GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Power Electronics Engineering

Subject Code: DI04024081

Subject Name : Electric Traction

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

Prerequisite:	Basic laws of electrical engineering, fundamentals of electrical machines and working principles of Power electronics switches.
Rationale:	Electric Traction is an important subject for Electrical and Power Electronics Engineering as it applies electrical energy for propulsion in trains, metros, and electric vehicles. It integrates the principles of electrical machines, power converters, and control systems to achieve efficient and reliable motion control. With the growing demand for electrified transportation and energy-efficient systems, this subject equips students with essential knowledge of traction motors, braking methods, power supply arrangements, and modern drive technologies used in railway and electric vehicle applications.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Apply the basic principles of various traction systems to identify suitable traction systems for specific transportation application.	R, U
02	Interpret traction power supply systems, overhead equipment, and substation layouts to ensure efficient traction power distribution.	R, U, A
03	Demonstrate and select appropriate motor-control methods for specific traction requirements.	R, U, A
04	Evaluate various performance parameters and apply suitable braking techniques to enhance traction system efficiency.	R, U, A
05	Apply knowledge of emerging technologies to assess modern developments and sustainability in electric traction.	R, U

**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.	**Introduction to Electric Traction** Definition, classification of traction systems Advantages and disadvantages of Electric Drive, Diesel Electric Drive, Battery Drive, Requirements of ideal traction system Applications of electric traction (railway, metro, EV) General arrangement of D.C., A.C. singlephase,3phasehase, Composite systems, Choice of traction system - Diesel- Electric or Electric Historical background of track electrification in India. Present scenario of Indian Railways – High speed traction, Metro	7	16
2.	**Supply Systems for Electric Traction** Different systems of electric traction supply: DC systems: 600 V, 750 V, 1500 V, 3000 V AC systems: 15 kV, 25 kV, 50 Hz **(**Single-phase and three-phase systems) Overhead equipment: Different types of overhead equipment Pentagonal OHE Catenary Construction. Overhead system- Trolley collector, bow collector; Pantograph Collector Types and construction of pantograph Traction substation – layout, components (transformer, circuit breaker, feeder, SCADA) Earthing, protection and safety measures Electrical block diagram of an electric locomotive with description of various equipment and accessories used.	10	22
3.	**Traction Motors and Their Control** Features of traction motors. Significance of D.C. series motor as traction motor	12	26

	A. C. Traction motors-single phase, three phase, Linear Induction Motor Comparison and characteristics of different traction motors Speed control methods of DC and AC traction motors: Rheostatic control, Series-Parallel control, Tap changer control, PWM inverter-fed induction motor control Starting and transition of traction motors. Power electronic converters used in traction drives (choppers, inverters, IGBT-based drives)		
4.	Braking and Performance of Traction Systems Braking: Requirement of a braking system. Mechanical braking: vacuum braking, compressed air braking, Magnet rail brake, hand brake for parking. Electric braking: Rheostatic braking and regenerative braking, Plugging. Braking characteristics and energy saving. Speed-time curve and tractive effort. Calculations: Acceleration, Retardation, Schedule speed. Adhesive weight and efficiency.	10	22
5.	**Modern Trends and Applications** Metro rail traction system Introduction to Hydrogen Energy, Hydrogen Fuel Cell Fundamentals. Concept of Hydrogen Fuel Cell Electric Train (FCET). Block diagram and working of a hydrogen-electric traction system. Hydrogen in Rockets, cars, Aero-planes, Ships, Aircrafts, Buses & Military vehicles. Case Studies, Advantages, Challenges, and Future Prospects.	6	14
	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**
30	**60**	**10**			

