

Program Name : Electrical Engineering Program Group
Program Code : EE/EP/EU
Semester : Third
Course Title : Electrical Materials and Wiring Practice
Course Code : 22328

1. RATIONALE

Electrical diploma engineers (also called as electrical technologists) are required to work as supervisors in small and large scale industries the construction field. They should be well equipped with the skills of wiring related to the electrical engineering field. They should also be able to select relevant electrical materials and accessories for different applications while carrying out original works or maintenance works. Hence they should be well conversant with the specifications of material as per the applications. This course will arm the students to face such situations successfully with confidence.

2. COMPETENCY

Aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Plan and carry out wiring/cabling activities using relevant materials following safe practices.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

- Follow safe practices when undertaking electrical works.
- Select relevant conductors and electromagnetic/magnetic materials.
- Select relevant insulating materials.
- Perform different types of electrical wiring/cabling activities.
- Implement relevant earthing systems.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	4	7	3	70	28	30*	00	100	40	50@	20	50	20	100	40

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C -- Credit, ESE - End Semester Examination; PA - Practical Assessment.



5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

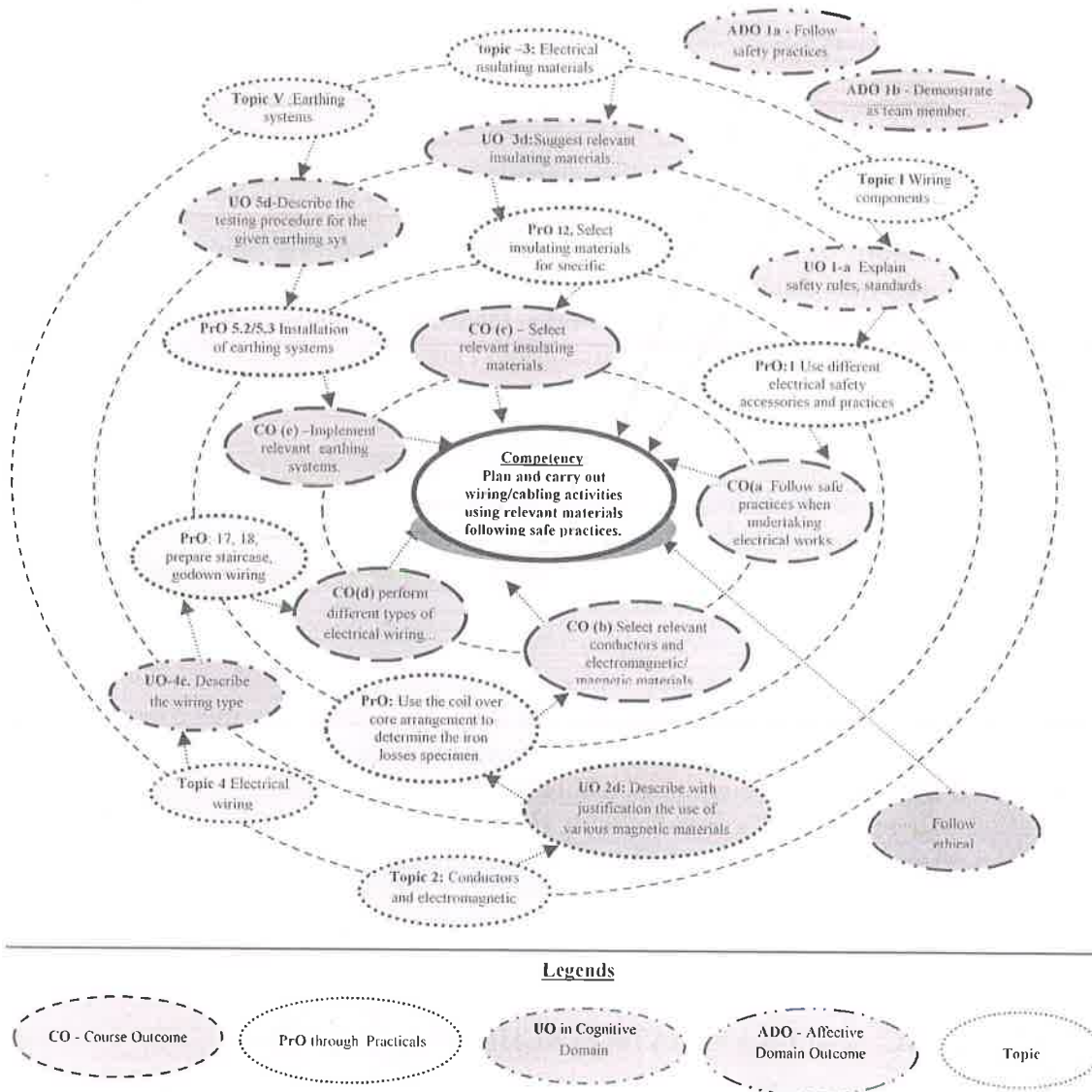


Figure 1 - Course Map

6. SUGGESTED PRACTICALS / EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1.	Use different electrical safety accessories and practices.	I*	2
2.	Use different types of electrical/electronic tools.	I*	2
3.	Test the working of the given components: i) single pole one way and two way switches and ii) MCB using relevant tools and instruments.	I*	2



S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
4.	Test the working of the given components: i) RCB and ii) ELCB using relevant tools and instruments.	I*	2
5.	Measure conductor resistance of cables using Kelvin's double bridge.	II*	2
6.	Use the Megger to measure insulation resistance of cables.	II*	2
7.	Use the Wheatstone's bridge to measure resistance of a conductor bundle (to determine per unit length resistance).	II*	2
8.	Use Wheatstone's bridge to measure resistance of conductor bundles (to determine per unit length resistance) (two specimens of different cross sections area).	II*	2
9.	Select and place relevant fuses in different lighting circuits.	II*	2
