Pimpri Chinchwad Education Trust's

PIMPRI CHINCHWAD COLLEGE OF ENGINEERING

SECTOR NO. 26, PRADHIKARAN, NIGDI, PUNE 411044

An Autonomous Institute Approved by AICTE and Affiliated to SPPU, Pune

DEPARTMENT OF MECHANICAL ENGINEERING

Curriculum Structure and Syllabus
of
Honor in Electric Vehicle Technology
(Approved by BoS Mechanical Engineering)
(Course 2020)

Effective from Academic Year 2023-24

(Updated with minor changes)

Institute Vision

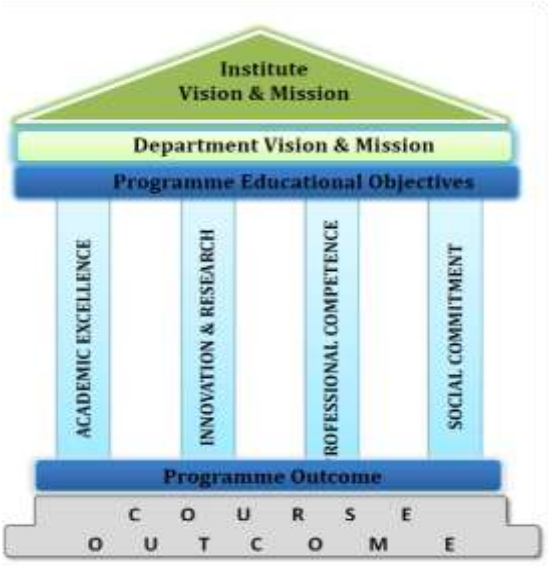
To be one of the top 100 Engineering Institutes of India in coming five years by offering exemplarily Ethical, Sustainable and Value Added Quality Education through a matching ecosystem for building successful careers.

Institute Mission

1. Serving the needs of the society at large through establishment of a state-of-art Engineering Institute.
2. Imparting right Attitude, Skills and Knowledge for self-sustenance through Quality Education.
3. Creating globally competent and Sensible engineers, researchers and entrepreneurs with ability to think and act independently in demanding situations.

Quality Policy

We at PCCOE are committed to impart Value Added Quality Education to satisfy the applicable requirements, needs and expectations of the Students and Stakeholders. We shall strive for academic excellence, professional competence and social commitment in fine blend with innovation and research. We shall achieve this by establishing and strengthening state-of- the-art Engineering and Management Institute through continual improvement in effective implementation of Quality Management System.



.

Preface

Looking at Global Scenario to enhance the employability skills and impart deep knowledge in emerging/ multidisciplinary areas, an additional avenue is provided to passionate learners through the Minors and Honors Degree Scheme in academic structure.

For Honors degree program, student has to earn additional 20 credits in emerging area of one's own domain.

Objectives of Honors Degree

- To enable students to pursue allied academic interest in contemporary areas.
- To provide effective yet flexible options for students to achieve basic to intermediate level competence in the contemporary area.
- To enhance the employability skills with different combinations of competencies and flavors.
- To provide an academic mechanism for fulfilling demand of specialized areas from industries for higher order skill jobs.
- To provide a strong foundation to students aiming to pursue research/ higher studies in the Contemporary field of study.

Preface of Honor in Electric Vehicle Technology

There is a major shift of Automotive Industry from I.C. Engine Vehicles to Hybrid and Electric Vehicles going on throughout the world and the country. Government of India as adopted FAME Policy (Faster Adoption and Manufacture of (Hybrid and) Electric Vehicles) with the objective of promoting electric mobility in the country. A lot of new job opportunities are going to open in the design, manufacturing and service sectors of the automobile industry. Pimpri Chinchwad College of Engineering is located at the midst of Automobile Industry which consists of giants like Tata Motors, Mahindra & Mahindra, Volkswagen etc.

The Honor's program in Electric Vehicle Technology is offered in light of the aforementioned rapidly changing circumstances. The curriculum is designed for enhancing the technical skills and employability of the students. Some of the program's key features are collaboration with industry and the involvement of industrial expertise in course content delivery.

