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Industrial Automation & MES — Complete Syllabus (Open Elective-3, Option 3)

BTEUP Diploma in Electronics Engineering • 5th Semester • Session 2026-27

Subject 5.6.3 — Open Elective-3, Option 3 (Practicum) • Qualifying (Q) • 2 Credits • L 1 - P 3 • Choose this OR AI & ML OR IoT

Note: The PDF gives this subject as 8 numbered topic sections (not 5 units), with no unit-wise periods, no marks-distribution table and no reference-books list — so periods, weightages and books are not shown. The 5.6 scheme row is shared by all three Open Elective-3 options.

Examination Scheme

Code	Paper	Type	L - P	Credits	Internal	External	Total
5.6.3	Open Elective-3: Industrial Automation & MES	Practicum (Q)	1 - 3	2	50	—	N/A (Q)
Industrial Automation & MES Total				2	50	—	N/A (Q)

What This Subject Aims To Do

To provide a comprehensive understanding and hands-on experience of Industrial Automation and Manufacturing Execution Systems (MES) — PLC, SCADA, HMI, Variable Frequency Drives (VFD) and MES, integrated into cohesive, efficient systems — with the latest software and hardware tools, in line with industry standards.

Unit-Wise Complete Topic List

Note: no marks-distribution table is given for this subject in the official syllabus, so unit weightages are not shown.

Section 1 — Industrial Safety Practices

Topics: Fire Extinguishers & its Types; Safely handling Tools & Equipment; Use of proper Tools & Equipment & its maintenance; OSH & practices to be observed as a precaution

In simple words: Workshop safety: fire extinguishers, correct tool use and occupational safety and health.

Section 2 — Fundamentals of Industrial Automation

Topics: Introduction to industrial automation; Need and application of automation; Benefits of automation; Types of Industrial automation; Important Components of Automation; Discrete, Continuous and Batch Manufacturing; Open-loop vs. Closed-loop systems; Introduction to PLC, HMI, VFD, SCADA, MES; Industrial sensors: types and applications; Actuators: motors, valves, pneumatics; Signal conditioning and A/D conversion; Process variables: temperature, pressure, flow, level; PID control and its applications; Control panel components and wiring standards; Industrial communication protocols

In simple words: Why factories automate: the types of manufacturing, the main components (PLC, HMI, VFD, SCADA, MES), sensors and actuators, PID control, and industrial communication.

Section 3 — Programmable Logic Controller (PLC)

Topics: Introduction to Programmable Logic Controller (PLC); Types of PLCs and selection criteria; Application and advantages of PLC; Important components of PLC; Numbering systems: binary, hexadecimal, BCD; PLC memory organization and addressing; Explain sink and source concept; Interfacing of PLC with field devices; PLC communication protocols: Modbus, Profibus, ethernet/IP; Types of PLC programming; Ladder logic programming basics; Conditional logic: AND, OR, NOT, NAND, NOR XOR, XNOR Gates; Timers and counters in PLC; Explain advance instruction used in PLC; Fault handling and troubleshooting in PLCs; Industrial case study of PLC.

In simple words: The PLC: its types, memory and addressing, ladder-logic programming, timers and counters, communication protocols, and troubleshooting.

Section 4 — Variable Frequency Drive (VFD)

Topics: Introduction to Variable Frequency Drive (VFD); Basics of AC motors; Application of VFD; Components of a VFD: rectifier, DC bus, inverter; Types of VFDs: scalar control vs. vector control; Connections and control mechanism; VFD parameter configuration and settings; Study motor protection and overload prevention; Understand energy efficiency optimization using VFD; Troubleshooting and fault diagnosis in VFDs; Regenerative braking and energy recovery in VFD; Learn Modbus and ethernet communication for VFDs; Industry applications of VFD in HVAC, pumps, and conveyors; Case study: VFD implementation for smart energy saving; Interfacing of VFD with PLC & SCADA.

In simple words: Variable frequency drives: how they control AC motor speed, their components and settings, energy saving, and interfacing with PLC and SCADA.

Section 5 — Human Machine Interface

Topics: Introduction to HMI; Role of HMI in industrial automation; Components of HMI; Compare HMI and SCADA; Communication protocols in HMI; User interface of HMI software; Building basic HMI control animations; Alarms and event logging; Security and user access management; Multi-screen navigation in HMI systems; Study trending and historical data logging; Communication between HMI and PLC; SCADA-HMI integration; Troubleshooting common issues in HMI; Industrial case study: HMI in production line

In simple words: HMI screens: building operator interfaces with buttons, indicators, alarms and trends, and connecting them to PLCs and SCADA.