10.	Use the coil over core arrangement to determine the iron losses per unit weight of first electromagnetic specimen.	II^	2
11.	Use the coil over core arrangement to determine the iron losses per unit weight of second electromagnetic specimen.	II^	2
12.	Select insulating materials for specific applications from given samples(at least five).	III*	2
13.	Investigate (and record observations) a cable failure by insulation breakdown (1 st case).	III*	2
14.	Investigate (and record observations) a cable failure by insulation breakdown (2 nd case).	III*	2
15.	Dielectric strength test of one insulating oil sample.	III*	2
16.	Dielectric strength test of two different insulating oil samples of varied usages.	III*	2
17.	Prepare staircase wiring and test it.	III*	2
18.	Prepare godown wiring and test it.	III*	2
19.	Prepare switch board containing four switch four socket arrangements (with fuse, indicator, internal wiring etc.).	III*	2
20.	Prepare fluorescent tube light fixture wiring and test it.	III*	2
21.	Perform cable laying from incoming bus to a machine installation.	III*	2
22.	Cable from incoming main to a residential unit.	III@	2
23.	Trace laid down cables and identify the path.	III@	2
24.	Prepare cable joints (different joints).	II#	2
25.	Perform lug crimping for cable leads of a specific size.	II#	2
26.	Perform lug crimping for cable leads of a size other than above.	II#	2
27.	Perform compound filling and water proof taping of cable joint	II#	2
28.	Perform plate earthing for a machine laboratory.	V\$	2
29.	Perform plate earthing for a computer centre.	V\$	2
30.	Perform plate earthing for a building.	V\$	2
31.	Test / measure earthing system resistance of a computer centre.	V\$	2
32.	Test / measure earthing system resistance of a building.	V\$	2
	Minimum number of practicals: 24		
	Total		64 hours

Note



- i. A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 24 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

#	Minimum one practical to be performed
&	Minimum one practical to be performed
@	Minimum one practical to be performed
^	Minimum one practical to be performed
\$	Minimum one practical to be performed

S. No.	Performance Indicators	Weightage in %
1	Plan (draw) the wiring circuit.	20
2	Use of the relevant wiring tools.	20
3	Follow safety practices.	20
4	Timely submission of work.	20
5	Answers to sample questions.	20
Total		100

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

- Practice good housekeeping with safety measures.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year and
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Pliers, nose pliers, cutter cum insulation remover, screw driver, tester, test	Common



