries.
2. Compare and contrast Open-Loop and Closed-Loop Control Systems. Explain the complete working principle of a closed-loop feedback system with a neat block diagram



and suitable industrial examples.

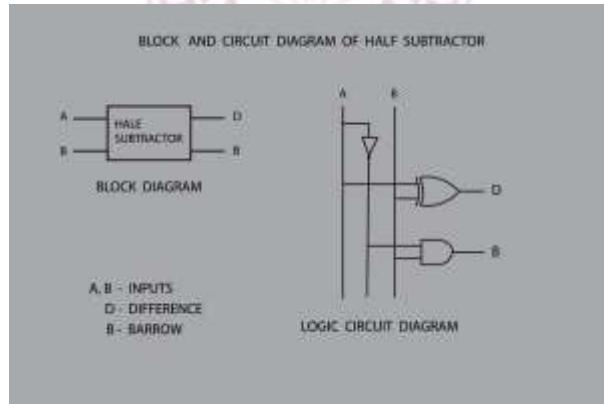
3. Describe the different levels or hierarchy of Industrial Automation (from Field Level to Enterprise Level). Illustrate this structure using a clear organizational block diagram .

**Unit 2 & 3: PLC Programming and Hardware**

4. Explain the Five Critical Steps involved in PLC Program Development (e.g., Define Task, Define I/O, Develop Logical Sequence, etc.). Describe the importance of the input/output (I/O) definition and logical sequencing phases in detail.
5. Describe the structure, parameters, and functionality of various Timer Instructions used in PLCs. Specifically, explain the working of **On-Delay Timer**, **Off-Delay Timer**, and **Retentive On-Delay Timer**.
6. Discuss the key criteria (Selection Criteria) that must be considered when selecting a suitable PLC for a specific industrial application. Briefly compare the different types and brands of PLCs available.
7. What are the necessary safety precautions that must be followed during the physical installation of a PLC system? Explain the system's power requirements, and the essential roles of safety circuitry like Emergency Stop (E-Stop) and Master Control Relay (MCR).
8. Write a detailed note on the common causes of PLC failure and the classification of faults (Hardware vs. Software Faults). Describe the troubleshooting resources and step-by-step procedures for diagnosing and resolving a hardware fault in a PLC system.

#### **Unit 4 & 5: Drives and Motion Control**

9. Describe the main building blocks and the complete working principle of Variable Frequency Drives (VFDs)



- . Explain the concept of V/F control and detail the industrial advantages of using VFDs for AC motor speed regulation.
10. Explain the fundamentals of Servo Motors and their application in precise motion control systems. Differentiate between Servo Drives and general AC Drives based on their operation, feedback mechanism, and typical application areas.

## **Unit 9 & 10: SCADA and Industrial Networking**

11. What is SCADA (Supervisory Control and Data Acquisition)? Explain its core objectives, primary functions (e.g., Data Acquisition, Control, Alarms), and key applications in real-time monitoring and control.
12. Describe the SCADA hardware components, focusing specifically on the functions, hardware, and software of Remote Terminal Units (RTUs). Clearly distinguish and explain the primary functional differences between an RTU and a PLC.
13. Explain the necessity of Industrial Networking. Describe the different networking architecture types (e.g., Ring, Bus, Star) and topologies used in automation systems .
14. Write a comparative note on three major Industrial Communication Protocols (e.g., Modbus, Profibus, and Industrial Ethernet) detailing their usage, speed, and typical application in a Master-Slave configuration.
15. Describe the specifications and industry interfaces of Color Touch Screen HMI panels. Explain how security features, such as user groups and authentication, are implemented to restrict access and control commands.

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### **Part B: IMPORTANT & SHORT QUESTIONS (Expected Probability: 60–70%)**

*(Answer briefly. Focus on definitions, short comparisons, and basic theory.)*

1. State the purpose of the Set (S) and Reset (R) Bit Logic Instructions.
2. What are the advantages of using PLC over traditional relay logic?
3. Distinguish between Count Up (CTU) and Count Down (CTD) instructions in PLC programming.
4. Explain the function of any two PLC Comparison Instructions (like EQU, GRT, or LIM).
5. What are the roles of Isolation Transformers and SMPS in a PLC setup?
6. List the common causes of PLC failure related to the operating environment.
7. What is the importance of wire size and cable labelling during PLC I/O installation?
8. What are the torque/current vs. frequency characteristics of VFDs?
9. List three commonly used communication standards and protocols in industrial drives.
10. Define the role of the Master Terminal Unit (MTU) in a SCADA system.
11. What is the significance of the OSI model in industrial networking?
12. List the widely-used open software (e.g., Citect, Wonderware) used for SCADA applications.
13. What is the function of Remote I/O units?
14. Briefly explain the purpose of Tag Logging and Command Execution in HMI systems.

