Program Name : **Electrical Engineering Program Group**

Program Code : **EE/EP/EU**

Semester : **Sixth**

Course Title : **Utilization of Electrical Energy**

Course Code : **22626**

1. RATIONALE

Electricity is used in every walk of life whether it is home, office, industry or farm. It is being used for lighting, heating, cooking, air conditioning, operating machines/computers, welding, traction, irrigation. Due to power crisis, economical utilization of electrical energy and energy conservation is an essential aspect. Every diploma electrical engineer therefore should know to operate and maintain main electrical utilities for their efficient operations. Essential theoretical and practical knowledge will be achieved by this course.Keeping the above objectives in view, besides giving him basic knowledge in the topics concerned, attempts have been made to ensure that the knowledge acquired is applied in various fields as per his job requirements.

2. COMPETENCY

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

- **Maintain different types of electrical utilities and systems.**

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:

a) Maintain the functioning of different types of lamps and fittings.
b) Maintain different electric heating and welding equipment.
c) Maintain different electric drives and elevators.
d) Use different electric traction systems.
e) Use equipment for economic operation.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): 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** - Progressive 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.

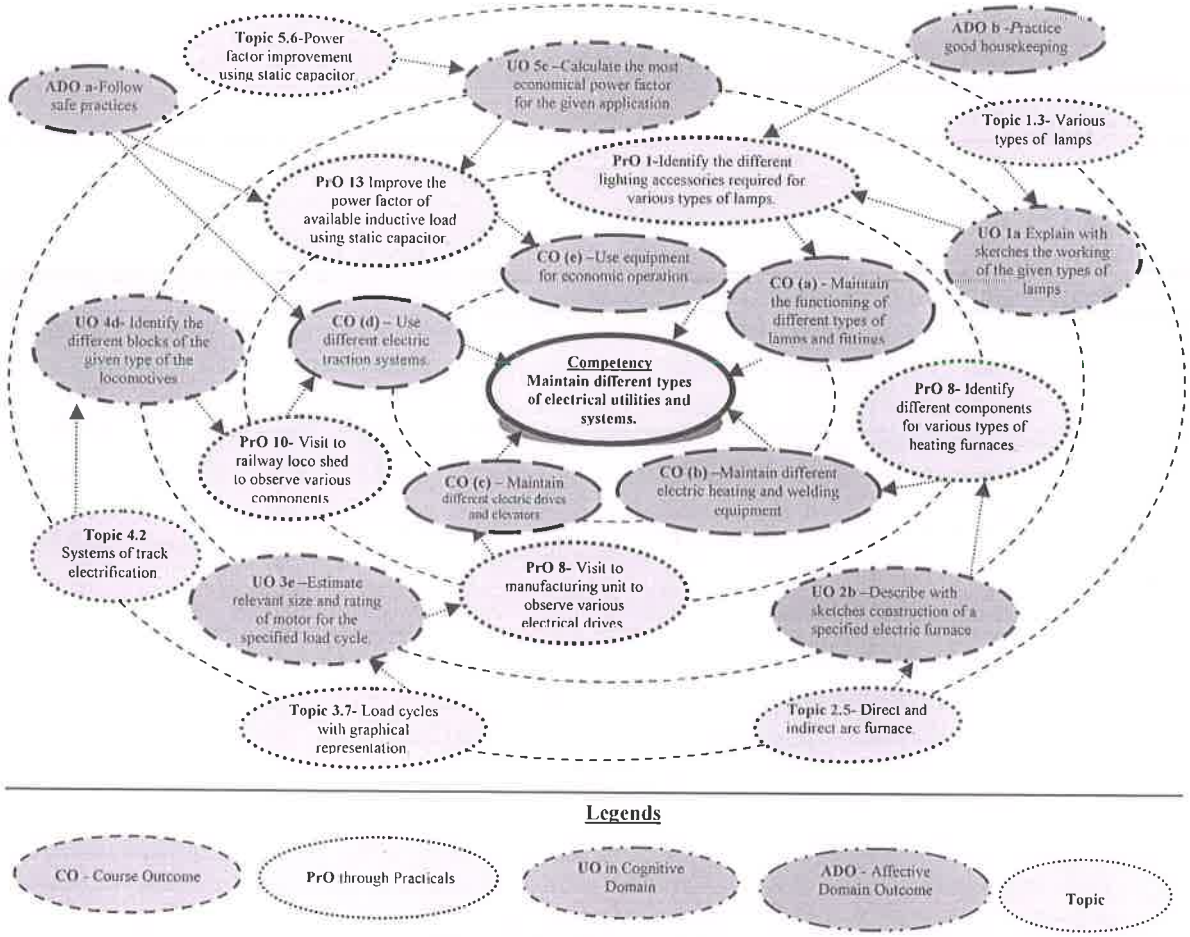

Figure 1 - Course Map

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	Identify the different lighting accessories required for various types of lamps.	I	02*
2	Identify the different lighting accessories required for various types of lamp fittings.	I	02
3	Measure illumination at different places in college using luxmeter.	I	02*
4	Identify the different components required for various types heating furnaces	II	02*
5	Observe construction and working of various heating furnaces by watching video programmes.	II	02
6	Identify the different accessories and safety devices required for various types of welding system.	II	02
7	Prepare a report of specification of various electrical welding machines available in college workshop	II	02*
8	Visit a small manufacturing unit to observe various electrical drives and prepare a technical report.	III	02*

