Program : **Diploma in Electrical and Electronics Engineering**	
Course Code : **6032D**	Course Title: **Electric Vehicles & Traction**
Semester : **6**	Credits: **4**
Course Category: **Program Elective**	
Periods per week: **4 (L:3 T:1 P:0)**	Periods per semester: **60**

Course Objectives:

- To express the relevance of electric vehicles for the future transportation sector.
- To illustrate the fundamental concept of electric traction and identify various motors used for electric vehicles.
- To outline the various energy storage options in EV.
- To identify the charging infrastructure requirements.

Course Prerequisites:

Topic/Description	Course code	Course Title	Semester
Basics of Electrical Circuits.		Fundamentals of Electrical & Electronics Engineering	2

Course Outcomes

On completion of the course, the students will be able to:

COn	Description	Duration (Hours)	Cognitive Level
CO1	Outline the basic concepts of electrical vehicles and matching the power train needs.	15	Understanding
CO2	Explain the principle of electric traction and application of various electric motors in EV.	15	Understanding
CO3	Outline the importance of hybridization of various energy storage in electric vehicles.	14	Understanding
CO4	Summarize the scope for public charging infrastructure and e-mobility.	14	Understanding
	Series Test	2	

CO-PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2				3		
CO2	2						
CO3	2						
CO4	2						

3-Strongly mapped, 2-Moderately mapped, 1-Weakly mapped

Course Outline

Module Outcomes	Description	Duration (Hours)	Cognitive Level
CO1	**Outline the basic concepts of electrical vehicles and matching the power train needs.**		
M1.01	Summarize the general classifications of vehicles and explain the importance of electric vehicles.	3	Understanding
M1.02	Illustrate the factors affecting vehicle motion.	4	Understanding
M1.03	Summarize the basic idea of conventional automobile power trains.	4	Understanding
M1.04	Compare the powertrain of EV, HEV and PHEV.	4	Understanding
Contents: Overview of automobile development - technical parameters and working - gasoline powered vehicle - electric vehicle(EV) - hybrid electric vehicle(HEV) - plug in hybrid electric vehicle(PHEV) - social and environmental importance of EV and HEV – comparisons (technical, economical and environmental aspects). Vehicle movement - various factors - definitions - vehicle resistance, - tyre ground adhesion - rolling resistance - aerodynamic drag - equation of grading resistance - tractive effort on wheels (basic idea with equation). Automobile powertrain (IC engine based) - basic concepts - clutch - gearbox - differential. Electric vehicle powertrain - block diagrams - basic concept - hybrid electric vehicle - plug in hybrid electric vehicle - comparisons - EV - HEV - PHEV.			
CO2	**Explain the principle of electric traction and application of various electric motors in EV.**		
M2.01	Outline the importance of Electric traction and various systems of electric traction.	4	Understanding
M2.02	Illustrate the Speed Time Curve and its importance	3	Understanding

M2.03	Explain the basic architecture of hybrid drive trains and their configurations.	4	Understanding
M2.04	Explain the various motors used in EVs and HEV's.	4	Understanding
	Series Test-1	1	

Contents:

Electric traction - introduction - relevance- types - advantages - requirement of an ideal traction system - supply system - types - specifications - layout of electric locomotive system - traction motors(listing only) - dc series motor - single phase ac series motor - three phase induction motors - important requirements of traction motors .

Passenger services - types - typical speed time curve - stages - speed time curve for different services (diagramatic representation only) - importance of speed time curve - terms related with train movement - average speed, scheduled speed and crest speed (definition only).

Hybrid electric powertrain - hybrid design philosophy - overview - configurations (series, parallel and series parallel).

Special motors in EV - principle of operation-working with diagrams - Brushless DC motor - Permanent Magnet Synchronous Motor (PMSM)

CO3	**Outline the importance of hybridization of various energy storage in electric vehicles.**		
M3.01	Summarize the parameters of various batteries.	4	Understanding
M3.02	Explain the role of ultra capacitors, fly wheels in EV applications.	4	Understanding
M3.03	Outline the working of fuel cells and significance of hydrogen fuel cells.	3	Understanding
M3.04	Explain the hybridization of different energy storage devices.	3	Understanding

Contents:

Batteries - overview - parameters - definitions - specific power - energy efficiency - thermodynamic voltage - criterion for selection of batteries - batteries for EV - types (listing only) - lithium batteries - types - working principle - lithium polymer (Li-P) - Lithium - Ion(Li-Ion) - advantages - limitations.

Energy storage in EV - principle of operation - working - features - ultra capacitors - flywheels - fuel cells - types of fuel cells(listing only) - working of hydrogen fuel cells - advantages and limitations of fuel cells.

Hybridization of energy storage- basic concept- necessity- importance.

CO4	**Summarize the scope for public charging infrastructure and e-mobility.**		
M4.01	Illustrate the control architecture of HEV.	4	Understanding
M4.02	Explain the various EV charging standards and	4	Understanding

	connectors.		
M4.03	Outline the general requirements of a public charging infrastructure.	4	Understanding
M4.04	Summarize the scope and challenges in e-mobility	2	Understanding
	Series Test-2	1	

Contents:

Control systems in HEVs - control architecture (block diagram approach only).

EV charging system - block diagram - EV charging standards - V2G - G2V - V2B - V2H - charging - types - modes (as per SAEJ1772). Connectors in EV - types - requirements - input - output - safety - CCS - Bharat EV AC- Bharat EV DC.

Public charging infrastructure - general requirements (operational and technical).

E-mobility and electrification - scope and challenges.

Text / Reference:

T/R	Book Title/Author
T1	Ehsani, M. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press
T2	B.L.Theraja, A K Theraja: A textbook of Electrical Technology-Volume III-S.Chand Publications.
R1	Husain, I. Electric and Hybrid Electric Vehicles, CRC Press
R2	A.K. Babu, Electric & Hybrid Vehicles, Khanna Publishing House, New Delhi (Ed. 2018)
R3	Fuhs, A. E. Hybrid Vehicles and the Future of Personal Transportation, CRC Press,
R4	Gianfranco, Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure And The Market, Pistoia Consultant, Rome, Italy,
R5	Chan C. C. and K. T. Chau, Modern Electric Vehicle Technology, Oxford Science Publication,
R6	Lechner G. and H. Naunheimer, Automotive Transmissions: Fundamentals, Selection,Design and Application, Springer
R7	Rashid, M. H. Power Electronics: Circuits, Devices and Applications, 3rd edition, Pearson,
R8	Moorthi, V. R. Power Electronics: Devices, Circuits and Industrial Applications, Oxford University Press

Online resources:

Sl.No	Website Link
1	https://nptel.ac.in/courses/108/103/108103009/
2	https://onlinecourses.nptel.ac.in/noc20_ee99/preview
3	https://fame2.heavyindustry.gov.in/
4	http://www.anert.gov.in/
5	https://powermin.nic.in/
6	https://www.kseb.in/