Program :	**Diploma in Electronics Engineering / Electronics & Communication Engineering**
Course Code :**6042C**	Course Title: **Introduction to Hybrid and Electric Vehicles**
Semester : **6**	Credits: **4**
Course Category: **Open Elective**	
Periods per week: **4 (L:4, T:0, P:0)**	Periods per semester:**60**

Course Objectives:

- To design and develop basic schemes of electric vehicles and hybrid electric vehicles.
- To choose a suitable drive scheme for developing an electric hybrid vehicle depending onresources.
- To explore the working principle of electric vehicles, role of motors, learn on battery technology, EV charging, smart charging and trends in electric vehicles.

Course Outcomes:

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

COn	**Description**	**Duration (Hours)**	**Cognitive level**
CO1	Extend various Electric & Hybrid technologies and challenges	14	Understanding
CO2	Evaluate energy efficiency of the vehicle for its drive trains	20	Understanding
CO3	Evaluate the power and energy need of the various hybrid electric vehicle	14	Understanding
CO4	Illustrate the various energy management strategies used in hybrid and electric vehicles.	10	Understanding
	Series Test	2	

CO-PO Mapping:

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	2						
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	**Extend various Electric & Hybrid technologies and challenges**		
M1.01	Illustrate the need and principle of operation of electric vehicles	3	Understanding
M1.02	Derive the motion and dynamic equations of electric vehicles	3	Understanding
M1.03	Explain in detail on various EV technologies	4	Understanding
M1.04	Explain the social and economic importance of hybrid and electric vehicles	4	Understanding
Contents: **Introduction to Electric Vehicle:** History of Hybrid & Electric Vehicles, Development towards 21st Century, Types of Electric Vehicles in use today – Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles. Motion and Dynamic Equations of the Electric Vehicles: various forces acting on the Vehicle in static and dynamic conditions. **Induction to Hybrid Electric Vehicle:** Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.			
CO2	**Evaluate energy efficiency of the vehicle for its drive trains.**		
M2.01	Compare various electric drive train topologies	3	Understanding
M2.02	Explain the operation of various electric components used in hybrid and electric vehicles	7	Understanding
M2.03	Compare various motor drives used in hybrid and electric vehicles	7	Understanding
M2.04	Compare various hybrid drive-train topologies	3	Understanding
	Series Test – 1	1	
Contents: **Electric Drive Trains:** Basic concept of electric traction, introduction to various electric drive-train topologies,			

power flow control in electric drive-train topologies, fuelefficiency analysis.

Electric Propulsion unit:

Introduction to electric componentsused in hybrid and electric vehicles, Configuration and control of DC Motordrives, Configuration and control of Induction Motor drives, configuration andcontrol of Permanent Magnet Motor drives, Configuration and control of SwitchReluctance Motor drives, drive system efficiency.

Hybrid Electric Drive-trains:

Basic concept of hybrid traction,introduction to various hybrid drive-train topologies, power flow controlin hybrid drive-train topologies, fuel efficiency analysis

CO3	**Evaluate the power and energy need of the various hybrid electric vehicle**		
M3.01	Compare various batteries which can be used for Electric Vehicles	5	Understanding
M3.02	Explain on various alternative energy sources which can be used for Electric Vehicles	4	Understanding
M3.03	Compare the electric machine and the internal combustion engine	3	Understanding
M3.04	Select a drive system based on various sizing parameters	2	Understanding

Contents:

Types of Storage Systems:

Introduction to Energy Storage Requirements in Hybrid and ElectricVehicles, Battery based energy storage and its analysis - Battery Parameters, Lead Acid Batteries, Nickel-based Batteries, Sodium-based Batteries, Lithium Batteries, Metal Air Batteries, Fuel Cell based energystorage and its analysis, Super Capacitor based energy storage and its analysis,Flywheel based energy storage and its analysis, Hybridization of different energystorage devices.

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Calculation for the ratings.

CO4	**Illustrate the various energy management strategies used in hybrid and electric vehicles**		
M4.01	Explain the implementation of CAN in Electric Vehicles for communication.	3	Understanding
M4.02	Compare and classify different energy management strategies.	2	Understanding
M4.03	Discuss the issues during the implementation of energy management strategies.	2	Understanding
M4.04	Draw and explain the schematic of charging stations.	3	Understanding

	Series Test – 2	1	

Contents:

Communications, supporting subsystems in vehicle networks

Overview, CAN

Energy Management Strategies:

Introduction to energy management strategies used in hybrid and electricvehicles, classification of different energy management strategies, comparison ofdifferent energy management strategies, implementation issues of energymanagement strategies. Introduction to various charging techniques andschematic of charging stations.

Text / Reference:

T/R	Book Title/Author
T1	James Larminie and John Lowry, **Electric Vehicle Technology Explained**, John Wiley & Sons Ltd
T2	MeherdadEhsani, Y. Gao, S. E. Gay and A. Emadi, "**Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design**", CRC Press, 2004
T3	S. Onori, L. Serrao and G. Rizzoni, "**Hybrid Electric Vehicles: Energy Management Strategies**",Springer, 2015
T4	Iqbal Hussein, "**Electric and Hybrid Vehicles: Design Fundamentals**", CRC Press, 2003.
R1	K. T. Chau, **Electric Vehicle Machines And Drives**John Wiley & Sons Ltd
R2	C.C. Chan and K.T. Chau, **Modern Electric Vehicle Technology**, Oxford University Press

Online Resources:

Sl. No	Website Link
1	https://www.eng.mcmaster.ca/mech/content/electric-and-hybrid-vehicles
2	https://onlinecourses.nptel.ac.in/noc20_ee18/preview
3	https://fr.coursera.org/learn/electric-vehicles-mobility
4	https://www.udemy.com/course/electric-vehicles/
5	https://oli.cmu.edu/courses/electric-vehicle-technology-nsc-stem-pathways-open-free/