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

S. No.	Title of Book	Author	Publication
1.	Modern Electric Traction	H. Partab	Dhanpat Rai and Sons, New Delhi
2.	Electric Traction	J. Upadhyay S. N. Mahendra	Allied Publishers Ltd., Dhanpat Rai and Sons, New Delhi
3.	Electric Traction	A.T. Dover	Mac millan, Dhanpat Rai and Sons, New Delhi
4.	Electric Traction Hand Book	R. B. Brooks.	Sir Isaac Pitman and sons ltd.
5	Utilization of Electric Power& Electric Traction	G.C. Garg	Khanna Book Publishing Co., New Delhi (ISBN: 978-93-86173-355)
6	Utilization of Electric power and traction	Gupta J.B.	S.K.Kataria and Son

(b) Open-source software and website:

- www.vlab.co.in
- www.youtube.com

Suggested Course Practical List:

S. No.	Practical Exercises
1.	Study of different types of traction systems.
2.	Compare of electric, diesel-electric, and battery drives.
3.	Study various components of a typical electric traction system.
4.	Study historical development of traction electrification in India.
5.	Study of various AC and DC supply systems used in electric traction.
6.	Study overhead equipment (OHE) used for electric traction system.
7.	Study of traction substation layout and equipment.
8.	Simulate single-line diagram of an electric locomotive power circuit.
9.	Demonstrate earthing and protection arrangements for electric traction.
10.	Study of construction and characteristics of DC Series motor
11.	Study speed-torque characteristics of a DC Series motor
12.	Study speed-torque characteristics of a 1-phase and 3-phase induction motor.
13.	Study speed-torque characteristics of a Linear induction motor.
14.	Study speed control of DC traction motor using rheostatic or chopper control method.

15.	Study Speed control of 3-phase induction motor using inverter-fed PWM technique.
16.	Study transition methods for traction motors (series–parallel transition and field weakening).
17.	Study of mechanical braking systems for electric traction.
18.	Plot or simulate a typical speed–time curve for urban and mainline trains.
19.	Study various electric braking — rheostatic, regenerative, and plugging methods using simulation.
20.	Study of metro rail traction system (25 kV AC and 750 V DC).
21.	Demonstration of a fuel cell using trainer kit.
22.	Study of a Hydrogen Fuel Cell Electric Train (FCET).

List of Laboratory/Learning Resources Required:

Sr. No.	Resources
1.	DC Motor Control Trainer Kit (Rheostatic and Chopper Control)
2.	3-Phase Induction Motor Drive Trainer Kit
3.	Power Electronics Converter Trainer • For study of chopper, inverter, and IGBT-based converter circuits used in traction drives. • *Includes:* MOSFET/IGBT modules, PWM generation unit, current/voltage sensors.
4.	Traction Motor Characteristics Trainer • For plotting torque-speed and speed-current characteristics of DC series and AC induction motors.
5.	Regenerative Braking Trainer Kit or Simulation Setup • To demonstrate rheostatic and regenerative braking methods.
6.	Fuel Cell Trainer Kit (Hydrogen Energy Experiment Set)
7.	Overhead Line Equipment (OHE) Model or Simulation Board
8.	Traction Substation Model / Simulation Setup
9.	Electric Locomotive Electrical Layout Demonstrator

Suggested Project List:

- Prepare Report on Track Electrification in India.
- Make a Demonstration Model of Metro / Railway Traction Line.
- Prepare Report of Case Study on Indian Metro Rail Systems (Delhi, Mumbai, Ahmedabad, etc.)
- Mini Project on Overhead Equipment (OHE) Model (Display model)
- Simulation of Electric Traction Drive using software.
- Make a Report on "National Green Hydrogen Mission" and Its Relevance to Railway Electrification.
- IoT-Based Monitoring of Traction Motor Parameters (Using sensors like temperature, current, speed and Node-MCU/32).

Suggested Activities for Students:

- Prepare a comparative chart showing differences between: Steam, Diesel, and Electric Traction systems.
- Prepare a comparative chart showing differences between DC and AC traction supply systems.
- Prepare a poster or chart on the History of Track Electrification in India.
- Make a presentation on "Types of Electric Locomotives in Indian Railways."
- Prepare a report on "Advantages and Disadvantages of Electric Drive vs. Diesel-Electric Drive."
- Draw block diagrams of electric and diesel-electric traction systems and label key components.

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