S.No	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
9	Prepare a comparative chart of two different manufacturing company in India for any two Lift/Elevator with technical data.	III	02
10	Visit a railway loco shed to observe various components and working of electric locomotive and prepare a technical report.	IV	02
11	Prepare a report /chart on various types of traction systems.	IV	02*
12	Prepare a report/chart on speed time curves.	IV	02
13	Improve the power factor of available inductive load using static capacitor.	V	02*
14	Prepare a report based on comparative study of various tariff structure of Maharashtra.	V	02
15	Prepare Energy Bill based on energy consumption of residence/ Institute	V	02*
16	Prepare a technical report after visiting an industry, various power factor improvement devices used. (otherwise from internet)	V	02
	Total		**32**

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 judicial mix of minimum 12 or more practical need to be performed, out of which, the practical's marked as '*' are compulsory and any 04 of remaining 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:*

S.No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and Recording	10
5	Interpretation of result and Conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
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:

a) Follow safety practices.
b) Practice good housekeeping.
c) Practice energy conservation.
d) Work as a leader/a team member.
e) 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
- 'Organisation Level' in 2nd year
- 'Characterisation Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTSREQUIRED

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	FTL,CFL,LED of different suitable ratings,	01
2	Electric choke, Electronic ballast of different suitable ratings,	02
3	Digital Lux meter (UptoLUX-100K)	03
4	Heating furnace / Oven of suitable ratings	04,05
5	Video programme / internet information on various types of heating furnaces	05
6	Electrical welding machine of suitable rating.	06
7	Video programme / internet information on various types of welding systems	06,07
8	Industry visit / internet information for various types industrial drive	08
9	Video programme / internet information on various types of Elevators	09
10	Loco shed/ Track Electrification system visit for observing components /equipment related to traction	10,11
11	Ammeters MI Type: AC/DC 0-5-10Amp	13
12	Voltmeter MI Type: AC/DC, 0-150/300V, 0-250/500V	13
13	Wattmeter: Three phase double element 5/10Amp, 250/500V	13
14	Wattmeter: Single phase, single element 2.5/5Amp, 200/400V,	13
15	Dimmer: 1-phase,1kVA,230V	13
16	Dimmer: 3-phase, 5kVA	13
17	Three phase Power factor meters: AC, 415V, 50 Hz , 5-10 Amp	13
18	Load bank: Resistive, 3-phase, 5kW, 415V	13
19	Automatic power factor controller (APFC)	13
20	Video programme /internet information Tariffs electricity calculation	13
21	Clip on meter (amp, volts) digital/analog	13

8. UNDERPINNING THEORY COMPONENTS

The following topicsare to betaught 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 Illumination.	1a. Explain with sketches the working of the given types of lamp (s) 1b. Describe with sketches the construction of the given type of lamp fitting. 1c. Explain with sketches the specified lighting scheme for the given application. 1d. Select the relevant lamp for the specified application with justification.	1.1 Definitions of various illumination terminology- Luminous flux, solid angle, luminous intensity, lux, candlepower, MHCP, MSCP, MHSCP, illumination, lamp efficiency, depreciation factor, maintenance factor, coefficient of utilization, space to height ratio, reflection factor, waste light factor, glare, shadow. 1.2 Laws of illumination: Inverse squares and Lambert's Cosine law. 1.3 Various types of lamps: Low pressure mercury vapour lamps(fluorescent