S. No.	Equipment Name with Broad Specifications	PrO. No.
	lamp, crimping tool, lugs, continuity tester, wire gauge, knife, safety hand gloves, safety boots, safety goggles, safety rubber mats (ISI Mark).	to all
2	Exhaustive samples of wires/wire bundles (as per standard table), samples of non-armoured and armoured cables, MCB/ELCB/RCB. Single pole one way and two switches, fluorescent tube circuit, ceiling roses, switch boards, casing-capping strips, PVC and iron conduits, lugs, different types of fuses earthing equipment and all other wiring components for LT electrical installation system.	3, 4, 9, 13, 14, 17 to 27
3	Test lamps suitable for 250 V and 400V.	Common to all
4	Line tester.	Common to all
5	Clamp-on meter/Tong Tester 0 – 50A (digital or analog).	Common to all
6	Megger 500 V,(digital or analog).	Common to all
7	Multimeter: Frequency: 0.1Hz ~ 30MHz, DC Voltage: 0.1mV ~ 1000V AC Voltage: 0.1mV ~ 750V, approximate resistance range: 0 to 100 M.Ohms (digital or analog).	Common to all
8	Exhaustive samples of insulations, insulating oils and damaged cables.	12 to 16
9	Electromagnetic stampings laminated electromagnetic cores (assembled) with suitable coils placed over them for iron losses measurement.	10, 11
10	LPF wattmeters up to (250 V, 0 to 2 A, 5A depending on capacity of above core/coil).	10, 11
11	Wheatstone bridge, Kelvin's double bridge.	5, 7, 8
12	Plate earthing sets as per IS norms / IE rules.	28 to 32

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Wiring component s, tools and safety devices	1a.Explain safety rules/ standards in the given electrical systems. 1b.Describe the use of the given tools in the given electrical engineering situation 1c.Explain the use of the given safety accessories in the given electrical engineering situation. 1d.Explain the functions/applications of the given components of wiring.	1.1 IE rules of safety. 1.2 Safety Tools used in wiring: Pliers, nose pliers, cutter cum insulation remover, screw driver, tester, test lamp, crimping tool, continuity tester, wire gauge, knife. 1.3 Accessories: safety hand gloves, safety boots, safety goggles, safety rubber mats. 1.4 Components with specifications used in wiring systems: different types of iron clad switches, DBs, switches, plugs, sockets, MCBs.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		RCBs, ELCBs, holders, wires, cables.
Unit– II Conductor s and electromag netic materials	<p>2a. Describe the salient features of the given type of conductor with respect to the needed functional properties.</p> <p>2b. Explain with justification the applications for the given electrical conductors in specified situations.</p> <p>2c. Describe the salient features of electromagnetic materials in the given electrical engineering situation.</p> <p>2d. Describe with justification the use of various magnetic materials in the given electrical engineering situation.</p>	<p>2.1 Properties of conducting materials: electrical, mechanical and thermal properties of conducting materials.</p> <p>2.2 Conducting materials and their applications: copper, aluminium, tungsten, brass, bronze, mercury, silver, lead, nickel and tin).</p> <p>2.3 Types of magnetic materials: Ferromagnetic, paramagnetic and diamagnetic materials.</p> <p>2.4 Properties and applications of magnetic materials: Magnetization curve. hysteresis, hysteresis loss, magneto-striction, materials, C. R. G. O. silicon Steel, H. R .G. O. silicon steel, typical hysteresis loops for different ferromagnetic materials (hard steel, wrought iron and alloyed steel), Loss of magnetism.</p>
Unit– III Electrical insulating materials.	<p>3a. Describe the properties of the given electrical insulating materials.</p> <p>3b. Classify the given insulating material-with examples of gaseous, liquid and solid insulators.</p> <p>3c. Describe the failure phenomena in the given type of insulating material(s).</p> <p>3d. Suggest relevant insulating material(s) for given application(s) with justification.</p>	<p>3.1 Significance and properties of electrical insulating materials: electrical, mechanical and thermal properties.</p> <p>3.2 Thermal classification of insulators, classes of insulators.</p> <p>3.3 Dielectric failure of insulating materials. (Gaseous, Liquid & Solid state).</p> <p>3.4 Applications of insulating materials in electrical machines and devices.</p>
Unit– IV Electrical wiring	<p>4a. Explain with justification the criteria for selecting wire/cable and other electrical components for the given type of installation.</p> <p>4b. Describe with sketches the installation of wiring systems for the given type of occupancy.</p> <p>4c. Describe with sketches the wiring type as per the functional requirements of the given type of occupancy.</p>	<p>4.1 Types of wires and cables, components and accessories of electrical wiring systems.</p> <p>4.2 Electrical Wiring systems (such as casing and capping etc.).</p> <p>4.3 Electrical Wiring types (one lamp control, staircase and godown)</p> <p>4.4 Cable laying, Cable joints (terminations), proper size lugs, crimping of joints.</p>



