

Program : Diploma in Electrical and Electronics Engineering	
Course Code : 6031B	Course Title: Electric Vehicle Technology
Semester : 6	Credits: 5
Course Category: Program Elective	
Periods per week: 5 (L:4 T:1 P:0)	Periods per semester: 75

Course Objectives:

- To express the relevance of electric vehicles(EV) for the future transportation sector.
- To understand the application of electric motors in EV application.
- To summarize various energy storage options in EV.
- To identify the charging infrastructure requirements for EV.

Course Prerequisites:

Topic/Description	Course code	Course Name	Semester
Traction motors and speed characteristics		DC Machines and Traction Motors	3
Working ,speed – torque characteristics, speed control		Induction Machines	4
Chopper, Inverter.		Power Electronics Devices & Circuits	4
Storage batteries		Elementary concepts of electrical systems	2

Course Outcomes

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

CO _n	Description	Duration (Hours)	Cognitive Level
CO1	Outline the basic concepts of electrical vehicles and matching the power train needs.	18	Understanding

CO2	Identify the application of various electric motors and its control for EV.	20	Understanding
CO3	Outline the importance of hybridization of various energy storage in electric vehicles.	17	Understanding
CO4	Explain the control architecture for HEV and summarize the requirements for charging infrastructure.	18	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 powertrain.	5	Understanding
M1.04	Compare the powertrain of EV,HEV and PHEV.	6	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)- Faster Adoption and Manufacturing of Hybrid and EV (FAME) initiative of Govt. of India (GoI)-EV policy of Govt of Kerala(GoK)- role of Kerala State Electricity Board Limited .

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	Identify the application of various electric motors and its control for EV.		
M2.01	Summarize the characteristics of traction motors	2	Understanding
M2.02	Illustrate the different hybrid design philosophy and estimate the hybridness factor.	6	Understanding
M2.03	Explain the principle and operation of various electric drives.	5	Understanding
M2.04	Explain the various motors used in EVs and HEVs.	7	Understanding
	Series Test-1	1	

Contents:

Traction Motors- overview of ac and dc traction- characteristics-power vs speed-torque vs speed-energy consumption from battery-basic concept with equation only.

Hybrid electric vehicle powertrain-classifications - hybridness - simple numerical- hybrid design philosophy- overview- configurations(series, parallel and series parallel)

Drives - working with diagrams-chopper fed DC drives(four quadrant operation)-induction motor drives(constant V/f control)

Special motors in EV-principle of operation-working with diagrams-Brushless DC motor-Permanent Magnet Synchronous Motor(PMSM) -Switched Reluctance Motor (SRM)-braking in SRM-basic concept-listing of braking modes-block diagram representation of generation mode only.

CO3	Outline the importance of hybridization of various energy storage in electric vehicles.		
M3.01	Explain the electrical characteristics and parameters of batteries.	4	Understanding

M3.02	Compare 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.	5	Understanding
M3.04	Summarize the hybridization of different energy storage devices.	4	Understanding

Contents:

Batteries- overview- parameters- definitions- specific power- energy efficiency- battery characteristic curves- charging- discharging- criterion for selection of batteries- batteries for EV- types(listing only)- lithiumbatteries- 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- ultra high speed 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	Explain the control architecture for HEV and summarize the requirements for charging infrastructure.		
M4.01	Illustrate the control architecture of HEV.	4	Understanding
M4.02	Explain the EV charging system and charging standards in practice.	5	Understanding
M4.03	Compare the various EV charging connectors.	5	Understanding
M4.04	Outline the general requirements of a public charging infrastructure.	4	Understanding
	Series Test-2	1	

Contents:

Control systems in HEVs -control architecture- block diagram- electronic control units (ECU's) - control variables of different ECU's.

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).

Text / Reference:

T/R	Book Title/Author
T1	Ehsani, M. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press
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
R9	Krishnan, R. Electric motor drives: modelling, analysis, and control, Prentice Hall 11. Krause, O. P. ; C. Wasynczuk, S. D. Sudhoff, Analysis of electric machinery, IEEE 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/