



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Electrical Engineering

Subject Code: DI04009041

Course / Subject Name: Electrical Control Panels

w. e. f. Academic Year:	2025-26
Semester:	4 th
Category of the Course:	Professional Elective - II

Prerequisite:	Students should have basic knowledge of electrical circuits, machines, and control principles, along with understanding of protective devices, wiring practices, and safety procedures. Familiarity with electrical drawings and standard symbols will help in learning panel wiring and control logic effectively
Rationale:	This subject aims to prepare diploma electrical engineering students with practical and theoretical knowledge of industrial control systems used in power distribution, motor control, protection, and automation. It focuses on understanding various types of panels such as PCC, MCC, DG set, Synchronization, and APFC panels, along with their wiring, components, and safety features. The syllabus emphasizes industry-oriented skills including panel layout design, control and power wiring, interlocking, and troubleshooting, aligned with IS/IEC standards for switchgear and control gear assemblies. By integrating concepts from electrical machines, protection, and instrumentation, this subject prepares students for employment in panel manufacturing, testing, commissioning, and maintenance, ensuring they are industry-ready and capable of handling modern electrical and automation systems efficiently.

Course Outcomes: After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level*
1	Identify and describe various types, components, and functions of electrical control panels.	R, U
2	Interpret and prepare control and power wiring diagrams for motor control applications.	U, A
3	Demonstrate operation and examine interlocking and protection schemes in circuit breaker and relay panels.	U, A
4	Operate and test DG set, AMF/ATS, and synchronization control panels as per standard	A



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	procedures.	
5	Apply knowledge of APFC panels and troubleshoot faults in different electrical control panels.	A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial / Practical		
				ESE (E)	PA(M)	PA(I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	<p>Unit 1 –Introduction to Electrical Control Panels</p> <p>1.1 Definition, Purpose, and Applications of Control Panels.</p> <p>1.2 Types of Panels: Power Control Center (PCC), Motor Control Panel (MCP), Circuit Breaker Control Panel (CBCP), Relay / Protection Panel, DG Set Panel / AMF / ATS Panel, Synchronization Panel, Substation / Switchyard Panel, APFC Panel</p> <p>1.3 Power Devices (ACB, MCCB, MCB, Isolators, Busbars)</p> <p>1.4 Control Devices (Contactors, Push Buttons, Selector Switches, Timers, Overload Relay, Pilot Lamp / Indicator, Auxiliary Relays), Protection Devices.</p> <p>1.5 Instrumentation & Metering (CT/PT, Ammeter, Voltmeter, Frequency Meter, PF Meter, Energy Meter).</p> <p>1.6 Panel Layout Design: Front and Rear Views, Wiring Ducts, Cable Entry, Earthing, Nameplates</p> <p>1.7 Control and Power Wiring – Ferruling, Color Coding, Cable Lugs, Termination, Numbering</p>	8	18%



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2.	<p>Unit 2 –Motor Control Panel</p> <p>2.1 Purpose of Motor Control Wiring in Industrial Applications.</p> <p>2.2 Role in Protection, Automation, and Energy Efficiency.</p> <p>2.3 Direct-On-Line (DOL) Starter-Wiring Diagram, Components, and Working Principle, Advantages and Limitations, Applications</p> <p>2.4 Star-Delta Starter-Wiring Diagram and Stepwise Operation, Timer Integration for Automatic Changeover, Wiring Sequence and Safety Interlocks</p> <p>2.5 Forward-Reverse Motor Control-Wiring for Forward and Reverse Operation, Electrical Interlocks</p> <p>2.6 Auto/Manual Motor Control-Use of Selector Switches for Manual and Automatic Operation, Integration with PLCs Or Timer, Wiring for Remote Start/Stop.</p> <p>2.7 Soft Starter / VFD Wiring-Basic Control Wiring for Soft Starters, Motor Protection Features, Integration with Control Circuits and Panel Wiring.</p> <p>2.8 Troubleshooting Motor Control Wiring</p>	12	26%
3.	<p>Unit 3 – Circuit Breaker and Relay Control Panel</p> <p>3.1 Definition and Purpose of Circuit Breaker Control Panels (CBCP) and Relay Panels.</p> <p>3.2 Single Line Representation of Control & Protection Scheme.</p> <p>3.3 Front and Rear Layout of Circuit Breaker and Relay Panel</p> <p>3.4 Panel Labeling, Nameplate Details, and Safety Signage</p> <p>3.5 Control Wiring of Circuit Breakers (Open/Close/Trip/Health Status)</p> <p>3.6 Interlocking Between Breakers and Isolators</p> <p>3.7 Components of Breaker Control Panel</p> <p>3.8 Spring Charging Motor Control Wiring and Interlocks</p> <p>3.9 Remote Control and Scada Interface Provisions</p> <p>3.10 Safety Interlocks and Trip Circuit Supervision Relay</p> <p>3.11 Mounting and Wiring of Protection Relays on Panel</p> <p>3.12 Interface Between Control Panel and Switchyard Equipment</p> <p>3.13 Pre-Commissioning Checks for Circuit Breaker and Relay Panels</p>	12	26%



