CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET445	ELECTRIC VEHICLES	OEC	2	1	0	3

Preamble: This course introduces basic knowledge about electric vehicles. Basic knowledge about the drives used in EV and HEV, battery management system , energy sources and communication networks are also discussed.

Prerequisite: NIL.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the basic concept of electric and hybrid electric vehicle
CO 2	Choose proper energy storage systems for vehicle applications
CO 3	Identify various communication protocols and technologies used in vehicle networks

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	**2**					1	1					1
CO 2	**2**					1	1					1
CO 3	**2**					1	1					1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	25	25	50
Apply	15	15	30
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. List various vehicle performance indices. (K1, PO1, PO6, PO7)

2. List various hybrid electric vehicle topologies.(K1, PO1)

3. Highlight the importance of control of electric motor drives in electric and hybrid electric vehicle powertrains. (K2, PO1, PO6, PO7)

Course Outcome 2 (CO2)

1. State the different characteristics of the energy storage system used in electric and hybrid electric vehicles .(K2, PO1, PO6, PO7)

2. Describe how the battery size can be reduced in electric and hybrid electric vehicles. (K2, PO1, PO6, PO7)

3. Illustrate the different methods used for increasing the battery life in electric and hybrid electric vehicles. (K2, PO1, PO6, PO7)

Course Outcome 3 (CO3):

1. List the general objectives of energy management strategies employed in electric and hybrid electric vehicles. (K1, PO1, PO6, PO7)

2. Identify various communication protocols used in electric and hybrid electric vehicles. (K1, PO1, PO6)

3. Illustrate how fuel economy is maintained in hybrid electric vehicles. (K2, PO1, PO6, PO7)

Model Question Paper

QP CODE:

PAGES: 3

Reg. No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EET455

Course Name: Electric Vehicles

Max. Marks: 100 Duration: 3 Hours

PART A (3 x 10 = 30 Marks)

Answer all Questions. Each question carries 3 Marks

1. List the reasons that led to the evolution of hybrid electric vehicles.
2. List the characteristics of the transmission system in a vehicle.
3. Mention one instance, when the internal combustion engine shall take up extra torque in the drivetrain of a parallel hybrid while being driven.
4. List major components in the drivetrain of an electric vehicle.
5. Discuss the advantage and disadvantage of using DC motors in the drivetrain of electric and hybrid electric vehicles.
6. List any three motors that can be used in the drivetrain of electric and hybrid electric vehicles.
7. Explain the C-rating of a battery
8. Explain the basic fuel cell structure with the help of a neat diagram
9. What are the seven layers of Open System Interconnection (OSI)?
10. What is meant by CAN transfer protocol

PART B (14 x 5 = 70 Marks)
Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. Explain the history of electric and hybrid electric vehicles. 14

12. Explain the essential characteristics in the power sources intended to be used in electric and hybrid electric vehicles. 14

Module 2

13. a. Highlight various factors that influence the component sizing in the power trains of hybrid electric vehicles. 7

b. Illustrate how an internal combustion engine is always operated in its maximum operating efficiency region in a hybrid electric vehicle. 7

14. a. Highlight the limitations posed by the battery during the power flow control in electric drive-train topologies. 8

b. Suggest various methods to minimize the battery size and maximize battery life during the power flow control in electric drive-train topologies. 6

Module 3

15. a. List the desired characteristics of motors used in the drive trains of electric and hybrid electric vehicles. 7

b. Demonstrate the control of separately excited DC motors in electric vehicles. 7

16. a. Explain the block diagram of electric drive system used in electric vehicles. 7

b. Demonstrate the Field Oriented Control of Induction Motors in the powertrain of electric vehicles. 7

Module 4

17. Explain about Lithium ion batteries with the help of necessary diagram. Write the chemical reactions involved in it. 14

18. What are the various battery parameters? Briefly explain 14

Module 5

19. Compare various energy management strategies in electric vehicles. 14

20. Discuss about a typical CAN layout in a hybrid electric vehicle with the help of block diagram 14

Syllabus

Module 1 (6 hrs)

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles

Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance

Module II (8 hrs)

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, Introduction to electric components used in hybrid electric vehicles

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies.

Module III (8 hrs)

Block diagram of electric drive system, Introduction to electric motors used in hybrid and electric vehicles: configuration and control of separately excited DC motors, Induction Motors (block diagram representation of FOC).

Module IV (7 hrs)

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage, Fuel Cell based energy storage, Hybridization of different energy storage devices, Introduction to Super capacitor and Hydrogen energy storage.

Module V (7 hrs)

Communications, supporting subsystems: In vehicle networks- CAN

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies

Text/References Books

1 Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003

2. NPTEL (notes) – Electrical Engineering – Introduction to Hybrid and Electric Vehicles

3 K Sundareswaran, Elementary Concepts of Power Electronic Drives: CRC Press, Taylor & Francis Group

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Hybrid Electric Vehicles (6)**	
1.1	History of hybrid and electric vehicles,	1
1.2	Social and environmental importance of hybrid and electric vehicles	1
1.3	Basics of vehicle performance	1
1.4	Vehicle power source characterization, transmission characteristics	1
1.5	Mathematical models to describe vehicle performance	1
1.6	Dynamics of electric motion	1
2	**Hybrid Electric Drive -trains and Electric drive trains (8)**	
2.1	Basic concept of hybrid traction	1
2.2	Introduction to various hybrid drive-train topologies	1

2.3	Power flow control in hybrid drive-train topologies	2
2.4	Basic concept of electric traction	1
2.5	Introduction to various electric drive-train topologies,	1
2.6	Power flow control in electric drive-train topologies	2
3	**Electric drive system in electric and hybrid electric vehicles (8)**	
3.1	DC motors and induction motors	2
3.2	Introduction to Electric drive system	2
3.3	Separately excited DC motor speed control	1
3.4	V/f control of induction motor drive	1
3.5	Introduction to vector control (block diagram representation only)	2
4	**Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles (7)**	
4.1	Battery based energy storage	**3**
4.2	Fuel Cell based energy storage	**2**
4.3	Hybridization of different energy storage devices	**1**

	Introduction to Super capacitor and Hydrogen energy storage	**1**
5	**Communications, supporting subsystems and energy management strategies (7)**	
5.1	Communications networks	**2**
5.2	Introduction to energy management strategies used in hybrid and electric vehicles	**1**
5.3	Classification of different energy management strategies	**2**
5.4	Comparison of different energy management strategies	**2**