GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Electrical Engineering / Renewable Energy

Subject Code: DI04000181

Subject Name: Utilization of Electrical Power

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

Prerequisite:	Basic electrical engineering concepts, electrical machines, basic of electronics, mathematics and physics
Rationale:	The study of utilization of electrical power is a study of application of electrical power. It includes core principle of application of electrical power in the field of electric furnaces, electrical heating, capacitor for power factor improvement, traction supply system, street light supply system and energy conservation.

Course Outcome:

After Completion of the Course, Student will able to:

CO No	Course Outcomes	RBT Level
01	Understand Traction supply and lighting system	R, U
02	Application of electric furnace and energy efficient technologies	R, U, A
03	Design of street lighting	U, A
04	Applications of regenerative braking and capacitor for power factor improvement	U, 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
				Theory		Tutorial / Practical		
L	T	PR	C	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.	**Unit 1: Electrical Traction Supply System** Contents: • Current scenario of Electrification of Railway lines in India • Single line diagram of traction substation / traction power supply • Overhead equipment (OHE):Catenary and contact wire, Span, stagger, supply control post, interrupter, isolator and pantograph, neutral section, NETRA Car, Two conductor supply to electrical locomotive • Types of Auxiliary supply (Lighting, Fan, AC etc.): self-generating system, Mid-on generation and End-on generation system • Train lighting supply: Brushless alternator (onlyprinciple), rectifier cum regulator and battery • Traction powering: Distributed power, Concentrated power and Loco hauled, Key features of distributed power, compare distributed power and concentrated power • Lighting system: Advantages of 110 V DC over 24 V DC system (334) **Locomotive** • Classification of electrical locomotives • Electric supply to Locomotive: Pantograph, ARNO converter and Static converter, Hotel load converter (HLC) • Dynamic, Rheostatic and Regenerative braking to Locomotive • Distributed power wireless control system (DPWCS), needs for distributed power system • Block diagram of locomotive power circuit • Three phase AC Locomotive • Effect of speed on specific energy consumption	10	22%
2	**Unit 2: Applications of Electric Furnace** Contents • Application of Electric Arc furnace in steel industries • Steel industry scenario in India: Production, Import and Export (2024-25) • Methods of Steel production process • Construction of Electric arc furnace (EAF)	8	18%

	• Operation of EAF: Charging, Complete meltdown, oxidation and refining, de-oxidation and tapping of liquid steel • Terminology: Capacity utilization, yield and specific energy consumption, Energy balance • Energy efficient EAF technologies: Ultra high-power transformer, high impedance operation, aluminum electrode arm, improve regulation control, oxy fuel burners, Mist cooling of electrodes, water cooled cables, Estimation of saving and payback period of all energy efficient methods **Induction furnace** • Construction and working of induction furnace		
3	**Unit 3: Electrostatics & Electroplating Applications** Contents: • Application of electrostatics in electrostatic paint • Charged particles: Positive charge, Negative charge and neutral particles • What is electrostatic paint?Working of electrostatic paint • Electrostatic charging methods: Corona charging, contact charging Induction charging and frictional charging • Faraday cage effect, Wraparound effect, High voltage power supply, Electrostatic accessories, Importance of resistivity of coating material **Electroplating** • Industrial applications of electroplating • Principle of electroplating • Materials used in electroplating	8	18%
4	**Unit 4: Street Lighting** • Components of street lighting system: lamp, ballast and luminaries • Performance parameter: total luminous flux, luminous intensity, luminous efficacy, chromaticity coordinates, correlated colour temperature, colour rendering index, photometry, relation between lumen and lux • Laws of illumination **Street light design** • Street light pole arrangement by lumen-based method, pole height as compare wattage of lamp, pole spacing optimization, Distance between two poles by approximation method &actual method, Estimate watt rating of street light luminaries	10	22%

	Illumination measurement • Estimation of illuminance measurement: correction factor for lux meter, determination of illumination points in area, room index, average illuminance, installed load efficacy, total power of light sources in area, estimate target installed load efficacy, reasons for Installed load efficacy ratio (ILER), steps to provide energy efficacy, case study		
5	**Unit 5: Applications of Regenerative Braking** • Regenerative braking in electric cars, electrical train / metros, E bicycle/ E scooter, electric buses • Case study of energy saving by applying braking in electric car on flat surface and descent considering 50% and 75% efficiency • Case study of energy saving by number of stops in electric train considering 50% and 75% efficiency • Compare energy saving in both cases	3	7%
6	**Unit 6: Reactive Power Compensation** • Concept of reactive power, causes of low power factor, advantages of reactive power management by capacitor • Centralized compensation, individual and group compensation • Capacitor rating for power factor improvement by using standard table and formula • Case study on Effect of power factor on three phase line current and copper losses • Capacitor rating for star and delta connection for power factor improvement • Case study on Effect of power factor on cable size and energy saving	6	13%
	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**
25 %	35 %	40 %	-	-	-