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	1e. Design simple lighting scheme for the given data. 1f. Describe the procedure to maintain the given type of lamp and fitting.	tube),Compact fluorescent Lamps (C.F.L.), High pressure mercury vapour lamps, Sodium vapour lamps, Metal halide lamps, LED lamps. 1.4 Various lighting schemes: features and application. 1.5 Domestic and industrial lamp fittings. 1.6 Electronic ballast.
Unit– II Electric Heating and welding systems.	2a. Explain with sketches and broad specifications working principle of the specified electrical heating system. 2b. Describewithsketches construction of the specified electric furnace. 2c. Recommend therelevantheatingsystem for the given application with justification. 2d. Design the heating element of the given type of furnace forthe specified data. 2e. Select the relevant welding system for aspecifiedapplication with justification. 2f. Describe the procedure to maintain the given type of heating and welding system.	2.1 Concept of electrical heating, classification of electric heating, modes of heat transfer. 2.2 Direct andindirect resistance heating: workingprincipleandconstruction and applications. 2.3 Requirements of resistance heating element material, methods of temperature control, design of heating element. 2.4 Arc Heating: Working principle,properties of material used for electrode, advantages of graphite electrode over carbon electrode. 2.5 Direct arc furnace and indirect arc furnace:construction and operation, specifications,applications. 2.6 Induction heating: Working principle, applications. 2.7 Direct core type furnace:Constructionand working of horizontal and vertical type. 2.8 Coreless type inductionfurnace: Construction, working and applications. 2.9 Dielectric heating: workingprinciple, and applications. 2.10 Eddy current heating: working principle and applications. 2.11 Types of welding systems:plastic and fusion, classifications of electrical welding system. 2.12 Quality of a good weld, welding defects. 2.13 Resistance welding:spot,seam,butt, projection welding and their working principles and applications. 2.14 Arc welding: working principle, characteristics of arc, factors on which arc length, methods of arc stabilization,types of electrodes, advantages of coated electrode. 2.15 Metal and carbon arc applications. 2.16 Supply requirements;AC welding machines-welding transformer, safety precautions.
Unit-III Electric Drives and	3a. Differentiate the salient features between the given types of electric drives.	3.1 Electric drives: concept,factors governing selection of electric drives (motor).

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Elevators.	3b. Recommend relevant motor for the given application with justification. 3c. Select the relevant enclosure of motor for the given atmospheric condition with justification. 3d. Select the power transmission drive of the electric motor for the given application with justification. 3e. Estimate relevant size and rating of electric motor for the specified load cycles. 3f. Explain with sketches relevant braking system for the given electric motor. 3g. Select relevant elevator machine and electric motor for the specified application with justification. 3h. Describe the procedure to maintain the given electric drive and elevator.	3.2 Types of electrical drives: Individual and group drive, applications. 3.3 Mechanical features of drives: Purpose, types and application of various types of enclosures. 3.4 Transmission of mechanical power: Direct and indirect drive(Belt, Rope, Chain, Gear),Vertical drives and its applications. 3.5 Bearing: Types and applications. 3.6 Size and rating of motor, Definition of standard rating as per IS. 3.7 Load cycles: Concept with graphical representation. 3.8 Load Equalization: Meaning, methods and condition of load equalization. 3.9 Braking : Definition of braking, requirements of ideal braking system, 3.10 Types of electrical braking systems: Plugging, rheostatic (Dynamic) and regenerative braking for D.C. series motor and three phase Induction motor. 3.11 Elevators: Function, application, Types, its motors and safety. 3.12 Factors on which shape and size of car depends. 3.13 Bombay Lift Act 1939. (Latest Amendment).
Unit –IV Electric Traction	4a. Recommend relevant traction system for the given application with justification. 4b. Select the relevant track electrification system for the specified traction services with justification. 4c. Differentiate the salient features between the given types of track electrification system. 4d. Draw the speed-time curvefor the specified electric traction application. 4e. Differentiate between the given types traction services based on the given criteria. 4f. Determine average and schedule speed for the giventraction services. 4g. Describe the procedure to	4.1 Requirements of an ideal traction system, different types of traction system used in India: Electric and diesel electric 4.2 Systems of track electrification: D.C., single phase 25kV A.C., composite system 4.3 Traction mechanics : Block diagram of A.C. electric locomotive and function of each part. 4.4 Traction motors: Desirable characteristics, D.C. series motor, single phase A.C. series motor, chopper controlled motors 4.5 Definition of average and schedule speed, factors affecting schedule speed. 4.6 Speed-time curve: Trapezoidal and quadrilateral speed time curve and its applications. 4.7 Current collecting system: Over head wire and conductor rail system, current

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	maintain the given electric traction system.	collector - pantograph types. 4.8 Traction services: Urban, suburban, main line services. Metro rail and monorail: main features that different them, types of electric motors used, current collectors, speed time characteristics
Unit-V Tariff and Power Factor Improve ment	5a. Select the relevant tariff for the given applications with justification. 5b. Explain with the sketches the relevant method for power factor improvementforthe given load. 5c. Calculate the most economicalpower factor forthegiven application(s). 5d. Describe the procedure to maintain the specifiedpower factor of the system.	5.1 Tariff: Desirable characteristics, types(Flat rate, block rate, KVA maximum demand andTime of Day tariff). 5.2 Power factor: Disadvantage of low power factor, advantages ofimprovedp.f., causes of low p.f.,avoidance of low p.f. without using p.f.improvementdevices. 5.3 Power factor improvement using; static capacitor, most economical power factor,location of power factorimprovement devices from consumer and electrical supply company point of view.