Section 6 — Supervisory Control and Data Acquisition (SCADA)

Topics: Introduction to Supervisory Control and Data Acquisition (SCADA); Application and advantages of SCADA; Important components of SCADA; Block diagram of SCADA; SCADA communication protocols; Types of tags and its usage; Explore the features of SCADA; User interface of SCADA software; Building basic SCADA screens with animation; Dynamic properties like sizing, location, blinking, visibility, percentage filling, object size, orientation, etc.; Alarm management and event logging in SCADA; Historical data logging and trending in SCADA; Recipe management; Script programming; Security options and administrative levels in SCADA; Explore data transfer feature in SCADA software; SCADA and PLC interfacing for real-time control; Troubleshooting and fault detection; Role of SCADA in industry 4.0 and IIoT; SCADA applications in water treatment, energy, and manufacturing.

In simple words: SCADA: supervising whole plants from a control room — screens, alarms, trends, recipes, security, and its role in Industry 4.0 and IIoT.

Section 7 — Flexible Manufacturing System (FMS)

Topics: Introduction to FMS and its importance in modern manufacturing; Important Components of FMS, Advantages and Disadvantages of FMS; Applications of Pneumatics in Manufacturing; Use of Machine Vision, important components, sorting application; Pick and Place concept and its important components

In simple words: Flexible manufacturing systems: their components and advantages, pneumatics, machine vision for sorting, and pick-and-place.

Section 8 — Overview of Manufacturing Execution Systems (MES)

Topics: Introduction to manufacturing execution systems (MES); ISA 88 AND ISA 95; MES architecture and MES core functionalities; Key functions of MES: production scheduling, quality control, tracking; MES data flow and communication protocols; Real-time work order management in MES; Resource allocation via MES; MES reporting and dashboards for production insights; Barcode integration for MES automation; Exploring MES and industry 4.0: digital twin and smart manufacturing; Case study: MES implementation in a smart factory.

In simple words: MES: the software layer that tracks raw material to finished goods — scheduling, quality control, work orders, dashboards, barcodes, and the digital twin.

Practical Work

- Explain different safety tools & Kits, Hazard identification & avoidance, proper waste management.
- Demonstrate various components of the automation simulator panel.
- Demonstrate signal measurement using Multimeter.
- Identifying and testing of different type of sensors.
- Demonstrate wiring and testing of various output devices.
- Show on-off control using relays.
- Test Emergency stop and safety interlock.
- Decode alarm and status indications.
- Configuring and opening PLC programming software.
- Use of basic commands and instructions.
- Demonstrate XIC, XIO, coil and addressing concept.
- Interfacing digital I/O with PLC.
- Configuring analog, I/O with PLC.
- Writing basic ladder logic programs.
- Implementing start-stop logic using push buttons.
- Design logic gates concept using ladder diagram.

- Design and practice various real time scenarios.
- Configuring and programming timers and counters.
- Create various programs based on timer's application.
- Create various programs based on timer, counter and comparators.
- Design a PLC program to execute the elevator system in a 3-floor apartment.
- Troubleshooting faulty I/O modules in a PLC system.
- Programming safety interlocks for emergency shutdown.
- Demonstration of buttons/keys present on VFD.
- Configuring basic VFD parameters for motor speed control.
- Implementing start/stop and forward/reverse operation.
- Adjusting acceleration and deceleration ramp times.
- Interfacing VFD with PLC for automated speed control.
- Implementing emergency stop and safety interlocks.
- Analysing VFD faults and troubleshooting issues.
- Opening the HMI programming software.
- Designing HMI screens with buttons and indicators.
- Configuring alarms and event logging in HMI.
- Setting up data entry fields in HMI for operator input.
- Creating HMI screens for tank level monitoring.
- Implementing multi-screen navigation and setting up trends in HMI.
- Integration of HMI with PLC.
- Debugging HMI-PLC communication issues.
- Demonstrate the SCADA software interface.
- Design program for a switch and a lamp and check out results in runtime.
- Designing start/stop control for pumps and motors via SCADA.
- Configuring alarm management system with alerts.
- Logging and retrieving historical data for analysis.
- Creating live graphs and trend displays for process monitoring.
- Interfacing SCADA with PLC, HMI and VFD for motor control applications.
- Implementing data export and report generation in SCADA.
- Using SCADA for batch processing and recipe management.
- Designing a SCADA simulation for a smart dashboard energy monitoring system.
- Integrate pneumatic systems, sorting, and pick and place.
- Configuring MES software for the first time.
- Setting up work order tracking in MES.
- Implementing barcode/RFIDs-based inventory management.
- Creating automated production reports using MES dashboards.
- Setting up automated work scheduling for assembly line operations.

- Demonstrate integration of MES with PLC for process automation.
- Setting up role-based user access for MES data security.
- Identify and resolve common issues in the MES assembly line like communication failure, alarms, equipment malfunction and data irregularity.

Reference Books

Reference books are not listed for this subject in the official syllabus.

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Source: BTEUP 3rd Year curriculum (folder2627), approved in C.D.C. meeting held on 16.07.2026. Topic lists follow the official syllabus; short explanations are the author's own plain-English summaries, not syllabus text.

Please confirm with your own polytechnic for any local changes.

