

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)**Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)**
Semester-IV**Course Title: Distribution and Utilization of Electrical Power**
(Course Code: 4340902)

Diploma programmer in which this course is offered	Semester in which offered
Electrical Engineering	4 th Semester

1. RATIONALE

The study of distribution and utilization of electrical energy is critical for diploma electrical students as it provides a comprehensive understanding of the various electrical energy systems and the various methods of distribution and utilization of electrical energy. This course deals in detail about distribution system components, substation, cables, power factor improvement, illumination, electric drive and domestic appliances. The skilled technocrats are required to operate and maintain efficient as well as reliable power distribution and utilization. Essential efforts are made in this course to develop basic skills required to maintain economic power distribution and utilization.

2. COMPETENCY

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

- **Operate and maintain various distribution system and different types of electrical utilities and systems.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

1. Identify basic components of power system distribution.
2. Interpret cable specifications, site selection process and layout of substations.
3. Acquire knowledge about tariff structures and power factor improvement.
4. Select appropriate lighting source on the basis of different parameters related to illumination.
5. Compare electrical drives and demonstrate working of various domestic electrical appliances.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			C	CA	ESE	CA	ESE	
3	0	2	4	30	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment 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, *CA* - Continuous Assessment; *ESE* -End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (Cos). Some of the PrOs marked “*” are compulsory, as they are crucial for that particular CO at the ‘Precision Level’ of Dave’s Taxonomy related to ‘Psychomotor Domain’.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	To study performance characteristics of typical AC distribution system in radial & ring main configuration.	1	2*
2	To Solve problem related to voltage drop and sending/ receiving end voltage of distribution line.	1	2
3	Prepare a report after studying distribution system of a residential colony.	1	2
4	Interpret the Blue Print of a Sub-Station.	2	2
5	Prepare a report on substation with its layout after visiting a nearby substation.	2	2
6	Prepare a report on pole mounted substation.	2	2*
7	Prepare a report about types of cables used in distribution system by visiting nearby cable suppliers/industries or otherwise with the help of internet.	2	2
8	To carry out pipe/plate/chemical earthing.	2	2
9	Measure a power factor of various electrical equipments with and without power factor improvement scheme.	3	2
10	Improve the power factor of available inductive load using static capacitor.	3	2*
11	Perform power factor correction using synchronous condenser.	3	2
12	Prepare a technical report on various power factor improvement devices adopted in an industry after visit of that industry. (otherwise from internet)	3	2
13	Prepare a report based on comparative study of various tariff structures of Gujarat state.	3	2*
14	Prepare Energy Bill based on energy consumption of residence/ Institute.	3	2
15	Identify the different lighting accessories required for various types of lamps and lamp fittings.	4	2
16	Measure Illumination at different places in college using luxmeter.	4	2*
17	Visit a small manufacturing unit to observe various electrical drives and prepare a technical report.	5	2
18	Analytical comparison between Electrical & Mechanical Drive.	5	2*

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
19	Write the procedure of servicing of any two domestic appliances after visiting nearby servicing centers of electrical domestic appliances.	5	2
20	Prepare a comparative report on two different manufacturing companies in India for any two electrical domestic appliances.	5	2*
21	Study about IE safety rules.	5	2
22	Study about recycle cables and electrical/electronic waste.	2	2
Minimum 14 Practical Exercises			28

Note

- i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.
- ii. Care must be taken in assigning and assessing study report as it is a first year study report. Study report, data collection and analysis report must be assigned in a group. Teacher has to discuss about type of data (which and why) before group start their market survey.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

Sr.No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Diagrams/Sketches/Tables	20
2	Experimental procedure and conduction by following safety practices.(for performance base experiment) Or Lucidity of report.(for study type experiment)	30
3	Conceptual clarity	30
4	Time bound completion, team work & ethical values	20
Total		100

6. EQUIPMENT/ INSTRUMENTS REQUIRED :

These equipments with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practical's in all institutions across the state.

Sr. No.	Equipment Name
1	Prototype of Radial, parallel and ring main feeder.
2	Various safety devices used for first aid and electrical hazards.
3	Electrical safety devices for Protection such as Fuse, MCB, ELCB, earthing rods.
4	Different charts of Substation layout.
5	Raw material of Earthing.
6	Cut-section of different types of cable.
7	Electrical Component like Resistor, Inductor, Capacitor bank etc.
8	Various electrical measuring instruments such as Digital and analog Multimeter, Ammeter, Voltmeter, Wattmeter, Clamp on Meter, Megger, Digital Tachometer, power factor meter etc.
9	Synchronous condenser for Power factor improvement
10	AC & DC Drive Module.
11	Various Types of Lamps i.e Halogen lamp, SL, LED Lamp etc.
12	Software for design a lighting scheme i.e. Calculux etc.
13	Various Domestic appliances like fan, tube light, electrical iron, Microwave oven, Mixer, Vacuum cleaner etc.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit -I Distribution System Components	<p>1a. State the need of distribution system & Various related terminology.</p> <p>1b. Describe with sketches various connection schemes of the distribution system.</p> <p>1c. Describe the Impact of wind and solar power on the distribution system.</p> <p>1d. Describe the measures to be adapted to take care of the distributed generation in the distribution system.</p>	<p>1.1 AC distribution and its Requirements.</p> <p>1.2 Classification of Distribution system.</p> <p>1.3 Various Connection schemes of AC primary & secondary distribution system.</p> <p>1.4 Issues of Distributed Generation Integrated to distribution Grid.</p> <p>1.5 Impact a renewable energy on Distribution system.</p> <p>1.6 Solution to challenges due to distribution generation integrated to distribution</p>