This major program will help students to develop analytical, experimentation, and investigative skills to solve complex engineering problems along with project-based learning. It consists of four courses viz. Electric vehicle Systems & Vehicle Dynamics, Battery Technologies for EVs, Design of EV Powertrain and Charging Infrastructure & Testing Standards for EVs along with an integrated project. The courses and integrated project are distributed in semester V to VIII. The students will develop the diverse knowledge, skills, abilities, and dispositions needed to succeed in the changing scenario of the automobile industry.

Course Objectives:

1. To introduce the students to the rapidly changing developments in the Automobile industry.
2. To develop analytical, experimentation, and investigative skills related to electric vehicle technology.
3. To develop professional skills and abilities needed to cope up with the rapidly transforming automotive sector.

Course Outcomes:

After completing the honor’s curriculum in Electric Vehicle Technology, the learners will be able to

1. Apply the knowledge of EV systems, Battery technology and e-power train to analyze/design EV systems and components.
2. pursue research in different areas related to Electric Vehicle technology
3. Project themselves as potential employees in the electric vehicle sector.

INDEX

LIST OF ABBREVIATIONS IN CURRICULUM STRUCTURE

Sr. No.	Abbreviation	Type of Course
1.	L	Lecture
2.	P	Practical
3.	T	Tutorial
4.	H	Hours
5.	CR	Credits
6.	IE1	Internal Evaluation 1
7.	IE2	Internal Evaluation 2
8.	ETE	End Term Evaluation
9.	TW	Term Work
10.	OR	Oral
11.	PR	Practical
12.	PROJ	Project

CREDIT DISTRIBUTION : SEMESTER WISE						
1 Lecture hour = 1 Credit 2 Lab Hours = 1 Credit 1 Tutorial Hour = 1 Credit						
Sr. No.	**Course Title**	**Credits/Semester**				
		5	**6**	**7**	**8**	Total
1.	Electric vehicle Systems & Vehicle Dynamics	3	0	0	0	3
2.	Electric vehicle Systems & Vehicle Dynamics Lab	1	0	0	0	1
3.	Battery Technologies for Electrical Vehicles	0	4	0	0	4
4.	Battery Technologies for Electrical Vehicles Lab	0	1	0	0	1
5.	Design of Electrical Vehicles Powertrain	0	0	3	0	3
6.	Design of Electrical Vehicles Powertrain Lab	0	0	1	0	1
7.	Seminar/Mini Project/Internship/MOOC course	0	0	2	0	2
8.	Integrated Project	0	0	0	5	5
Total		**4**	**5**	**6**	**5**	**20**

Curriculum structure

ELECTRIC VEHICLE TECHNOLOGY

Honor in Mechanical Engineering

Curriculum structure

ELECTRIC VEHICLE TECHNOLOGY

Honor in Mechanical Engineering

Semester	Course Code	Course Name	Teaching Scheme					Evaluation Scheme						
			L	P	T	H	CR	IE	MTE	ETE	TW	PR	OR	Total
V	HME5983	Electric vehicle Systems & Vehicle Dynamics	3		-	3	3	20	30	50	-	-		100
V	HME5984	Electric vehicle Systems & Vehicle Dynamics Lab	-	2		2	1	-	-	-	-	-	25	25
VI	HME6985	Battery Technologies for Electrical Vehicles	3	-	1	4	4	20	30	50	-	-	-	100
VI	HME6986	Battery Technologies for Electrical Vehicles Lab	-	2	-	2	1	-	-	-	25	-	25	50
VII	HME7987	Design of Electrical Vehicles Powertrain	3	-	-	3	3	20	30	50	-	-	-	100
VII	HME7988	Design of Electrical Vehicles Powertrain Lab	-	2	-	2	1	-	-	-	-	-	25	25
VII	HME7989	Seminar/Mini Project/Internship/MOOC course	-	4	-	4	2	-	-	-	-	-	50	50
VIII	HME8982	Integrated Project	-	10	-	10	5	50	-	-	50	-	50	150
			09	20	1	30	**20**	110	90	150	75	-	175	**600**

