



Semester – II

Subject Name: Electrical Control Panel Design

Subject Code: 09EE1105

Diploma Branches in which this subject is offered: Electrical Engineering

Objective: The electrical control panel designing are the brain centre for all process industry and represent important element in the proper working and performance of the system. Control panels are mostly made by push buttons, indicators, various control switch, selector switch, control wiring, protective equipment, analog & digital measuring instrument, monitoring device and other accessories to control and monitor real field electrical devices. This skill oriented course is covered the engineering and technical of electrical panels. It is very useful course for every electrical engineers.

Credits Earned: 3 Credits

Course Outcomes: After learning the course the students should be able:

1. To usage proper material, tools and testing equipment for panel designing.
2. To understand basic concept of switchgear equipment, measuring equipment, earthing, bus bar arrangement, contactors and interlocking for standard panel design.
3. To prepare different type of panel wiring using software tools with electrical standard.
4. To design, installation, testing and maintenance of panel
5. To understand concept of automation and electrical drive.

Pre-requisite of course: Basic knowledge of DC circuit, AC circuit and electrical practices.

Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE	IA	CSE	Viva	Term work	
0	0	6	3	00	30	20	25	25	100



Contents:

Unit	Topics	Contact Hours	Weightage (%)
1	Basic accessories required for panel designing <ul style="list-style-type: none">• Introduction• Types of cable (shielded & unshielded cables), cable laying, cable connector/joint, cable connection with panel, cable rating, cable gauges & AWG sizes, cabling of panels cable tie, cable tag, cable tray, lug and lug crimping, gland (single compression/double compression), gland booting,• Type of wire used in panel, wire connector, wire rating, wire laying, ferrule, connection of wire with panel instrument, color code of wire and terminal blocks and din rails• Different types of switch used for panel operation limit switch, toggle switch, PB, E-PB, selector switch, on/off switch, push button, emergency stop switch, interlocking switch, multipoint switch, key operated switch• Tools used for panel wiring and its application• Safety equipment used during panel wiring• Testing equipments for panel Multi meter, tester, continuity tester, tong tester/ clamp-on meter, megger, earth tester• Type of indicator lamps, its operation and importance	14	16
2	Protective & measuring instruments and bus bar arrangement for panel <ul style="list-style-type: none">• Introduction• Types of instrument, analog and digital instrument• Protective and control instruments structure and working of Fuse, MCB, MCCB, RCCB, ELCB, CT, PT, solenoids, actuators• Measuring instrument CT, PT, volt meter, ammeter, frequency meter, energy meter, KW meter, PF meter, energy manager, reactive power meter, multi-function meter• Earthing, neutral system and grounding Basic of earthing, type of earthing, necessity of earthing, earthing resistance, earthing pit, earthing plates and strips, necessity of neutral and grounding• Basic of concept of contactor (NO/NC)• Internal structure and operation of contactor• Bus bar arrangement, prepare general arrangement diagrams, bus bar sizing• Basic concept of relay, relay construction, relay logic, relay contactor, and types of relay• Basic concept of circuit breaker, operation of circuit breaker and types of circuit breaker - ACB, VCB	26	28



	<ul style="list-style-type: none">• DC supply requirement for panel Inverter, UPS, battery and battery charger• Necessity of interlocking		
3	Type of panel, panel wiring drawing and standard <ul style="list-style-type: none">• Introduction• Understand the industry process• Different types of panel and distribution box LT, HT, domestic, commercial, industrial, LDB, MLDB ASB, HDB, MDB, MCB, MCCB etc.• General arrangement drawing• Type of panel wiring and panel layout• Principles of wiring and assembly• Wiring details of panel, daisy chain & point to point networking, channel layout, piping and instrumentation diagram/drawing (P&ID)• Internal arrangement of panel, basic components to be installed in a panel• Software used for panel design Auto CAD, basic AutoCAD commands, reading AutoCAD drawings• Basic of control circuit and power circuit, its drawing• Symbol, abbreviation, IS standards for colour codes & its application for panel wiring, electrical code and standards used for panel designing	16	18
4	Control panel designing, installation, testing and maintenance <ul style="list-style-type: none">• Introduction• General wiring guideline in panel designing, panel layout• Capture the user's required specification of control panel system during site visit• Type of load and load calculation• Load distribution and power management Load calculation, connected load, running load and load factor• Design of panel as per connected load/application• Designing of control circuits using contactors, relays, timers• Rating and dimension of component use in panel, electrical, electronics and instrumentation• Material used for enclosure of panel, name plate details, location of panel• Installation, commissioning and testing of panel• Provide technical support for the installation and commissioning of control panel, understand work requirements• Panel arrangement and panel capacity• Basic safety standards as per company's norms	18	20



	<ul style="list-style-type: none"> Identifying faulty components Checking the circuits, testing of power supply, shorts/continuity, CT/PT, relay, contactors, switches, indicator, meters Maintenance and troubleshooting of control circuit IR measurement, frequently occurring errors, causes and preventive measures Protection provide to panel Protection against fire, short circuit, leakage current and shock, panel heater and its application 		
5	<p>Panel automation and electrical drive</p> <ul style="list-style-type: none"> Introduction of automation History and need of industrial automation Application of industrial automation Basic concept and component of automation Necessity of a control system in panel Basic concept of PLC, SCADA, DCS (direct control station), HMI(Human machine interface) Basic components of PLC, need of PLC in electric control, software details Fundamental of different types of electrical motor and its control panel, working details of electrical motors, starter and there control circuit(DOL, Star delta starter), basic protection for motor Introduction of AC drive and soft starter, its panel, types of drives, components of drive, its application, basic criteria for drive selection, control panel designing, introduction of stepper and servo motor DG connection with panel 	16	18

