INSTITUTE	**FACULTY OF TECHNOLOGY**
PROGRAM	**MASTER OF TECHNOLOGY in ELECTRICAL ENGINEERING**
SEMESTER	**1**
COURSE TITLE	**INTRODUCTION OF ELECTRIC AND HYBRID VEHICLES**
COURSE CODE	**01PE1106**
COURSE CREDITS	**4**

Objective:

1 The course introduces basic aspects of Electric and Hybrid Vehicle systems such as their configuration, energy storage devices, electric propulsion systems and parameters associated with such systems.

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

1 Differentiate among different types of Electric and Hybrid Vehicles and their configurations.

2 Decide suitable electric propulsion system for EV and HEV.

3 Determine the rating of energy source requirement of EV and HEV.

4 Analyse the role of auxiliaries in Electric and Hybrid Vehicles.

Pre-requisite of course: None

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	**Introduction to Electric Vehicles:** Evolution of Electric Vehicles, EV configurations - Fixed and variable gearing, , Single- and multiple-motor drives, In-wheel drives, , Parameters of EV systems - Weight and size parameters, , Force parameters, Energy parameters, Performance parameters	6
2	**Hybrid EV systems:** HEV configurations - Series hybrid system, Parallel hybrid system, Series-parallel hybrid system, Complex hybrid system, Power flow control in Series hybrid system, Parallel hybrid system, Series-parallel hybrid system, Complex hybrid system, Case Study	6

DR. TAPANKUMAR ANIRUDHDH TRIVEDI
Digitally signed by (Name of HOD)

DR. RAJENDRASINH BAHADURSINH JADEJA
Digitally signed by (Name of Dean/ Principal)

Contents : Unit	Topics	Contact Hours
3	**Electric Propulsion Systems:** DC motor drives,, Induction motor drives,, Permanent-magnet motor drives,, Switched reluctance motor drives and their role in EV and HEV systems, Performance study of electrical propulsion system with respect to application.	10
4	**Energy Sources in EV and HEV systems:** Electrochemical Batteries – Terminology, Specific Energy, Specific Power, Energy Efficiency in Lead-Acid Batteries, Nickel based batteries, Lithium based batteries,, Requirement of Ultracapacitors – Features, Principle of operation and Performance of UC,, High Speed Flywheels – Operating Principles, Power capacity, Flywheel technologies,, Hybrid Energy Storage Systems,, Fuel Cell – Principle of Operation and Performance	12
5	**EV Auxiliary Systems:** Battery characteristics and chargers, Battery indication, Temperature control unit, Power Steering Unit, Auxiliary Power Supply, Navigation system	8
Total Hours		**42**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Experiment List** modelling a lead-acid battery cell using the Simscape, Observe the charging and discharging process, and plot graph of charging/load current, SOC, temperature, DOC, and terminal voltage of Li-ion battery in MATLAB Simscape, Analysing the effect of temperature on the performance of a Lithium-Ion battery model.	6
2	**Experiment No. 04** Simulating and plot the result of temperature, SOC, current, and terminal voltage for the HV Battery Charge/Discharge using realistic DC-link current profile, which originates from a dynamic driving cycle.	2
3	**Experiment No. 05** modelling of the acceleration and performance simulation of EV using MATLAB script file	2
4	**Experiment No. 06** Importing and Creating Driving Cycles using MATLAB script file used for range modelling of vehicle.	2
5	**Experiment No. 07** Parallel hybrid transmission	2
6	**Experiment No. 08** Series hybrid transmission	2
7	**Experiment No. 09** EV battery cooling system	2

DR. TAPANKUMAR ANIRUDHDH TRIVEDI
Digitally signed by (Name of HOD)

DR. RAJENDRASINH BAHADURSINH JADEJA
Digitally signed by (Name of Dean/ Principal)

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
8	**Experiment No. 10** Supercapacitor Charging and Discharging Behavior	2
9	**Experiment No. 11** 6 kW 45 Vdc Fuel Cell Stack	2
Total Hours		**22**

Textbook :

1 Electric Vehicle Technology Explained, James Larminie, John Lowry, Willey, 2003

References:

1 Modern Electric Vehicle Technology, Modern Electric Vehicle Technology, C.C Chan, K.T Chau, Oxford University Press Inc., New York , 2001

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

3 Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, CRC Press, 2nd edition, 2009

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
5.00	10.00	15.00	30.00	20.00	20.00

Instructional Method:

1 The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

2 The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and classroom.

3 Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

4 Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory.

Supplementary Resources:

1 https://nptel.ac.in/courses/108/103/108103009/
2 https://www.edx.org/course/electric-cars-technology
3 https://www.youtube.com/channel/UC5PK4aUlSYMfnEjig_fdGsg

DR. TAPANKUMAR ANIRUDHDH TRIVEDI
Digitally signed by (Name of HOD)

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Digitally signed by (Name of Dean/ Principal)