Abbreviations: L-Lecture, P-Practical, T-Tutorial, H- Hours, IE- Internal Evaluation, MTE- Mid Term Evaluation, ETE- End Term Evaluation, TW –Termwork, OR - Oral

Course Syllabus

ELECTRIC VEHICLE TECHNOLOGY

Semester - V

Program:	Honors in Electric Vehicle Technology			Semester : V			
Course:	Electric vehicle Systems & Vehicle Dynamics			Code : HME5983			
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	IE	MTE	ETE	Total
3	-	-	3	20	30	50	100

Prior Knowledge of:

a. IC Engines,
b. vehicle systems, machine design ,
c. engineering mechanics …….are essential

Course Objectives:

1. To study basic fundamentals of electric vehicle
2. To understand the Electric vehicle Architecture
3. To develop understanding of hybrid electric vehicle
4. Design & analysis of vehicle performance parameters
5. Design of transmission system for electric vehicle
6. To understand the Current scenario of electric vehicle in India

Course Outcomes:

After learning the course, the learners will be able,

1. To analyze the Current scenario of electric vehicle in India
2. To compare various types of vehicles on road
3. To compare types of Hybrid Electric vehicles
4. To identify electric vehicle components and architectures
5. To evaluate & analyze the vehicle performance parameters
6. To identify various systems of electric vehicles

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Current scenario & Future of electric vehicle in India**: Technology scenario, Market scenario, Paris climate agreement, social and environmental importance of electric vehicles, impact of modern drive-trains on energy supplies. Policies & regulation, Indian policies, Challenges, National Electric Mobility Mission Plan, FAME 1 and 2 India Scheme	7
2.	**Overview of Electric vehicle (EV):** History, Components of Electric vehicles, EV Layouts, EV classification, Working of EV, Comparison with IC Engine, Advantages and disadvantages of EV, Well-to-Wheel Efficiency, Tank-to-Wheel Efficiency, Energy flow analysis for EV & ICEV	8
3.	**Hybrid Electric vehicles :** Classification – Micro, Mild, Full, Plug-in, EV, Components, Layout of Hybrid EV, Comparison with EV, Layout & architecture: -Series hybrid vehicle, Parallel hybrid vehicle, Series- a parallel hybrid vehicle, Range Extended HEV ,Advantages and Disadvantages of HEV	7
4.	**Electric vehicle Architecture:** Battery electric vehicle (BEV), Electric Vehicle Architectures, Powertrains: Electric motor, Battery pack, Inverter, Charger, converter, Regenerative braking	8
5.	**Vehicle Dynamics:** Vehicle resistance, Rolling resistance, Grading Resistance, Aerodynamic drag, Dynamic Equation, Vehicle performance (Maxi. Speed, Gradeability & acceleration), Calculation of acceleration force, maximum speed. Tractive effort, Torque required on the wheel, Torque speed characteristics of electric vehicle	7
6.	**Vehicle Systems:** Transmission system: Need, Torque Speed Characteristics of IC Engine and Motor, Comparison with ICEV Transmission system, Selection of transmission system, Estimation of gear ratio, Differential, Brake system, Steering system, Suspension system	8
	Total	45

Reference Books:

1. Modem Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory, and Design, Mehrdad Ehsani and Yimin Gao, Power Electronics and application series
2. Build Your Own Electric Vehicle, Seth Leitman arid Bob Brant
3. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Husain, CRC Press, 2003
4. Fundamental of vehicle dynamics, Thomas D Gillipse, Society of Automotive Engineers, second edition
5. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
6. Theory of Ground Vehicles. Third Edition. J.Y Wong. John Wiley ISBN: 0-471-35461-9

Program:	Honors in Electric Vehicle Technology					Semester : V	
Course:	Electric vehicle Systems & Vehicle Dynamics Lab					Code : HME5984	
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	IE	OR	ETE	Total
-	2	-	1	-	25	-	25

Prior Knowledge of:

a. IC Engines,
b. vehicle systems, machine design
c. engineering mechanics …….are essential

Course Objectives:

1. To understand the Electric vehicle Architecture
2. Design & analysis of vehicle performance parameters
3. To understand the Current scenario of electric vehicle in India

Course Outcomes:

After learning the course, the learners will be able,

1. To identify and analyze the systems and components used in Electric Vehicles
2. To evaluate & analyze the performance of electric vehicle
3. To appreciate the recent developments in EV technology.