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15. How does IIoT (Industrial IoT) differ from consumer IoT?
16. Give a brief introduction to the basic components used in pneumatic systems.

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## **Part C: “AA BHI SAKTA HAI” QUESTIONS (Expected Probability: 20–30%)**

*(Attempt if time permits. Covers new, rare, or conceptually extended topics.)*

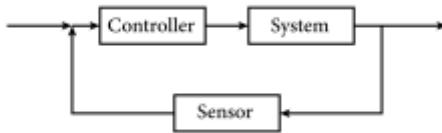
1. Explain the difference between Increment and Decrement Math Instructions in a PLC.
2. Describe the elements of a logic panel (like DIN rail, Cable channel, Contactor, and Terminal).
3. How is the process of Static I/O check carried out during PLC start-up?
4. What is meant by Constant Flux Density control in AC motor speed regulation?
5. Explain the necessity of using communication cables and adapters for fault diagnosis in communication modules.
6. Briefly describe the application of IoT technologies in the Electric Power Industry.
7. How is Basic Report Generation carried out in a SCADA system when interfacing with Analog Alarms?
8. Describe the basic operation and standards of Remote Terminal Units (RTUs).

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## QUICK REVISE

### **UNIT 1: Introduction to Automation & Control Systems**

- **Automation Necessity:** Improves quality, productivity, safety, and operational efficiency; reduces cost.
- **Automation Types:** Fixed, Programmable, and Flexible.
- **Automation Hierarchy:** A vertical structure (Field -->Control -->Supervisory -->Enterprise Level).
- **Open-Loop System:** Output has **no influence** on the control action (No feedback). Simple and cheap.
- **Closed-Loop System:** Uses **feedback** to compare output with setpoint; minimizes error. Complex and accurate.



- **Process Control Components:** Sensor, Transmitter, Controller (PLC), and Final Control Element (Actuator).

## UNIT 2: PLC Advanced Instructions (Part 1 - Logic & Time)

- **Bit Logic (S/R):** Set (S) and Reset (R) instructions are used for latching/unlatching outputs, acting as a simple memory function.
- **Latching/Seal-In Logic:** A circuit using the output's contact to maintain the power path, keeping the coil energized even after the momentary start input is removed.
- **TON (On-Delay Timer):** Starts timing when the input is TRUE; turns output ON after the preset time (PT) expires.
- **TOF (Off-Delay Timer):** Starts timing when the input goes FALSE; turns output OFF after the preset time (PT) expires.
- **RTO (Retentive On-Delay Timer):** Retains the accumulated time (ACC) even if the input signal goes FALSE. Requires a separate RESET instruction.
- **CTU (Count Up) / CTD (Count Down):** Used to count input pulses; CTU counts to a preset value (PV), CTD counts down from a PV.

## UNIT 3: PLC Advanced Instructions (Part 2 - Data & Control)

- **Comparison Instructions:** EQU (Equal), NEQ (Not Equal), LES (Less Than), GRT (Greater Than), LIM (Limit Test). Used to execute logic based on data comparisons (e.g., check if temperature is within limits).
- **Math Instructions:** Simple operations like **Multiply**, **Divide**, **Increment**, **Decrement**. Used for scaling or basic calculations on data registers.
- **MOVE Instruction:** Transfers data from a Source memory location to a Destination memory location.
- **Masked MOVE:** Allows only specific bits of the Source word to be transferred to the Destination word, based on a Mask value.
- **PLC Program Development Steps:** 1. Define Task, 2. Define I/O, 3. Develop Logical Sequence, 4. Develop Program, 5. Test/Debug.

## UNIT 4: PLC Hardware, Selection & Installation

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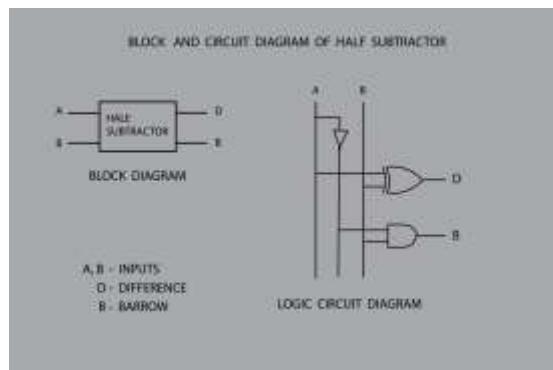
- **Selection Criteria:** I/O point count (digital/analog), memory size, scan time requirement, communication ports, environmental rating, and cost.
- **Installation Safety:** Requires proper grounding, use of Isolation Transformers, proper routing (separation of AC/DC wires), and secure mounting on a DIN rail.
- **Safety Circuitry: E-Stop** (Emergency Stop) and **MCR** (Master Control Relay) are crucial for immediate, hardwired system shutdown.
- **I/O Installation:** Use correct wire size, proper termination, wire labelling, and cable bundling (to reduce noise).