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	4d. Explain the process of installing the given type of cable(s).	
Unit-V Earthing systems.	5a. Recommend with justification the necessity of the type of earthing in the given electrical installation system(s). 5b. Explain the criteria for recommending the earthing system for the given electrical installation. 5c. Describe with sketches the installation of the given earthing system. 5d. Describe the testing procedure for the given earthing systems.	5.1 Types of earthing systems. 5.2 Installation of earthing systems. 5.3 Testing/ measurement of earthing resistance for various installations as per IE rules. 5.4 Significance and adverse effects of improper earthing systems

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Wiring components, tools and safety devices.	08	02	04	08	14
II	Conductors and electromagnetic materials	12	04	04	06	14
III	Electrical insulating materials.	10	02	06	08	16
IV	Electrical wiring	10	02	04	08	14
V	Earthing systems.	08	02	04	06	12
Total		48	12	22	36	70

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

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 conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Collect from market the catalogues of electrical engineering materials such as conductors and insulators.



- b. Collect from internet or otherwise information on the different electromagnetic materials along with the forms in which they are available.
- c. Trace the connection diagram of control circuit of any equipment in the electrical laboratory.
- d. Make the list of manufacturers of wiring components and accessories.
- e. Make the list of manufacturers and suppliers of light fittings.
- f. Collect the information of substation earthing.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- a. Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
- b. '*L*' in *item No. 4* does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- c. About *15-20% of the topics/sub-topics* which is relatively simpler or descriptive in nature is to be given to the students for *self-directed learning* and assess the development of the COs through classroom presentations (see implementation guideline for details).
- d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
- e. Guide student(s) in undertaking micro-projects.
- f. Show video demonstration on safety precautions while working in electrical environment.
- g. Demonstrate the actions and care to be taken in case of electrical accidents.
- h. Arrange a visit to appliances/wire manufacturing unit / transformer or coil manufacturing unit/electrical shops / workshops.
- i. Arrange expert lecture of industry person in the area of electrical safety.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be *individually* undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should *not exceed three*.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than *16 (sixteen) student engagement hours* during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

- a. Draw labeled lighting circuit diagram, list the accessories used with their specifications and complete wiring work of following simple electrical circuits on test board with appropriate testing under guidance of supervisor / teacher
- b. Circuit consists of suitable MCB, one lamp holder, one indicator, one 5 A five pin socket and two 5A single pole switches.



- c. Circuit consisting of suitable MCB, one call bell, one indicator, one lamp control from two places, three switches [Two switches are two way controlled] (all for 5A rating)
- d. Circuit consisting of relevant MCB, 15A single pole switch, one indicator, one 5 pin 15A power socket.
- e. Prepare series test board containing one lamp, one indicator, one socket for 230 V operations.
- f. Latest techniques in cabling and wiring.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electrical Engineering Drawing	Bhattacharya S. K.	New Age International, New Delhi, 2013, ISBN: 978-81-224-0855-3.
2	Electrical Wiring, Estimating and Costing	Uppal S.L; Garg G.C.	Khanna Publishers, New Delhi, 2013, ISBN-13: 978-81-7409-240-3.
4	Electrical Workshop	Singh R.P.	I.K. International Publishing House , Pvt. Ltd. New Delhi 2012, ISBN:9789381141205.
5	Electrical Estimating and Costing	Gupta J. B.	S. K. Kataria & Sons, New Delhi,2012, ISBN:978-93-5014-279-0

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

- a. www.nsc.org.in/
- b. www.esfi.org/
- c. www.osha.gov/Publications/electrical_safety
- d. www.nfpa.org/safety
- e. www.electrical4u.com

