

**GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)****Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)**

Semester-V

**Course Title: Electric Traction & Control**

(Course Code: 4350907)

Diploma Programme in which this course is offered	Semester in which offered
Electrical Engineering	5 <sup>th</sup> Semester

**1. RATIONALE**

The country is leading towards the railway electrification and also moving towards metro, monorail system. The diploma student is required to know about the electric traction scheme and its latest trends. This subject is offered as one of the elective, highlighting the current and future trends in traction systems, auxiliary equipment, electric locomotives, control of traction motors and future-trends. The Diploma pass student with this elective will be able to maintain the traction systems, auxiliary equipment, electric locomotives and traction motors.

**2. COURSE OUTCOMES**

The theory should be taught and practical should be undertaken in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domains to demonstrate the following course outcomes:

- I :-Distinguish different traction systems and Differentiate services of traction system based on speed time curve.
- II:-Control different types of traction motors.
- III:-Explain the distribution system of a traction system and specific energy consumption.
- IV:-Use various traction system auxiliaries
- V : - Latest trends in traction systems.

**3.TEACHING AND EXAMINATION SCHEME**

Teaching scheme (in hours)			Total contact hrs/week	Total credits L+T+(P/2)	Examination Scheme				
L	T	P			Theory marks		Practical marks		Total marks
CA	ESE	CA	ESE						
3	0	2	5	4	70	30	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.

**4.SUGGESTED LIST OF EXERCISES/PRACTICALS**

The tutorial/practical/exercises should be properly designed and implemented with an attempt to develop different types of cognitive and practical skills (**Outcomes in cognitive, psychomotor and affective domain**) so that students are able to acquire the competencies.

Note: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of **Programme Outcomes/Course Outcomes in affective domain** as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those Programme Outcomes/Course Outcomes related to affective domain.

Sr. No.	Unit No	Practical Exercises (Major outcomes in Psychomotor Domain)	Approx Hours. required
1	I	Investigate the various traction systems in Indian railways.	02
2	I	Solve Numerical on speed time curves	02
3	II	Justify the use of D. C. Series motor as traction motor	02
4	II	Calculate energy saving by series parallel control of D. C. Motor (for two and four motors).	02
5	II	Investigate the energy recovered using regenerative braking	02
6	III	Study of major equipments in AC traction substations.	02
7	III	Solve numerical on specific energy consumption.	02
8	IV	Study of layout of D. C. locomotive and diesel locomotive.	02
9	IV	Study of power diagram of A.C. locomotive and its equipment.	02
10	IV	Draw sketch of the Overhead current collecting equipment.	02
11	IV	Describe the train lighting system	02
12	V	Investigate various latest trends in electric traction systems	02
13	V	Understand the working of high speed train	02
14	V	Prepare A report on Traction visit / Metro visit	02
		<b>TOTAL HOURS</b>	<b>26</b>

#### Note

- More Practical Exercises can be designed and offered by the respective course teacher to develop the present industry/traction system relevant skills/outcomes to match the COs. The above table is only a suggestive list.
- 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.	Diagram / sketches / tables	30
2.	Conceptual clarity	20
3.	Team work & ethical values	20
4.	Experimental setup, Procedure and conduction by following safety practices.	30