List of Experiments

Sr. No.	Unit No.	Name of Topics	Contact Hours
1	1	To study type of cable, cable construction, cable laying, cable joint, cable rating & size and cable connection with panel	4
2	1	To study type of wire used in panel, wire laying, wire joint/connector, wire rating & size, color code of wire and wire connection with panel instruments	4
3	1	Identify and specify different types of switch used for panel operation/application as per current and voltage rating, like limit switch, multi point switch, rotary switch, toggle switch, push button, PB, E-PB, selector switch, on/off switch, emergency stop switch, interlocking switch, key operated switch etc.	2



4	1	To study and application of tools, safety equipment and testing equipment require for panel wiring	2
5	1	To study of different type of panel indicator lamp, it's operation and importance	2
6	2	To study of operation and basic construction of protective & control instruments	4
7	2	To use of different type of measuring instruments for panel parameter checking	2
8	2	To study of different type of earthing, necessity of earthing, earthing resistance and necessity of neutral & grounding	4
9	2	To study of basic concept, internal structure and operation of contactor	4
10	2	To prepare general arrangement diagram of bus bar for panel application with dimension	2
11	2	To study of basic concept, logic, construction, contactor and types of relay used in panel	4
12	2	To study of basic concept, construction, operation and types of circuit breaker used in panel	4
13	2	To study working of interlocking and requirement of DC supply in panel	2
14	3	Identify different type of panel and distribution box	2
15	3	To study of layout, general arrangement drawing, basic principle, basic concept, basic assembly, wiring details and type of wiring with internal structure of panel	6
16	3	To study of basic commands of AutoCAD, reading of AutoCAD wiring	4
17	3	Identify the different symbols, abbreviations, color code and electrical code and standards used for panel wiring	2
18	3	To understand drawing of control circuit and power circuit of control panel	2
19	4	To understand load distribution, load calculation and power management of panel	2
20	4	Identify the type of load and user's required specification for panel designing	2
21	4	To prepared design of control panel as per connected load by using various electrical, electronics and instrumentation component	4



22	4	To understand procedure of installation, commissioning and testing of control panel	2
23	4	To study related to enclosure material, name plate details, capacity and arrangement of panel	2
24	4	Identify the faulty components, done maintenance and troubleshooting of control panel as well as study of protection provide to panel	4
25	5	To study of history, need, application, basic concept and basic component of industrial automation	4
26	5	To study basic concept of PLC, SCADA, DCS, HMI and necessity of control system	2
27	5	To understand basic components and need of PLC for electrical controlling in panel	2
28	5	To study basic construction, types, working details, protection, starter and its control circuit of electrical motors	4
29	5	To study basic components, working details, protection, application, soft starter and its control panel circuit of AC electrical drives with control panel design	4

References:

1. R. P. Singh, "*Electrical Workshop*", I.K. International Publishing House Pvt. Ltd., 2013
2. Singh, S. K. Surjit, "*Electrical Engineering Drawing I & II*", Kataria & Sons, 2012
3. S. L. Uppal & G. C. Garg, "*Electrical Wiring, Estimating and Costing*", Khanna Publication, 2012
4. Shalini Gupta, Monte DePouw & John Ventura, "*Database Design for Electrical Panels*", May 2012
5. Neil Sclater & John E. Traister, "*Handbook of Electrical Design Details*", Second edition, 1997 The McGraw-Hill Companies
6. Stephen L. Herman, "*Electrical Wiring Industrial*", 15 edition January 13, 2014
7. Truman C. Surbrook "*Interpreting the National Electrical Code*", 9 edition August 2, 2011
8. National Electrical Code 2017, September 26, 2016



Instructional Method:

- a. The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.
- b. The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory.
- c. Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.
- d. Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory

Supplementary Resources:

1. <http://electrical-engineering-portal.com/download-center/books-and-guides/automation-control/design-of-industrial-control-panels>
2. <http://electrical-engineering-portal.com/download-center/books-and-guides/schneider-electric/control-panel-design>
3. <http://electrical-engineering-portal.com/download-center/books-and-guides/automation-control/industrial-control-wiring-guide>
4. <http://electrical-engineering-portal.com/download-center/books-and-guides/automation-control/industrial-control-panels>
5. <http://electrical-engineering-portal.com/electrical-design-plc-panel-wiring-diagrams>
6. <http://electrical-engineering-portal.com/tips-wiring-industrial-control-panel>
7. <https://www.element14.com/community/servlet/JiveServlet/downloadBody/50544-102-1-261525/Control%20Panel%20Design%20Guide.pdf>
8. <http://unitechplctraining.com/powerandelectrical.php>
9. <https://kvch.in/dcs-panel-designing-live-project-based-6-weeks-training-noida.html>
10. <http://aptronnoida.in/best-dcs-and-panel-designing-training-in-noida.html>
11. <https://ipcsautomation.com/Electric+Control+Panel+Designing/Training/>
12. <https://www.ugc.ac.in/skill/curriculum/Electronics/14%20Industrial%20Automation%20Engineer.pdf>
13. <https://www.ugc.ac.in/skill/curriculum/Electronics/12%20Wireman%20Control%20Panel%20Curriculum.pdf>
14. <http://www.klocknermoeller.com/>
15. [http://www.industry.siemens.nl/home/nl/nl/paneelbouw/Documents/Documentatie/Industrial Control Panels for North America en-US.pdf](http://www.industry.siemens.nl/home/nl/nl/paneelbouw/Documents/Documentatie/Industrial%20Control%20Panels%20for%20North%20America%20en-US.pdf)