Detailed Syllabus:

Any one of Category I, any 6 of Category II and any one of Category III, total 8 experiments to be performed.

I. Simulation based Experiments

Effect of various parameters on tractive efforts (speed, gradeability.....etc)

II. Laboratory Experiments

1. Study of various components of electric vehicle.
2. Analysis of different layouts of electric vehicle
3. Demonstration, Dismantling & Assembling of electric scooter.
4. Calculate & sizing the power rating of given electric vehicle
5. Determination of the Gear Ratios of the given electric vehicle
6. Study & Demonstration of various systems used in electric vehicle.
7. Determination of acceleration performance of electric vehicle
8. Industrial visit to electric vehicle industry (Manufacturer/ startup)

III. Case study-based Experiments

1. Case study on recent research in the field of EV Technology
2. Case study on challenges & future scope of electric vehicle

Reference Books:

1. Modem Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory, and Design, Mehrdad Ehsani and Yimin Gao, Power Electronics and application series
2. Build Your Own Electric Vehicle, Seth Leitman arid Bob Brant
3. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Husain, CRC Press, 2003
4. Fundamental of vehicle dynamics, Thomas D Gillipse, Society of Automotive Engineers, second edition
5. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
6. Theory of Ground Vehicles. Third Edition. J.Y Wong. John Wiley ISBN: 0-471-35461-9
7. Laboratory Manuals

Course Syllabus

ELECTRIC VEHICLE TECHNOLOGY

Semester - VI

Program:	Honors in Electric Vehicle Technology					Semester : VI	
Course :	Battery Technologies for Electric Vehicles					Code : HME6985	
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	IE	MTE	ETE	Total
3	-	1	4	20	30	50	100

Prior Knowledge of

a. Basic concepts of electronics ,
b. Electrical and thermal engineering, mathematic ……..are essential

Course Objectives:

1. To make the learners conversant with various battery chemistries used for Electric Vehicles
2. To impart through understanding of Lithium Ion Battery
3. To understand the various battery performance parameters and testing procedures
4. To make the learners aware of thermal issues of Lithium ion battery and thermal management system
5. To understand the requirements and functioning of battery management system
6. To make the learners conversant with Equivalent Circuit Cell Modeling of Battery

Course Outcomes:

After learning the course the learners will be able,

1. to select suitable battery for EV application
2. to compare the materials used for the components of the battery
3. to conduct tests on battery cells to determine various performance and operating parameters
4. to estimate heat generation inside battery and propose cooling strategy for the battery pack.
5. to select BMS for given battery pack
6. to design and simulate battery pack for given EV

Detailed Syllabus

Unit	Description	Duration (H)
1.	**Overview of Battery Technology of Electric vehicle (EV) :** History of Battery cells, Primary Battery, Secondary Battery , Performance parameters and operating variables of Battery, Electric vehicle (EV) requirements, Battery Technologies for EV applications, Lead Acid battery, Nickel Cadmium , Nickel Metal Hydrite, Lithium Ion Batteries : Working, chemical reactions, comparison, future battery trends and challenges, Metal-Air Batteries, fuel cells , ultra capacitors	7
2.	**Lithium-Ion Batteries** Introduction, Components, Functions, Cathode Materials, Anode Materials, Electrolytes: salts and solvents, separators, advantages and drawbacks ,Battey cell Manufacturing: Cylindrical, prismatic and Pouch cells**,** recycling/disposal of batteries	8
3.	**Battery Performance and Testing** Battery operating and performance parameters**,** Charge-discharge characteristics of batteries, Measurement of current, voltage, temperature, Estimation of SOC: Coulomb Counting method, OCV method, Estimation of SoH, Capacity, efficiency	7
4.	**Battery Thermal Management** Heat Generation inside battery, Thermal issues of Lithium-Ion Battery, impact of temperature on capacity, cycle life, Thermal Runaway, Cooling strategies: Direct/indirect cooling, Air cooling, liquid cooling, PCM based cooling, advanced colling methods	8
5.	**Battery Electric Management** Primary functions of BMS, sensing voltage, current and temperature of cell and battery pack, estimation of cell SOC and battery pack SOC, Estimation of available energy and power of cell and battery pack, criteria of selection of BMS battery pack balancing: Reasons, balancing set point and when to balance a battery pack ,Passive and active balancing methods, Active balancing methods for battery packs: capacitor-based circuits, transformer-based circuits, Estimation of available battery power using a simplified cell mode	7