## 5.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
<b>UNIT-I TRACTION SYSTEM AND SPEED TIME CURVE</b>	1a. History of Railway. Explain types of traction systems and their significance. 1b. Explain the general arrangement of different types of Electric traction systems and their significance. 1c. Select a traction system for a given application. 1d. Draw the speed time curve related to different traction system. 1e. Solve numerical based on speed time curve.	1.1 Steam, diesel, diesel-electric, Battery and electric traction systems 1.2 General arrangement of D.C., A.C single-phase, 3phase, Composite systems 1.3 Choice of traction system - Diesel-Electric or Electric. 1.4 Analysis of speed time curves for main line, suburban and urban services 1.5 Simplified speed time curves. 1.6 Relationship between principal quantities in speed time curves. 1.7 Numerical on speed time curve
<b>UNIT- II TRACTION MOTORS AND ITS CONTROL</b>	2a. State the desirable features of traction motors. 2b. Explain Significance of D.C. series motor over D.C. Shunt motor. 2c. Explain working of various A.C. motors as traction motors.	2.1 Features of traction motors. 2.2 Significance of D.C. series motor as traction motor 2.3 A.C. Traction motors - single phase, Three phase, Linear Induction Motor 2.4 Comparison between different traction motors
	2d. Compare different traction motors. 2e. Apply various control methods Applied to traction motors. 2f. Explain different types of electric braking system	2.5 Series-parallel control 2.6 Open circuit, Shunt and bridge transition 2.7 Pulse Width Modulation control of induction motors 2.8 Types of electric braking System.
<b>UNIT-III FEEDING, DISTRIBUTION SYSTEM AND SPECIFIC ENERGY CONSUMPTION CALCULATION</b>	3a. Explain the distribution & feeder system pertaining to traction 3b. Classify traction substations 3c. Describe different methods of feeding the traction sub-station	3.1 Distribution systems pertaining to traction (distributions and feeders) 3.2 Traction sub-station requirements and selection 3.3 Method of feeding the traction sub-station
	3d. Tractive effort 3e. Calculate specific energy consumption. 3f. State the factors affecting Specific energy consumption	3.4 Requirement of tractive effort 3.5 derivation of expression for tractive effort 3.5 Calculation of train resistance and derivation of general equation 3.6 Energy output from driving axle 3.7 Numerical on specific energy consumption
<b>UNIT-IV</b>	4a. Classify electric locomotive	4.1 Important features of electric locomotives

<b>Electric Locomotives and Auxiliary Equipment</b>	4b. Describe the function of auxiliaries in traction system 4c. Describe the different current collecting methods in locomotives 4d. Explain different control and auxiliary equipment used in the locomotive 4e. Describe the Power conversion and transmission systems 4f. Explain Coach wiring and lighting devices	4.2 Different types of locomotives 4.3 Current collecting equipment 4.4 Coach wiring and lighting devices 4.5 Power conversion and transmission systems 4.6 Control and auxiliary equipment
<b>UNIT V MODERN TRENDS IN ELECTRIC TRACTION SYSTEM</b>	5a. Explain the present scenario of INDIAN Railways- High speed traction, bullet train, hyper loop, Metro 5b. Detail the latest trends in traction. 5c. magnetic levitation 5d. linear Electric motor (LEM)	5.1 future plans for traction and present day facilities in INDIAN RAILWAYS 5.2 metro rail electrical system 5.2.1 substation 5.2.2 traction system and operational control centre (OCC) 5.2.3 Earthing system and reliability measures 5.3 magnetic levitation 5.4 linear induction motor (LIM) 5.5 high speed train on magnetic levitation 5.6 variable frequency operation of 3 phase induction motor 5.7 electro magnet suspension c and electro dynamic suspension

#### 6. SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Traction System And Speed Time Curve	08	04	02	04	10
II	Traction Motors And Its Control	14	05	07	10	22
III	Feeding, Distribution System And Specific Energy Consumption Calculation	08	02	04	04	10
IV	Electric Locomotives And Auxiliary Equipment	08	06	08	06	20
V	Modern Trends In Electric Traction System	04	04	04	00	08
	<b>TOTAL</b>	<b>42</b>	<b>21</b>	<b>25</b>	<b>24</b>	<b>70</b>

Legends: R = Remembrance; U = Understanding; A = Application and above levels (Revised Bloom's taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

#### 7. SUGGESTED LIST OF 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 (or individual) and prepare reports of about 10 pages for each activity. They should also collect/record physical evidence for their (student's) portfolio which may be useful for their placement interviews.

- Present seminar on various topic from course content
- Prepare a report after visiting electric traction substation / metro rail system

- c) Prepare report on the following D.C. locomotive ,A.C/DC locomotive and diesel electric locomotive
- d) Solve numerical problem regarding course contents
- e) Prepare a report on current collector system with complete arrangement of pantograph its location and electric wiring system with locomotive
- f) Seminar on latest electric traction in world.

#### 8.SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

- a) Massive open online courses (MOOCs) may be used to teach various topics/subtopics.
- b) Guide student(s) in undertaking mini-projects
- c) Arrange visit to nearby locomotive workshop / loco shed
- d) Arrange nearby visit to metro rail system
- e) Arrange nearby visit to electric locomotive loco shed
- f) Co-relating the importance of content of this course with other courses and practical applications
- g) Arrange nearby visit to traction substation
- h) Show animation/video related to course content
- i) Have group discussion on various topic on course content and get updated with latest trends in traction system