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

9. SUGGESTED SPECIFICATION TABLE FORQUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Illumination	08	02	02	04	08
II	Electric Heating and Welding System	18	04	06	08	18
III	Electric Drives and Elevator	16	02	08	08	18
IV	Electric Traction	16	04	06	08	18
V	Tariff and Power factor improvement	06	02	02	04	08
Total		64	**14**	**24**	**32**	**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 any two of the 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:

a) Prepare a survey report after collecting technical information of various lamps available in the local market(otherwise from internet).
b) Prepare a report on different luminaries available in the market and collect the technical data
c) Preparing reports based on tutorial practices.
d) Assignments for solving numerical.
e) Identify different types of illumination schemes in the Institute.
f) Note the ratings of various types of welding machines in the Institute workshop.
g) Prepare chart of various electrical equipment used for heating.
h) Seminar on elevators.
i) Seminar on latest electric traction in India.

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) Flash/Animations to explain working of Electric Locomotive and Elevators.
g) Pre-guided visits to, railway stations and elevator manufacturing companytoobserve operation.

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 isgroup-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 she/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 isgiven here. Similar micro-projects could be added by the concerned faculty:

a) **Illumination:** Design suitable lighting scheme for a laboratory or class room.
b) Prepare report on market survey of various types of lamps(specification, manufacturer, application and cost) and do its comparative analysis.
c) **Electric heating:** Prepare power point presentation related to heating furnaces.

d) **Electric welding:** Prepare power point presentation related to welding equipments and accessories.
e) **Electric Drives**: Prepare report on market survey of various drives (specification, manufacturer, application and cost).
f) **Elevators**: Prepare report on market survey of various Lift and Elevator (specification, manufacturer, application and cost) and collect Lift and Elevator Act.
g) **Electric Traction**: Prepare power point presentation related to Electric traction systems in India and its comparative analysis.
h) Prepare a chart of Electric Locomotive and show the various components.
i) **Tariff**: Calculation of electricity bill for their own residence/ Institute.
j) **Power factor Improvement**: Prepare the report on the power factor improvement process in the nearby substation/Institute/Small scale industry.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Art and Science of Utilization of Electrical Energy	Partab, H.	Dhanpat Rai &Sons, New Delhi, 2017, ISBN:9788177001440.
2	Utilization of Electric Power and Electric Traction.	Gupta,J. B.	S. K. Kataria& Sons, New Delhi, 2016, ISBN: 978-9350142585
3	Utilization of Electric Power and Electric Traction	Garg,G. C.	Khanna Publishers, New Delhi, 2016, ISBN-8174091645.
4	Electric Traction	Upadhyay, J. Mahendra,S. N.	Allied Publisher Ltd., New Delhi, Latest edition ISBN-8177640054|9788177640052
5	Fundamentals of Electrical Drives	Dubey,G. K.	Narosa Publishing House. New Delhi, Latest edition ISBN-8173190410, 9788173190414.
6	Principles of Power system	Mehta,V.K.	S.Chand, New Delhi, Latest edition ISBN-9788121924962.
7	Generation and Utilization of Electrical Energy	Sivanagaraju, S. Balasubba Reddy M., SrilathaB.	PearsonEducation, New Delhi, 2016 ISBN-9789332515673
8	Modern Electric Traction	Partab, H.	Dhanpat Rai & Sons , New Delhi, 2016, ISBN: 1234567147206

14. SOFTWARE/LEARNING WEBSITES

a) www.nptel.iitm.ac.in
b) www.howstuffworks.com
c) www.khanacademy.com
d) https://www.youtube.com/watch?v=CoHVA7nr82A
e) https://www.youtube.com/watch?v=7GLiBwgVBLQ
f) https://www.youtube.com/watch?v=fakGLu03jYg
g) https://www.youtube.com/watch?v=fQrZMMWo1mA
h) https://www.youtube.com/watch?v=BDMFsYnTdVI
i) https://www.youtube.com/watch?v=49rH3buD0bc
j) https://www.youtube.com/watch?v=82EFMvYcbN4
k) https://www.youtube.com/watch?v=AAyLKnz4UJY

l) https://www.youtube.com/watch?v=EN2ee15BIyg
m) https://www.youtube.com/watch?v=XdrVwsQIgao
n) https://www.youtube.com/watch?v=F1MM2gjCv7I

IS, BIS and International Codes:

o) IS 1860-1980 code of practice for installation, Operation and maintenance of electric Passenger and goods lifts.
p) IS 3534-1976 Outline Dimensions of Electric Lifts.