FACULTY OF ENGINEERING & TECHNOLOGY

Effective from Academic Batch: 2022-23

Programme: **Bachelor of Technology (Electrical Engineering)**

Semester: **VII**

Course Code: **202050701**

Course Title: **Electric and Hybrid Vehicles**

Course Group: **Professional Core Course-XV**

Course Objectives: The primary objective of the course is to deliver and discuss about architectures and technologies associated with electric and hybrid vehicles including their constituent components.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	0	2	4	50 / 18	50 /17	25 / 09	25 / 09	150 / 53

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Introduction to Electric Vehicles:** History of Electric Vehicles, Benefits of using EVs, Types of Electric Vehicles in use today (Battery Electric Vehicle, Hybrid Electric Vehicle, Fuel Cell EV, Solar Powered Vehicles) and Challenges. Motion and Dynamic Equations of the Electric Vehicles: various forces acting on the Vehicle in static and dynamic conditions.	05
2	**Hybrid Electric Drivetrains:** Social and environmental importance of hybrid and electric vehicles, impact of modern drivetrains on energy supplies. Hybrid Electric Drivetrains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.	07

Opp. Shastri Maidan, Beside BVM College, Vallabh Vidyanagar, Dist: Anand, Gujarat - 388120
(O): 02692-238001 | Email: adminoffice@cvmu.edu.in | www.cvmu.edu.in

3	**Electric Drivetrains and Propulsion Unit:** Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion Unit: Introduction to electric components used in hybrid and electric vehicles.	**08**
4	**Energy Storage:** Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.	**07**
5	**Battery Charging and Battery Management Systems:** Basic Requirements for Charging System, Charger Architectures, Grid Voltages, Frequencies, and Wiring, Charger Functions, Charging Standards and Technologies: SAE J1772, VDE-AR-E 2623-2-2, CHAdeMo, Tesla, Wireless Charging. Battery Management Systems: Background of Battery Management Systems, Typical Structure of BMSs, Representative Products, Key Points of BMSs in Future Generation.	**09**
6	**Energy Management Strategies and Introduction to Vehicle to Grid (V2G) Technologies:** Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Introduction to V2G technologies, need for power aggregators, V2G applications in power systems.	**09**

List of Practicals / Tutorials:

1	Study of Battery parameters and Testing of batteries for electric vehicles.
2	Modeling and Simulating Battery Performance for Design Optimization.
3	Study of fuel cells and their characteristics.
4	Study of different types of battery charging system.
5	To Understand battery management systems.
6	Study and analysis of different topologies used in electrical and hybrid vehicles.
7	Dynamic equation simulation with constant $F_{TE.}$
8	Dynamic equation simulation with Variable $F_{TE.}$
9	Analysis of selection of drives used for electric and hybrid vehicle.
10	Simulation and analysis of Induction motor characteristics used for electric vehicle.

Opp. Shastri Maidan, Beside BVM College, Vallabh Vidyanagar, Dist: Anand, Gujarat - 388120
(O): 02692-238001 | Email: adminoffice@cvmu.edu.in | www.cvmu.edu.in

11	Simulation and analysis of speed control characteristics of Induction motor used for electric vehicle.
12	Simulation and analysis of speed control characteristics of BLDC motor used for electric motor vehicle.

Reference Books:

1	James Larminie, J. Lowry, "Electric Vehicle Technology Explaned", John Wiley & Sons Ltd. 2003.
2	Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2003.
3	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.
4	Advanced Battery Management Technologies for Electric Vehicles, By RuiXiong and WeixiangShen, Wiley Publication.
5	S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies",Springer, 2015.

Supplementary learning Material:	
1	https://onlinecourses.nptel.ac.in/noc22_ee53/preview
2	https://onlinecourses.nptel.ac.in/noc21_ee112/preview
3	https://archive.nptel.ac.in/courses/108/106/108106170/
4	https://e-vehicleinfo.com/

Pedagogy:

- Direct classroom teaching
- Audio Visual presentations/demonstrations
- Assignments/Quiz
- Continuous assessment
- Interactive methods
- Seminar/Poster Presentation
- Industrial/ Field visits
- Course Projects

Internal Evaluation: The internal evaluation comprised of written exam (40% weightage) along with combination of various components such as Certification courses, Assignments, Mini Project, Simulation, Model making, Case study, Group activity, Seminar, Poster Presentation, Unit test, Quiz, Class Participation, Attendance, Achievements etc. where individual component weightage should not exceed 20%.

Opp. Shastri Maidan, Beside BVM College, Vallabh Vidyanagar, Dist: Anand, Gujarat - 388120
(O): 02692-238001 | Email: adminoffice@cvmu.edu.in | www.cvmu.edu.in

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
30%	30%	20%	10%	10%	0%	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Illustrate hybrid and electric vehicles.	**20%**
CO-2	Understand drive-train topologies.	**30%**
CO-3	Identify energy storage technologies.	**25%**
CO-4	Understand battery management systems.	**15%**
CO-5	Classify different energy management strategies.	**10%**

Curriculum Revision:	
Version:	2.0
Drafted on (Month-Year):	June-2022
Last Reviewed on (Month-Year):	-
Next Review on (Month-Year):	June-2025

Opp. Shastri Maidan, Beside BVM College, Vallabh Vidyanagar, Dist: Anand, Gujarat - 388120
(O): 02692-238001 | Email: adminoffice@cvmu.edu.in | www.cvmu.edu.in