#### 9.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). 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

- A) Prepare the model of traction substation
- B) Working model of hybrid locomotive
- C) Prepare Model for catenary system
- D) Making drawing sheet of control system and type of switch
- E) Working model of single battery system
- F) Collect the sample overhead cable, supports and line insulator
- G) Model for conductor rail system and finding the transformer rating based on loading
- H) Prepare chart of various upgrade locomotive and traction system
- I) Making drawing sheet of representing tractive effort

#### 10.SUGGESTED LEARNING RESOURCES

Sr.no.	Title of books	Author	Publication
1.	ELECTRIC TRACTION	J UPADHYAY,S.N.MAHENDRA	ALLIED PUBLISHERS LTD.
2.	ELECTRIC TRACTION	A.T.DOVER	MAC MILLAN, DHANPAT RAI AND SONS, NEW DELHI

3.	Power Electronics and Electric Drives for Traction Applications	Gonzalo Abad Top of Form Bottom of Form	<a href="#">John Wiley &amp; Sons.</a>
4.	Metro Rail in India for Urban Mobility	<a href="#">M. M. Agarwal</a> , <a href="#">Sudhir Chandra</a> , <a href="#">K. K. Miglani</a>	Prabha& Co.
5.	Electric Traction - Motive Power and Energy Supply	Andreas Steimel Top of Form Bottom of Form	OldenbourgIndustrieverlag
6.	Modern Electric Traction	<a href="#">Tarlok Singh</a>	S.k. Kataria
7.	Utilization of Electrical Energy and Traction	J.B.GUPTA, <a href="#">Rajeev Manglik</a> , <a href="#">RohitManglik</a>	S.K. Kataria& Sons
8.	ELECTRIC TRACTION HAND BOOK	R.B.BROOKS	SIR ISAAC PITMAN AND SON LTD. LONDON
9.	MODERN ELECTRIC TRACTION	H.PARTAB	DHANPAT RAI AND SONS, NEW DELHI

#### List of Major Equipment/ Instrument with Broad Specifications

- Models of different traction systems and equipment
- Working Models of different traction motor

#### 11.SOFTWARE/LEARNING WEBSITES WEBSITES

- [www.scrailway.gov.in](http://www.scrailway.gov.in)
- [www.wr.railnet.gov.in/bctweb/ELECTRICAL.htm](http://www.wr.railnet.gov.in/bctweb/ELECTRICAL.htm)
- [www.irreen.com](http://www.irreen.com)(IndianRailwaysInstituteofElectricalEngineering,NasikRoad)
- [www.vlab.co.in](http://www.vlab.co.in)
- [www.electricaltechnology.org/](http://www.electricaltechnology.org/)
- [www.electrical4u.com](http://www.electrical4u.com)
- [www.lectures.gtu.ac.in](http://www.lectures.gtu.ac.in)
- <https://circuitglobe.com/electrical-earthing.html>

#### 12.PO-COMPETENCY – CO MAPPING:

SEMESTER V	ELECTRICAL TRACTION AND CONTROL COURSE CODE (4350907)						
	POS						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledg	PO 2 Problem Analysis	PO 3 Design/ develop ment of solution	PO4 Engineering Tools, Experimentation &Testing	PO5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning

Competency	Operate and maintain various types of Electrical Traction System						
<b>Course Outcomes</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>-</b>	<b>3</b>	<b>-</b>	<b>2</b>
CO1 Distinguish different traction systems and Differentiate services of traction system based on speed time curve							
CO2 Control different types of traction motors	<b>3</b>	<b>3</b>	<b>3</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>2</b>
CO3 Explain the distribution system of a traction system and specific energy consumption	<b>3</b>	<b>2</b>	<b>2</b>	<b>-</b>	<b>2</b>	<b>-</b>	<b>2</b>
CO4 Use various traction system auxiliaries	<b>3</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>2</b>	<b>2</b>
CO5 Latest trends in traction systems.	<b>3</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>3</b>	<b>-</b>	<b>2</b>

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

### 13.COURSE CURRICULUM DEVELOPMENT COMMITTEE

#### GTU RESOURCE PERSON

SR.NO.	NAME	INSTITUTE	CONTACT NO.	EMAIL
1.	Smt. Devangi J Jain	B&B Institute of Technology v.v.nagar	9724308429	<a href="mailto:devangijain@gmail.com">devangijain@gmail.com</a>
2.	M.K.CHAWDA	Tolani F G Polytechnic Adipur	8460583331	<a href="mailto:Manishchawda1992@gmail.com">Manishchawda1992@gmail.com</a>