



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master Of Engineering

Level: PG

Branch: Mechanical Engineering (Thermal Engineering)

Course / Subject Code : ME01000441

Course / Subject Name : Electric & Hybrid Vehicles Technology

w. e. f. Academic Year:	2024-25
Semester:	1 st Semester
Category of the Course:	PEC

Prerequisite:	Basic knowledge in electrical engineering and mechanical systems, particularly related to motor drives and power electronics, as well as fundamental understanding of vehicle dynamics and control systems.
Rationale:	The course "Electrical and Hybrid Vehicle" is designed to provide students with comprehensive knowledge and practical skills related to the design, analysis, and application of electric and hybrid vehicles. This is increasingly important as the automotive industry shifts towards sustainable and energy-efficient transportation solutions. The course covers the development, components, energy management strategies, and various types of electric and hybrid vehicles, preparing students for careers in this rapidly evolving field.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT level
1	Understand the Basics of electric and hybrid vehicles, Tractive effort, vehicle performance	U
2	Demonstrate energy management concepts for EV	A
3	Analyze the requirements of Motors	N
4	Identify various configurations of Electric and hybrid vehicles.	R

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR		C	Theory		Tutorial / Practical	
			ESE (E)		PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150



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Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Electric and Hybrid Electric Vehicles: Benefits of EV, Configuration of Electric Vehicles, Performance of Electric Vehicles, Introduction of Different source of power for Electric Vehicle. Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Tractive effort in Gradient, Tractive effort for other forces	10	24
2.	Energy storage for EV and HEV: Energy storage requirements, Battery parameters, Types of Batteries, Charging method of battery, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Modeling of PEMFC, Super Capacitors, Introduction to Ultra fly wheel. Energy management and their strategies used in hybrid vehicle	10	24
3.	Electric Vehicle Motors: DC Motor, Induction Motor, BLDC Motor and Switch Reluctance Motor – Types, Construction operating Principle, Equivalent circuit for each motor and selection of motor for vehicle application	10	24
4.	Hybrid Electrical Vehicle Subsystem and Configuration: Series HEV, Parallel HEV, and Series Parallel HEV, Complex HEV system and Its Configuration, HEV mode of operation, Drive train comparison	12	28
Total			100

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	25	30	25	--	--

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. M. Ehsani, Y. Gao, S. Gay and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, CRC Press, 2005
2. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003



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3. Sheldon S. Williamson, Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer, 2013.
4. C.C. Chan and K.T. Chau, Modern Electric Vehicle Technology, OXFORD University Press, 2001.
5. Chris Mi, M. Abul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles Principles And Applications With Practical Perspectives, Wiley Publication, 2011.
6. Michael Nikowitz, “Advanced Hybrid and Electric Vehicles: System Optimization and Vehicle Integration”, Springer International Publishing, 2016.
7. James Larminie and John Lowry “Electric Vehicle Technology Explained”, JohnWiley and Sons, 2nd ed., 2014.
8. Electric and Hybrid Vehicles, Tom Denton, Taylor & Francis, 2018.

(b) Open-source software and website:

1. E-materials available at the website of NPTEL- <http://nptel.ac.in/>
2. MATLAB (Trial version): Software is useful for simulation and analysis of electrical systems

Suggested Course Practical List: If any

1. Modeling of electric vehicle sub-systems
2. Study of different Energy management strategies
3. Simulation of Vehicle Dynamics
4. Performance Analysis of Electric Motors
5. Battery Testing and Characterization
6. To study the basic principles, operation, and modeling of PEM fuel cells
7. To explore the characteristics and performance of super capacitors and ultra-flywheels as energy storage devices.
8. To design and implement power electronic converters (DC-DC, DC-AC) used in electric vehicles.
9. To design and analyze a regenerative braking system for electric vehicles.
10. To study the principles and implementation of Vehicle-to-Grid technology.
11. To design and evaluate thermal management systems for batteries and electric motors in electric vehicles.
12. To integrate various sub-systems of a hybrid electric vehicle and test the overall system performance.



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List of Laboratory/Learning Resources Required:

- Necessary instruments, kits and apparatus are to be provided for conducting above said practical in a group of maximum four students.
- Simulation software like MATLAB, PSIM or Scilab and Power Electronic Converters as demanded by the course

Suggested Project List:

The following project ideas are designed to provide practical experience and deeper understanding of the concepts covered in the "Electrical and Hybrid Vehicle" course. These projects aim to address real-world challenges and innovations in the field of electric and hybrid vehicles.

Project 1: Design and Development of a Battery Management System (BMS)

Project 2: Simulation and Analysis of Hybrid Electric Vehicle Drive-Train

Project 3: Development of an Electric Vehicle Charging Station

Project 4: Renewable Energy Integration for Electric Vehicle Charging

Project 5: Energy Consumption and Efficiency Analysis of Electric Vehicles

Project 6: Design and Implementation of a Regenerative Braking System

Project 7: Development of a Fuel Cell Electric Vehicle (FCEV) Prototype

Project 8: Wireless Charging System for Electric Vehicles

Project 9: Energy Management Strategies for Hybrid Electric Vehicles

Project 10: Autonomous Electric Vehicle Development

These projects aim to provide practical experience and enhance understanding of key concepts in electric and hybrid vehicle technology, preparing students for future challenges and innovations in the field

Suggested Activities for Students: Engaging students in practical activities is crucial for enhancing their understanding and skills in the field of electric and hybrid vehicles. Here are suggested activities that can complement the theoretical learning and laboratory experiments:

1. Field Trips and Industry Visits:
2. Guest Lectures and Expert Talks:
3. Technical Workshops and Hands-on Training:
4. Design and Innovation Challenges:
5. Research Projects on Emerging Technologies:



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6. Case Studies and Problem-Based Learning:
7. Simulation Exercises:
8. Public Awareness Campaigns:
9. Hackathons and Prototyping Events:
10. Internships and Industry Projects:

These activities are designed to complement classroom learning and laboratory experiments, providing students with a holistic educational experience in the field of electrical and hybrid vehicles. They promote practical skills development, critical thinking, and preparation for future careers in the evolving automotive industry.

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