Program : **Diploma in Automobile Engineering / Mechanical Engineering**	
Course Code : **6051A**	Course Title: **Electric and Hybrid Vehicles.**
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 understand general aspects of Electric and Hybrid Vehicles (EHV)
- To understand basic design considerations of EVs.
- To select the suitable electric propulsion systems.
- To select required energy storage and charging devices.

Course Prerequisites:

Topic	Course code	Course name	Semester
Knowledge on basic Automobile Engineering		Basic Automobile Engineering	2
Knowledge on Automobile electrical and electronics systems		Automobile Electrical and Electronics systems	4
Knowledge on Automobile electrical and electronics systems		Automobile Electrical and Electronics systems Lab	4
Knowledge on chassis and transmission systems.		Automobile Chassis and transmission	4

Course Outcomes:

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

COn	Description	Duration (Hours)	Cognitive level
CO1	Summarize the general aspects of Electric and Hybrid Vehicles (EHV)	18	Understanding
CO2	Outline basic design considerations of Electric vehicles.	18	Understanding

CO3	Select suitable electric propulsion systems	18	Applying
CO4	Select the required energy storage and charging devices for Electric and Hybrid vehicles	19	Applying
	Series Test	2	

CO – PO Mapping:

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

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

Course Outline:

Module Outcomes	Description	Duration (Hours)	Cognitive Level
CO1	**Summarize the general aspects of Electric and Hybrid Vehicles (EHV)**		
M1.01	Explain the need for hybrid and electric vehicles	2	Understanding
M1.02	Illustrate the constructional details and working principle of hybrid and electric vehicles	6	Understanding
M1.03	Summarize the different configurations of electric vehicles and hybrid vehicles	6	Understanding
M1.04	Compare petrol, diesel, hybrid and electric vehicles	2	Understanding
M1.05	Summarize the advantages and disadvantages of hybrid and electric vehicles	2	Understanding

Contents:

Need for hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles. Main components and working principles of a hybrid and electric vehicles. Different configurations of electric vehicles. Architecture of hybrid vehicle drive train - Series hybrid, Parallel hybrid and Series - Parallel hybrid. Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. Life cycle assessment of electric vehicles.

CO2	**Outline the basic design considerations of Electric vehicles.**		
M2.01	Infer the design requirements for electric vehicles	6	Understanding
M2.02	Summarize the performance of electric vehicles during acceleration, coasting, moving up and down a hill	3	Understanding
M2.03	Explain the construction of chassis and body of electric vehicles	4	Understanding
M2.04	Illustrate braking system in electric and hybrid vehicles	3	Understanding
M2.05	Summarize recharging and refueling of electric vehicles	2	Understanding
	Series Test – I	1	

Contents:

Design requirement for electric vehicles - Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance, Performance of electric vehicles - acceleration, coasting, moving up and down a hill. Transmission efficiency. Electric vehicle chassis and Body. Electric vehicles control system, Braking system in electric and Hybrid vehicles. Electric Vehicle Recharging and Refueling Systems

CO3	**Select suitable electric propulsion systems**		
M3.01	Identify the various types of motors used in electric vehicles	2	Applying
M3.02	Explain the principle of operation and characteristics of DC motor, AC single phase and 3-phase motor, Permanent Magnet motors and Switched reluctance motors	6	Understanding
M3.03	Illustrate speed control in motor drives	2	Understanding
M3.04	Interpret Torque vectoring and regenerative braking	4	Understanding
M3.05	Summarize the function of Rectifiers, Inverters, DC/DC converters and Power Split devices for Hybrid Vehicles	4	Understanding

Contents:

Types of Motors, Characteristics of DC motors, AC single phase and 3-phase motor, Permanent Magnet motors, Switched reluctance motors, Motor Drives and speed controllers. Torque Vectoring and Regenerative Braking. Rectifiers, Inverters, DC/DC converters, Power Split devices for Hybrid Vehicles. Economy of hybrid Vehicles.

CO4	**Select the required energy storage and charging devices for Electric and Hybrid vehicles**		
M4.01	Identify various batteries and battery parameters	3	Applying
M4.02	Illustrate the construction and working of various batteries used in electric and hybrid vehicles	6	Understanding
M4.03	Illustrate the basic principle of Ultra capacitors and Hybridization of energy storages	3	Understanding
M4.04	Explain battery management, battery charging technics and devices	4	Understanding
M4.05	Illustrate the operation of Fuel cells	3	Understanding
	Series Test – II	1	

Contents:

Energy storage requirements in hybrid and electric Vehicles. Battery Parameters - Different types of batteries - Lead Acid, Nickel based, Sodium based, Lithium based, Metal Air based. Battery charging - Quick Charging devices. Ultra-capacitors - Features and basic principle. Hybridization of different energy Storages, Battery Management System. Fuel Cell- basic principle and operation, Types of Fuel Cells.

Text / Reference:

T/R	Book Title/Author
T1	Jack Erjavec, Jeff Arias, “Hybrid, Electric and Fuel-cell Vehicles”, Cengage Learning India Pvt Ltd. New Delhi.
R1	C. Mi, M. A. Masrur and D. W. Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, John Wiley & Sons, 2011.
R2	S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.
R3	M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.
R4	T. Denton, “Electric and Hybrid Vehicles”, Routledge.
R5	Iqbal Hussein, “Electric and Hybrid Vehicles Design Fundamentals”, CRC Press

Online Resources:

Sl.No	Website Link
1	https://nptel.ac.in/courses/108/103/108103009/
2	https://www.youtube.com/watch?v=3E1SXG7VkQk&list=PLyqSpQzTE6M9spod-UH7Q69wQ3uRm5thr&index=2
3	https://www.youtube.com/watch?v=V004WUdpHeA&list=PL8qPObng38fHB4nPoBOA4l1ujmriiq_1E
4	https://www.sciencedirect.com/science/article/pii/S2095756420300647