6.	**Battery Pack Design, Modelling and simulation** Determination of Power, Voltage, Capacity of battery pack**,** trade-off between parallel and series cell connections, parallel-cell-module (PCM), series-cell-module (SCM) **Equivalent Circuit Modelling:** Modelling OCV and SOC, voltage polarization, Warburg impedance, Estimation of Model parameter values: OCV, Columbic Efficiency, total capacity, temperature dependence of OCV, using the ECM to simulate constant voltage/ power charge/ discharge characteristics	**8**
	Total	**45**

Reference Books:

1. Gregory L. Plett, Battery Management Systems, Volume I: Battery Modeling, Artech House, London
2. Gregory L. Plett, Battery Management Systems Volume II, Equivalent-Circuit Methods, Artech House, London
3. Gianfranco Pistoia, Boryann Liaw (eds.), Behaviour of Lithium-Ion Batteries in Electric Vehicles_ Battery Health, Performance, Safety, and Cost, Springer International Publication
4. Reiner_Korthauer, Li-I Batteries Basics and Applications, Springer International Publication
5. Jiuchun Jiang, Caiping Zhang - Fundamentals and Application of Lithium-ion Batteries in Electric Drive Vehicles-Wiley

Program:	Honors in Electric Vehicle Technology			Semester : VI			
Course :	Battery Technologies for Electric Vehicles Lab			Code : HME6986			
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	TW	OR	PR	Total
-	2	-	1	25	25	-	50

Prior Knowledge of:

a. Basic concepts of electronics
b. Electrical and thermal engineering, mathematic……..are essential

Course Objectives:

1. To make the learners conversant with various battery chemistries used for Electric Vehicles
2. To understand the various battery performance parameters and testing procedures
3. To understand the requirements and functioning of battery management system

Course Outcomes:

After learning the course the learners will be able,

1. To conduct tests on battery for measuring the performance parameters
2. To compare the performance of batteries under different operating conditions
3. To design and test the battery pack for given EV

Detailed Syllabus

Any one of Category I, any 6 of Category II and any one of Category III, total 8 experiments to be performed.

I. Simulation based Experiments

1. Mathematical Modelling of LIB and simulation using suitable software
2. Thermal analysis of LIB by using CFD

II. Laboratory Experiments

1. Study and Demonstration of Battery Voltage Measurement Methods (ADC, A/D, A–D, A2D, or A-to-D)
2. Study and Demonstration of Battery Current Measurement (Shunt Current Sensor, Hall effect sensor, four wire connection etc)
3. Study and Demonstration of Battery Temperature Measurement (Thermocouple, Thermistor etc)
4. Battery Cell testing to determine OCV Vs Time characteristics during charging and discharging , estimating coulombic efficiency and total capacity
5. Battery Cell testing to Estimate SOC
6. Battery Cell testing for Determination OCV -SOC relation
7. Determination of internal resistance of Battery Cell (Constant current Pulse Test)
8. Effect of temperature on Battery capacity, efficiency, charge/discharge characteristics , internal resistance Etc.
9. Battery pack design for given EV application (Testing Various series parallel combinations for given application)
10. Study of Battery Testing Standards