## **UNIT 5: PLC Troubleshooting**

- **Fault Causes:** Environmental (temperature, humidity, noise), Hardware failure (power supply, CPU, I/O module), and Software errors (logic, program bugs).
- **Fault Classification:** Hardware Faults vs. Software Faults.
- **Troubleshooting Resources:** Diagnostic indicators (LEDs), software monitors, and diagnostic screens.
- **Preventive Maintenance:** Scheduled checks, cleaning, replacing worn components (e.g., battery), and maintaining a spare parts inventory.
- **Start-Up Procedure:** Includes **Static I/O Check** (verifying wiring) and **Dynamic Checkout** (testing logic).

## **UNIT 6: Variable Frequency Drives (VFD)**

- **Function:** Controls the speed of AC induction motors by varying the output voltage and frequency.
- **Working Principle:** AC -->DC (Rectifier) -->DC Link -->DC -->Variable AC (Inverter).



- **V/f Control:** Keeps the ratio of Voltage (V) to Frequency (f) constant to maintain **Constant Flux Density**, which ensures constant torque up to the base speed.
- **Sizing of VFD:** Depends on motor horsepower/kW, load type (constant/variable torque), and required overload capacity.
- **Applications:** Pumps, fans, conveyors, and any system requiring variable speed or controlled acceleration/deceleration.

## **UNIT 7: Servo Motors & Communication in Drives**

- **Servo Motors:** Used for precise **motion control** (position, velocity, torque) due to fast response and closed-loop feedback (via encoder/resolver).
- **Servo vs. AC Drives:** Servo systems are inherently closed-loop and highly dynamic; AC VFD systems are typically open-loop or basic V/f control for speed regulation.
- **Communication Protocols in Drives:** Used for control and monitoring (e.g., setting speed, reading motor current) over a network (e.g., Modbus, Profibus).

## **UNIT 8: Human Machine Interface (HMI)**

- **HMI Function:** Provides a graphical interface between the operator and the control system (PLC/SCADA).
- **Features:** Color touch screens, graphical display of process variables, alarm management, historical trending, and recipe management.
- **Security:** Implemented using **User Groups** and **Authentication** (passwords) to restrict access to critical functions (e.g., command execution, configuration).
- **Troubleshooting:** Primarily involves checking the physical communication link (cable) and ensuring correct protocol settings between HMI and PLC.

## **UNIT 9: Industrial Communication Protocols & Networking**

- **Networking Need:** To integrate PLCs, HMIs, VFDs, and SCADA for data exchange and distributed control.
- **Networking Architecture/Topology:** Bus, Ring, Star, Mesh.
- **OSI Model:** A standard framework for understanding network communication (7 layers).
- **Protocols:**
  - **Modbus:** Simple, widely used, Master-Slave protocol.
  - **Profibus:** High-speed, commonly used in factory automation.
  - **Industrial Ethernet:** High bandwidth, uses standard TCP/IP framework.

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- **RTU (Remote Terminal Unit):** Specialized device for monitoring and control in large, geographically spread systems (e.g., pipelines).

### **UNIT 10: SCADA Systems and IIoT**

- **SCADA (Supervisory Control and Data Acquisition):** Centralized system for remote monitoring and supervisory control of large-scale processes.
- **SCADA Objectives:** Real-time monitoring, data acquisition, alarm logging, and historical reporting.
- **SCADA Hardware:** MTU (Master Terminal Unit) and RTU (Remote Terminal Unit).
- **SCADA Software/Protocols:** DNP3, IEC60870, HDLC, Modbus.
- **RTU vs. PLC:** RTU focuses on wide-area data collection and slower, scheduled communication; PLC focuses on high-speed deterministic local control.
- **IIoT (Industrial IoT):** Application of IoT principles (sensors, connectivity, data analytics) to industrial processes for predictive maintenance and optimization.
- **IIoT Applications:** Smart energy metering, remote asset monitoring, and predictive failure analysis.

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