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	3.14 Trip Circuit Continuity and Supervision Testing 3.15 Troubleshooting of Panels		
4.	Unit 4 – DG Set and Synchronization Control Panel 4.1 Purpose and Necessity of DG Set Control and Synchronization Panel in Industries and Power System 4.2 Manual DG Set Panel 4.3 AMF (Automatic Mains Failure) Panel 4.4 ATS (Automatic Transfer Switch) Panel 4.5 Auto Start/Stop DG Panels 4.6 Components of DG Set Control Panel 4.7 DG Set-Control Circuit and Power Circuit Wiring 4.8 Components of Synchronization Panel 4.9 Synchronization Panel -Power and Control Circuit Wiring 4.10 Troubleshooting	8	18%
5.	Unit 5 – Automatic Power Factor Control Panel 5.1 Purpose of APFC Panel 5.2 Components of APFC Panel 5.3 Working Principle of APFC Panel 5.4 Power and Control Wiring	5	12%
	Total	45	100%

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
10 %	40 %	50 %	00	00	00

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Reference Books:

- 1) "Electrical Wiring, Estimating and Costing" – B. S. Dhillon
- 2) "Industrial Control Panel Design Guide" – Siemens Press
- 3) "Practical Electrical Wiring" – V. K. Mehta
- 4) "Motor Control Circuits Handbook" – David Herres
- 5) "Practical Relay Logic & Control Wiring" – H. Cotton
- 6) "Diesel Generator Handbook" – L. L. Kerley



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- 7) "Automatic Power Factor Correction" – K. B. Raina
- 8) "IS & IEC Standards"

(b) Open-Source Software and Website:

- 1) <https://www.electrical4u.com>
- 2) <https://electrical-engineering-portal.com>
- 3) <https://www.realpars.com>
- 4) <https://www.eabel.com/electrical-control-panel-components/>
- 5) <https://forumelectrical.com/electrical-control-panel/>
- 6) <https://cea.nic.in>

Suggested Course Practical List:

Sr. No.	Practical Outcome/Title of experiment	Unit/ CO	Approx. Hours required
1	Identify industrial panel components like ACB, MCCB, MCB, contactors, and relays.	1	2
2	Connect and test meters: ammeter, voltmeter, PF, energy meters.	1	2
3	Design front/rear panel layout with cable entry and earthing.	1	2
4	Wire DOL starter and operate motor with overload protection.	2	2
5	Wire star-delta starter with timer for automatic start.	2	2
6	Forward-reverse motor wiring with safety interlocks.	2	2
7	Auto/manual motor control with remote start/stop.	2	2
8	Wire soft starter or VFD for smooth start and energy saving.	2	2
9	Operate CBCP and simulate open/close/trip conditions.	3	2
10	Mount and wire protection relays; test trip settings.	3	4
11	Implement interlocks between breakers and isolators.	2	2
12	Start/stop manual DG set for standby load.	4	2
13	Wire AMF panel for automatic mains failure.	4	4
14	Wire ATS panel for automatic load transfer.	4	4
15	Wire APFC panel for automatic capacitor switching.	4	2



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16	Measure power factor improvement after APFC operation.	5	4
17	Connect APFC panel to smart energy monitoring system.	5	2

Subject In-charge can add performance experiments only.

List of Laboratory/Learning Resources Required:

1. Air Circuit Breaker (ACB)-3-phase, 400/415V, 50Hz, 100–250A, with auxiliary contacts
2. MCCB-3-phase, 415V, 50Hz, 25–100A, adjustable
3. MCB-1/3-phase, 240/415V, 6–32A
4. Contactors-3-phase, 415V AC, 20–95A
5. Overload Relay-Thermal-magnetic, 0.5–10A adjustable
6. Push Buttons / Selector Switches
7. Pilot Lamps / Indicators-LED, 24/230V AC/DC
8. Auxiliary Relays-24–230V AC/DC coil, SPDT/DPDT
9. Timers-ON/OFF delay, 24–240V AC/DC
10. Soft Starter
11. Variable Frequency Drive (VFD)-3-phase, 0.5–5HP, 0–50Hz
12. Circuit Breaker Control Panel (CBCP)
13. AMF Panel
14. ATS Panel
15. Synchronization Panel
16. APFC Panel
17. Safety Equipment

Suggested Activities for Students:

Other than the classroom and laboratory learning, following are the suggested student-related co-curricular activities which can be undertaken to accelerate the attainment of the various outcomes in this course. Students should perform following activities in group (or individual) and prepare reports of about 5 pages for each activity. They should also collect/record physical evidence for their (student's) portfolio which may be useful for their placement interviews: Students can start with basic tasks like preparing component specification sheets and conducting market surveys.

- a) Assemble a small motor control or APFC panel on a board.
- b) Introduce simulated faults in DOL/Star-Delta/APFC circuits.
- c) Perform troubleshooting and rectification.
- d) Conduct safety audits of existing panels and wiring setups in labs or workshops.



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- e) Identify hazards, compliance with earthing, signage, and insulation standards.
- f) Calculate and select capacitor banks for improving power factor in a small load.

Suggested Project List: Suggested Project List as given below:

- Panel Layout & Wiring Design
- Instrumentation & Metering Demonstration Board
- Star-Delta Starter Panel
- Forward-Reverse Motor Control Panel
- Motor Control Troubleshooting Kit
- Trip Circuit Supervision & Safety Interlocks
- Panel Fault Simulation & Troubleshooting
- Manual DG Set Control Panel
- Auto Start/Stop DG Panel
- Synchronization Panel Demonstration
- APFC Panel Wiring & Simulation