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
	<p>1e. Solve simple numerical problems.</p>	<p>grid.</p> <p>1.7 Consequences of disconnecting neutral in a 3-Phase 4-wire System.</p> <p>1.8 Methods of solving A.C. Single phase and three phase connected (balanced) distribution system.</p>
<p style="text-align: center;">Unit-II Sub-Station And Cable</p>	<p>2a. State the need for electrical Substations.</p> <p>2b. Sketch the single line diagram typical 220/66/11 kV electrical substation with various switchgear.</p> <p>2c. Describe pole mounted substation with sketch</p> <p>2d. State the selection of the bus bar and their arrangement.</p> <p>2e. Describe with sketches the various types of earthing adapted for substations.</p> <p>2f. State the features of unarmored and armored cables used in substation.</p> <p>2g. State the features of different types of cables used in a substation.</p>	<p>2.1 Importance and Classification of substation.</p> <p>2.2 Selection of site for substation.</p> <p>2.3 Single line diagram of substation of 220/66/11 kV Substation.</p> <p>2.4 Pole mounted substation</p> <p>2.5 Different types of Busbar arrangement: Single Bus, Main and Transfer Bus, Breaker and Half Bus and Double bus & transfer bus.</p> <p>2.6 Types of earthing used in substation.</p> <p>2.7 General Construction of cable.</p> <p>2.8 Insulating materials for cable.</p> <p>2.9 Classification of cables.</p> <p>2.10 Recycling of Cables.</p>
<p style="text-align: center;">Unit-III Tariff and Power Factor improvement</p>	<p>3a. Select the relevant tariff for the given applications with justification.</p> <p>3b. Explain with the sketches relevant method of power factor improvement for the given load.</p> <p>3c. Describe the procedure to maintain specified power factor of the system.</p>	<p>3.1 Objectives and desirable characteristics of tariffs.</p> <p>3.2 Types of consumers and Types of tariffs: Flat Rate, Block Rate, Three part, KVA maximum demand.</p> <p>3.3 Problems based on tariff</p> <p>3.4 Power factor: Disadvantages of low power factor and their causes, Advantages of improved power factor.</p> <p>3.5 Power factor improvement by: Static capacitor, Synchronous Condenser, Location of power factor correction equipment.</p>

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit-IV Illumination	<p>4a. Define various illumination terminology and its units.</p> <p>4b. Explain the laws of illumination and its significance.</p> <p>4c. Explain with sketches the various lighting schemes.</p> <p>4d. Describe with the sketches working and applications of the various lamps and fittings in use.</p>	<p>4.1 illumination terminology: Solid and plane angle, Luminous Flux, Luminous Intensity, Lumen, Candle Power, Lux, Lamp Efficiency, Specific Consumption, Glare, Space Height Ratio, Utilization Factor, Maintenance Factor, Absorption Factor, Reflection Factor.</p> <p>4.2 Law of Inverse Squares and Lambert's Cosine Law</p> <p>4.3 Various lighting schemes: features and applications</p> <p>4.4 Construction and working of Incandescent Lamp, Halogen Lamps, Sodium Vapour Lamps, Compact Fluorescent Lamps (C.F.L.), L.E.D lamps and its comparative advantages.</p>
Unit-V Electric Drives & Domestic Appliances	<p>5a. Describe functions of major parts of an electric drive with block diagrams.</p> <p>5b. Differentiate between: I) A.C. and D.C. Drive. II) Individual & group drive.</p>	<p>5.1 Electric drives and its advantages.</p> <p>5.2 Block diagram of electric drive system and advantages of electric drive.</p> <p>5.3 Comparison of D.C.& A.C. Drive and Individual & Group Drive.</p>
	<p>5c. Explain the working of various domestic electrical appliances in use.</p>	<p>5.4 Working Domestic electrical appliances: i. Ceiling fan ii. Electric iron iii. Microwave oven iv. Mixer grinder v. Vacuum Cleaner vi. Washing machine</p>

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit	Unit Title	Teaching	Distribution of Theory Marks
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No.		Hours	R Level	U Level	A Level	Total Marks
I	Distribution System Components	10	6	5	5	16
II	Substation and cable	10	6	6	4	16
III	Tariff and Power Factor improvement	6	2	4	4	10
IV	Illumination	8	8	3	3	14
V	Electrical Drives and Domestic Appliances	8	6	4	4	14

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

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 perform following activities in group (max.3-4 students) and prepare reports for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews.