III. Case study-based Experiments

1. Survey of Batteries used for electric vehicles on road
2. Case study on recent research in the field of EV Battery Technology

Reference Books:

1. Gregory L. Plett, Battery Management Systems, Volume I: Battery Modeling, Artech House, London
2. Gregory L. Plett, Battery Management Systems Volume II, Equivalent-Circuit Methods, Artech House, London
3. Gianfranco Pistoia, Boryann Liaw (eds.), Behaviour of Lithium-Ion Batteries in Electric Vehicles_ Battery Health, Performance, Safety, and Cost, Springer International Publication
4. Reiner_Korthauer, Li-I Batteries Basics and Applications, Springer International Publication
5. Jiuchun Jiang, Caiping Zhang - Fundamentals and Application of Lithium-ion Batteries in Electric Drive Vehicles-Wiley Laboratory Manuals

Course Syllabus

ELECTRIC VEHICLE TECHNOLOGY

Semester - VII

Program:	Honors in Electric Vehicle Technology			Semester : VII			
Course :	Design of Electric Vehicle Powertrain			Code : HME7987			
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	IE	MTE	ETE	Total
3	-	-	3	20	30	50	100

Prior Knowledge of:

a. Machine design,
b. Electric vehicles
c. Vehicle dynamics …..are essential

Course Objectives:

1. To study fundamentals of traction motors used in electric vehicle
2. To identify & analyze motor controllers for Electric vehicle
3. To identify & analyze power converters for electric vehicle
4. To understand Modelling of Electric vehicle powertrain components
5. To design & analyze the EV propulsion system

Course Outcomes:

After learning the course the learners will be able,

1. To identify electric powertrain components
2. To select proper electric motor as per the requirements for an EV
3. To select appropriate motor controller as per the requirements of the powertrain
4. To select appropriate power converter as per the requirements of the powertrain
5. To develop mathematical model of EV powertrain
6. To design power train for given EV application

Detailed Syllabus

Unit	Description	Duration (H)
1.	**Fundamentals of EV Powertrain :** Need, Components of electric powertrain : Battery pack, Motor, Controller, Convertor etc. Possible EV Powertrain configurations and their comparison, Comparison with ICEV powertrain	8
2.	**Traction Motors** Motor & engine rating, Motor requirements for EV, Types of electric motor, Construction , working principle of DC Motors- shunt, series, PMDC, separately exited , cumulative compound, differential compound DC motor, AC Motors- Induction motors, Permanent magnet synchronous motor, Brush less D C motor, Switched reluctance motor, Synchronous Reluctance motor, Axial flux motor, Torque speed characteristics of traction motors, Advantages & disadvantages of traction motors, Applications	7
3.	**Motor controllers** Function of Motor Controller, DC Motor controls, speed control of DC motor- Armature voltage control , flux weakening control, BLDC speed control-sensor equipped BLDC motor, sensor less BLDC motor, Configuration and control of Induction motors, Configuration and control of Permanent magnet motors, Configuration and control of Switch Reluctance Motor drives, Field Oriented Control algorithm	8
4.	**Power converters/Electronics** Need of converters, Classification: DC-DC, DC-AC,AC-DC,AC-AC, unidirectional/ bidirectional, Magnetically isolated, , selection of convertor for EV, Location & power flow, four quadrant operation, input/ output voltage relations for converters	8
5.	**Modelling and Characteristics of EV Powertrains Components**- ICE Performance Characteristics, Electric Motor Performance Characteristics - Transmission and Drivetrain Characteristics- Regenerative Braking Characteristics-Driving Cycles Modelling and Analysis of Electric Propulsion and Braking - Longitudinal Dynamics Equation of Motion - Vehicle Propulsion Modelling and Analysis - Vehicle Braking Modelling and Analysis	7
6.	**Design of Propulsion system**: Matching the electric machine and the internal combustion engine requirements of vehicle, Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems. Traction motor sizing for different condition	7
	Total	45

Reference Books:

1. Modem Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory, and Design, Mehrdad Ehsani and Yimin Gao, Power Electronics and application series
2. Build Your Own Electric Vehicle, Seth Leitman arid Bob Brant
3. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Husain, CRC Press, 2003
4. Fundamental of vehicle dynamics, Thomas D Gillipse, Society of Automotive Engineers, second edition
5. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
6. Theory of Ground Vehicles. Third Edition. J.Y Wong. John Wiley ISBN: 0-471-35461-9

Program:	Honors in Electric Vehicle Technology					Semester : VII	
Course :	Design of Electric Vehicle Powertrain Lab					Code : HME7988	
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	TW	OR	PR	Total
-	2	-	1	-	25	-	25

Prior Knowledge of :

a. Machine design,
b. Electric vehicles
c. Vehicle dynamics …….are essential

Course Objectives:

1. To identify and analyze the components of electric power train.
2. To understand Modelling and simulation of Electric vehicle powertrain components
3. To design & analyze the EV propulsion system

Course Outcomes:

After learning the course the learners will be able,

1. To identify electric powertrain components
2. To select proper electric motor as per the requirements for an EV
3. To conduct trial on electric motor and evaluate it's performance

Detailed Syllabus

Any one of Category I, any 6 of Category II and any one of Category III, total 8 experiments to be performed.

I. Simulation based Experiments

1. Estimation of power rating of traction motor for different gradeability by using software
2. Estimation of power rating of traction motor for maximum vehicle speed by using software
3. Simulation of EV Power Train by using MATLAB/ Simulink

II. Laboratory Experiments

1. Study of various components of electric vehicle propulsion system layouts
2. Analysis of different motors used in electric vehicle
3. Speed control for BLDC motor by using V/F method
4. Speed control for IM motor by using PWM method
5. Performance testing of Electric Motor
6. Calculation & sizing the traction motor for given electric vehicle
7. Study of Electric Motor Testing standards
8. Industrial visit to electric vehicle industry / service center

III. Case study-based Experiments

1. Case study on recent research in the field of EV propulsion system
2. Case study on challenges & future scope of electric vehicle

Reference Books:

1. Modem Electric, HybridElectric and Fuel Cell Vehicles: Fundamentals,Theory, and Design, Mehrdad Ehsaniand Yimin Gao, Power Electronics and application series
2. Build Your Own Electric Vehicle, Seth Leitman arid Bob Brant
3. Electric and Hybrid Vehicles: DesignFundamentals, Iqbal Husain, CRC Press, 2003
4. Fundamental of vehicle dynamics, Thomas D Gillipse, Society of Automotive Engineers, second edition
5. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
6. Theory of Ground Vehicles. Third Edition. J.Y Wong. John Wiley ISBN: 0-471-35461-9
7. Laboratory Manuals

Program:	Honors in Electric Vehicle Technology					Semester: VII	
Course:	Seminar/Mini-Project/MOOC/Industrial Training					Code: HME7989	
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Credit	Hours	IE	TW	OR	Total
-	4	2	4	-	-	50	50

Course Content

Prior knowledge of:

a. Electric vehicle Systems & Vehicle Dynamics,
b. Battery Technologies for Electrical ……..are essential

Course Objectives:

Students are expected to acquaint themselves to ,

1. The latest developments in the field of electric vehicle technology.
2. The most recent developments and future trends in the field of EV batteries.
3. The developments in charging infrastructure and testing standards of battery and motor.

Course Outcomes:

The students will be able to,

1. Understand and plan a seminar/mini project/ industrial training based on EV Technology.
2. Analyse the problems associated with EV technology and provide viable solutions.
3. Prepare a technical report with context diagrams.
4. Deliver technical presentation based on the work carried out.

Seminar/Mini-Project/MOOC/Industrial Training is a course requirement where in under the guidance of a faculty member a student is expected to do an in depth study on the topic relevant to latest trends in the field of concerned Honors degree selected by him / her and approved by the authority; by doing literature survey, understanding different aspects of the problem and arriving at a status report in that area. While doing Seminar/Mini-Project/MOOC/Industrial Training, the student is expected to learn investigation methodologies, study relevant research papers, correlate work of various authors/researchers critically, study concepts, techniques, prevailing results etc., analyze it and present a seminar report. It is mandatory to give a presentation on Seminar/Mini-Project/MOOC/Industrial Training before a panel constituted for the purpose. The grading is done on the basis of the depth of the work done, understanding of the problem, report and presentation by the student concerned.