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) Books:

1.	Principal of power system by V. K. Mehta
2.	Nickel plating handbook
3.	Utilization of electrical power and electric traction by J B Gupta, Khanna Publication
4.	Utilization of electric energy by Er. Tarlok Singh

(b) Learning Websites & Web-Portals:

Sr. No	Web-Link of Websites / Web-Portal	Description
1	https://formlabs.com/global/blog/electroplating-metal-plating/?srsltid=AfmBOoqfMcQKJi7weqMbEJuzz2Bliye9y9DBZHNTl3dipIkXW9trrpb_	Electroplating
2	https://fractory.com/electroplating-explained/	Electroplating
3	https://howelectrical.com/electroplating/	Electroplating
4	https://sterc.org/pdf/other/0150.pdf	Electroplating
5	https://www.ghasterpaintinginc.com/blog/what-electrostatic-painting-is-and-why-it-works-so-well/	Electrostatic Painting
6	https://whisco.ca/static/site-content/files//electrostatic-spraying-white-paper-9-29-20.pdf	Electrostatic Spraying
7	https://steel.gov.in/sites/default/files/2025-04/Monthly%20Economic%20report%20January%202025_0.pdf	Electric Furnace
8	https://tenova.com/technologies/electric-arc-furnaces-eaf	Electric Furnace
9	https://indianrailways.gov.in/eng.html	Electrical Traction
10	https://indianrailways.gov.in/railwayboard/view_section.jsp?lang=0&id=0,1,304,366,549,1229	Railway Electrifications
11	https://www.zgsm-china.com/blog/key-factors-to-consider-in-the-design-of-road-lighting-projects.html	Street lighting
12	https://www.electrical4u.com/road-lighting-design/	Street lighting

Suggested Course Practical List:

The following Practical Outcomes (PrOs) are the sub-components of the Course Outcomes (COs). Some of the PrOsmarked**'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'

Subject In-charge can add performance experiments only.

Sr. No.	Practical Outcomes /Title of experiment	CO1	CO2	CO3	CO4
1	Draw and explain substation layout from supply to electric train preferably using computer software tool. (Autocad)	√			
2	Estimate illuminance points and average illuminance levelat any residential / commercial / industrial /academic workplace.			√	
3	Measurement of illumination at specific point / place using inverse square law			√	
4	To estimate the Installed Load Efficacy Ratio (ILER) of a drawing hall or workshop.			√	
5	To estimate energy saving due to braking in an electric vehicle on both flat and descending road surfaces.				√
6	To estimate energy saving by regenerative braking in an electric train considering the number of stops.				√
7	To perform power factor improvement in a single phase circuit using a capacitor and measurement of reactive power before and after improvement				√
8	To perform the power factor improvement in a three phase circuit using capacitor connection in star and delta configuration and measurement of reactive power before and after improvement				√
9	To estimate the optimum distance between two street-light poles.				√
10	To estimate the wattage rating of a street-light luminaire using assumed or standard data.				√
11	To perform measurement of reactive power of a three-phase motor or transformer using any suitable method.				√

Suggested List of Laboratory/Learning Resources Required:

1. PowerAnalyzer (0-10 A, 0-415 V, 1 or 3 phase, 0-20 kW)
2. Ammeter (0–5 A AC/DC)
3. Voltmeter (0–300 V AC/DC)
4. Wattmeter (0–300 V / 5 A range)
5. Power Factor Meter (0–1 lag–lead)
6. Energy Meter / Watt-hour Meter (230 V, 5–10 A)
7. Lux Meter (0–20000 lux range)
8. Clamp Meter (0–20 A)
9. Multimeter (digital, 3½ digit)
10. Tachometer (0–3000 rpm)
11. Single-phase inductive load (0.2–0.5 H choke or small motor)
12. Three-phase inductive load (induction motor 1–3 HP or load bank)
13. Three-phase transformer (1 kVA rating)
14. Capacitor bank (1–10 kVAR, both single-phase and three-phase, star/delta configurable)
15. Resistive load (lamp bank or heater, 230 V, 100–2000 W total)
16. Connecting leads (suitable gauge, insulated)
17. Terminal boards
18. Measuring tape (5–10 m)
19. Stopwatch/timer (digital)

SuggestedActivities / Project List:

1. Industrial visit to nearby electric traction substation / Furnace industry
2. Measure illumination level by using lux meter
3. Find out standard rating of LED for street light as per MNRE (MNRE Website)

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