SEMESTER S8

HYBRID AND ELECTRIC VEHICLES

Course Code	PEMET863	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

1. To understand the basic concepts of hybrid and electric vehicles.
2. To study the various energy storage and propulsion systems of hybrid and electric vehicles.
3. To study the various motor drives and controllers of hybrid and electric vehicles.

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SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Vehicle fundamentals – general description, vehicle resistances, tractive effort, vehicle performance - maximum speed, power, gradability, etc. Electric vehicles – introduction, history, social and environmental importance of hybrid and electric vehicles, Types of EVs. EV transmission – configurations – front wheel drive and rear-wheel drive. Traction motor characteristics and comparison with IC engine characteristics. Hybrid electric vehicles – concept, architecture, classification, series, parallel, series-parallel and complex, hybrid drivetrains, the configuration of the series hybrid electric drive train, the configuration of the parallel hybrid electric drive train.	9

2	Energy storage – Battery basics, battery parameters, battery technologies - Lead-Acid Battery, Nickel-Cadmium Battery, Nickel-Metal-Hydride (NiMH) Battery, Li-Ion Battery, Li-Polymer Battery. Alternative energy sources – fuel cell, supercapacitors and ultracapacitors, flywheel (Overview only). Battery pack design, battery management system (BMS), sensors used in BMS, thermal management systems of battery, battery safety standards in India, AIS 156 (2020) and AIS 038 Rev (2020). EV charging – types, layout of AC and DC chargers, different charging protocols-CHAdeMO, CCS2, GB/T, battery swapping.	**9**
3	Electric propulsion system – electric motors, classification, induction motors, basic principles and construction, torque–slip characteristics. Permanent magnets, ferrite, SmCo and NdFeB types, PM motors-BLDC, PMSM, basic principles and construction, switched reluctance motors (SRM), basic principles and construction. Regenerative braking – principle, block diagram. Gearbox, selection of gear ratio, Different kinds of gearboxes. EV motor sizing – need of gearbox.	**9**
4	Motor controllers – motor drive components, power electronic switches, MOSFET and IGBT, bidirectional switch. Induction motor controls – constant speed/frequency control, variable DC/AC inverter with sinusoidal PWM, field orientation control. BLDC motor controls – torque control and speed control methods, principles and block diagrams. SRM drive converter - classical half-bridge converter. Vehicle Sensors specific to EV sensors interfaced to the ECU's in the vehicle network. Controller Area Networking (CAN) – frame types of CAN, layered architecture of CAN.	**9**

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	Vehicle Validation - 6 levels of EV validations. Advances in electric and hybrid vehicle technology – autonomous driving, connected vehicles (overview only).	

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

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End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub-divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course, students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the general architecture of Electric vehicles.	**K2**
CO2	Describe various battery, charging types and battery management of Electric vehicles.	**K2**
CO3	Describe various motors and drives of Electric vehicles.	**K2**
CO4	Explain details of power transmission of Electric vehicles and select the appropriate components based on requirement.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3					2	2					3
CO2	3	1				1						3
CO3	3					1						3
CO4	3					1						2

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Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electric and Hybrid Vehicles": Design Fundamentals	Iqbal Husain	CRC press	2nd edition, 2010
2	Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design	Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi	CRC press	3rd edition, 2018
3	Electric Vehicle Technology Explained	James Larminie, John Lowry	Wiley-Blackwell	2nd edition, 2012

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electric and hybrid vehicles	Denton T.	CBS Publishers & Distributors Pvt. Ltd.	2nd edition, 2020
2	Electric Vehicle Battery Systems	Dhameja S.	Newnes (an imprint of Butterworth-Heinemann Ltd)	2001

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/108106170
2	https://nptel.ac.in/courses/108106170
3	https://onlinecourses.swayam2.ac.in/ntr24_ed54/preview
4	https://onlinecourses.swayam2.ac.in/ntr24_ed54/preview

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