Guidelines for Seminar

1. **Guidelines for the Preparation of Seminar/Mini-Project/MOOC/Industrial Training**
   - Report should have at least 20 and at most 30 pages.
   - The entire pages of the report should be in A4 size strictly, with 1" top and bottom margin and 1.25" left and right margin.
   - The entire report should be typed in Times New Roman with (12 Pt.)
   - The title and main headings of the paragraphs are to be in bold.
   - Report may be divided into the number of chapters as required, with chapter number assigned on the top left corner and chapter name immediately below it (with single line spacing) using Times New Roman (16 Pt. Bold).
   - Every sub heading should be given decimal of whole number of the heading. (e.g1.1).
   - The complete text should be justified in the report (no left or right aligning).
   - No short forms are to be used in the report besides the specified areas.
   - Numbering of each figure and table should be done according to the chapter number.
   - Numbering of each page should be done in the footer section at the bottom right corner.
   - Each line should be separated by a line spacing of 1.5, and each paragraph by line spacing of 2.
2. **List of Contents in the Report:**
   The Cover, Cover page. (Same as The Cover), Certificate from Department, Acknowledgement. , Abstract, Table of content, List of figures and tables , The report, References and appendices.
3. **Guidelines for Presentation:**
   - The presentation shall be limited to 15 minutes plus 10 minutes questions and answers.

Course Syllabus

ELECTRIC VEHICLE TECHNOLOGY

Semester - VIII

Program:	Honors in Electric Vehicle Technology				Semester : VIII		
Course:	Integrated Project				Code: HME8982		
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Credit	Hours	IE	TW	OR	Total
-	5	5	10	50	50	50	150

Prior knowledge of:

a. Electric vehicle Systems & Vehicle Dynamics
b. Battery Technologies and power train for EVs.
c. Safety Regulations & Testing Standards for EVs……..are essential

Course Objectives:

1. To be able to conceive and implement an idea with the understanding gained during the course work.
2. To plan for various activities of the project and direct the work towards product /process development.
3. To build, design, analyze and implement an application using available software/hardware platforms.

Course Outcomes:

The students will be able to,

1. Understand, plan and execute a project related to electric mobility
2. Design a real-time application based on electric vehicle components/process/application
3. Prepare a technical report based on the project.
4. Deliver technical seminars based on the project work carried out.
5. Understand publication and copyright process of research

Guidelines: Total: 24 h (contact) + 48 h (non-contact/implementation)

1. A group of 3 to 4 students needs to design and demonstrate the project under the guidance of the allocated guide.
2. Students can choose the project considering their implementation in Major Project.
3. The hardware implementation and or software simulation is compulsory.
4. Project Report should be submitted in compliance with term work associated with the subject.
5. Paper publication associated with the project as research outcome is appreciable.
6. Project work preferably should be completed in the laboratory/ industry.

Detailed Syllabus

Sr. No.	Activity	Duration (H)
1	Semester VIII (week 1&2): Project guide allotment, Finalization of topic and platform, Planning of the work, Literature review, identifying a problem, and formulating the problem for the project	20
2	Semester VIII (week 3 & 4): Methodology finalization, finalizing project proposal, Review 1 for finalization of topic and specification.	20
3	Semester VIII (week 5 & 6): Simulation of Ideas on appropriate software tools and finalization of hardware platform	20
4	Semester VIII (week 7 & 8): Understanding platform implementation and related software flow and execute the block-level design, Review 2 to understand the progress of the project	20
5	Semester VIII (week 9 & 10): Project Report writing and publication or copyright planning and execution.	20
6	Semester VIII (week 11 & 12): Demonstration of Project work and Final Review for submission and term work compliances.	20
	Total	120