- Present seminar on various topics from course content.
- Visit and prepare a report of substation
- Undertake a market survey of different types of lighting sources.
- Undertake a market survey of different types of light fitting accessory.
- Solve numerical problems regarding course contents
- Arrange group discussion on various topics on course content.
- To become a familiar with basic lighting design software. i.e. Calculux, etc.

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:

- Massive open online courses (**MOOCs**) may be used to teach various topics/sub topics.
- Guide student(s) in undertaking micro-projects.
- 'L' in section No. 4** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
- Show animation/video related to course content.
- Show charts/photos related to various types distribution schemes, single line diagram of substations and substation layouts.
- Guide students for interpretation of single line diagrams.
- Visit nearby substation.
- With respect to **section No.10**, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- Co-relating the importance of content of this course with other courses and practical applications
- Introduce E-waste recycling technology among the students.

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-projects are group-based (group of 3 to 4). However, **in the fifth and sixth semesters**, 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 students 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. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

- 1) Collect Different Samples Of Overhead Conductors, Underground Cables, Line Supports, And Line Insulators.
- 2) Prepare report on Survey of rural electrification and draw Single Line Diagram including following observation and calculation i) Visit to a village ii) Supply is taken from pole mounted transformer and distributed in various part of village iii) Load calculation iv) loading capacity of different equipment v) Verification of 3-phase balanced loading vi) Finding transformer rating based on loading.
- 3) Making drawing sheet representing Single line diagram of three phase distribution.
- 4) Prepare chart of various course topics like types of line Conductors, Various types of line supports, Types of Busbar arrangements, Single line diagram of various substation, Pole mounted substation, various tariff schemes, various earthing, working of various light sources, electric drives, working of domestic appliances etc.
- 5) Prepare a board of different types of wires or cables.
- 6) Prepare Model of Substation.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	A Course In Power Systems	Gupta J. B.	S.K.Kataria& Sons, New Delhi, 2013, ISBN: 978-9350143735
2	Electric Power Transmission and Distribution	Sivanagaraju S. Satyanarayana S.	Pearson Learning, New Delhi, 2008, ISBN: 978-8131707913,
3	Electrical Power Systems	Uppal S.L	Khanna publication, New Delhi, 2011, ISBN:978-8174092380
4	Electrical Power System	Wadhwa C. L.	New Age International Publishers, New Delhi, 2018 ISBN: 978-9393159175,
5	Principles of power system	Mehta V. K.	S. Chand and Co., New Delhi, 2020, ISBN: 978-8121924962,
6	Handbook of Electrical Power Distribution	Ramamurthy G.	Universities press, Hyderabad 2009, ISBN: 9788173716843

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
7	Sub-Station Engineering Design, Concepts & Computer Applications	Dahiya R. S.	S. K. Kataria & Sons, New Delhi, 2013, ISBN:978-9380027579,
8	Utilization of Electric Power & Electric Traction	Gupta J. B.	S. K. Kataria & Sons, New Delhi, 2012, ISBN:978-9350142585,
9	Utilization of Electric Power & Electric Traction	Garg G. C.	Khanna publication, New Delhi, 2019, ISBN:978-9386173355
10	Fundamentals of Electrical Drive	Dubey G. K.	Narosa Publishing, New Delhi, 2001, ISBN: 978-8173194283
11	Art & Science of Utilization of Electrical Energy	Partab H.	Dhanpat Rai & Sons, New Delhi, 2017, ISBN: 978-8177001440

14. SOFTWARE/LEARNING WEBSITES

- "Calculux" Software for lighting design.
- <https://nptel.ac.in> (for online courses and video of all engineering branches)
- <https://sa-nitk.vlabs.ac.in/List%20of%20experiments.html> (S/S Automation lab)
- <https://lectures.gtu.ac.in/listview.aspx?br=09&course=DI> (Course Content)
- <https://em-coep.vlabs.ac.in/List%20of%20experiments.html> (Synchronous condenser)
- <https://electricalgang.com/chemical-earthing> (For Chemical earthing)
- https://cpcb.nic.in/uploads/Projects/E-Waste/e_waste_amendment_notification_06.04.2018.pdf (For E-waste Recycle guidelines)

Semester 4	Distribution and Utilization of Electrical Power (Course Code: 4340902)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO3 Design/development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency							
CO1: Identify basic components of power system distribution.	3	--	--	--	--	--	2
CO2: Interpret cable specifications, site selection process	3	2	2	--	--	--	2

and layout of substations							
CO3: Acquire knowledge about tariff structures and power factor improvement	2	2	2	2	2	--	2
CO4: Select appropriate lighting source on the basis of different parameters related to illumination.	3	3	2	1	2	--	2
CO5: Compare electrical drives and demonstrate working of various domestic electrical appliances	3	--	--	2	--	--	2

Legend: '3' for high, '2' for medium, '1' for low and '-' for no correlation of each CO with PO.

15. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons:

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