Introduction to Hybrid and Electric Vehicles - Web course

COURSE OUTLINE

This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles.

The material for this course will be prepared in such a manner that it will be useful for post-graduate students, teachers, practitioners and final year undergraduate students.

This course goes deeper into the various aspects of hybrid and electric drive train such as their configuration, types of electric machines that can be used, energy storage devices, etc. Each topic will be developed in logical progression with up-to-date information.

A number of chosen problems will be solved to illustrate the concepts clearly. There shall be a suite of exercises based on MATLAB and Simulink.

Syllabus:

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Drive-trains: 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, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

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.

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

Energy Management Strategies: 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.

Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

NP-TEL

NPTEL

http://nptel.iitm.ac.in

Electrical Engineering

Pre-requisites:

1. Control Systems Engineering – I.
2. Electrical Machines-I.
3. Electrical Machines-II.
4. Power Electronics.

Coordinators:

Dr. Praveen Kumar
Department of Electronics and Communication EngineeringIIT Guwahati

Prof. S. Majhi
Department of Electronics and Communication EngineeringIIT Guwahati

COURSE DETAIL

Lecture No.	Topic/s
1	Air pollution and global warming.
2	Impact of different transportation technologies on environment and energy supply.
3	History of hybrid electric, electric and fuel cell vehicles.
4	Vehicle motion and the dynamic equations for the vehicle.
5	Vehicle power plant and transmission characteristics and vehicle performance including braking performance.
6	Fuel economy characteristics of internal combustion engine.
7	Basic architecture of hybrid drive train and analysis series drive train.
8	Analysis of parallel, series parallel and complex drive trains and power flow in each case.
9	Drive cycle implications and fuel efficiency estimations.
10	Sizing of components for different hybrid drive train topologies.
11	Basic concept of electric traction and architecture.
12	Topologies for electric drive-train and their analysis.
13	Drive cycle implications and fuel efficiency estimations and well to wheel fuel efficiency analysis.
14	Sizing of components for different electric drive train topologies.
15	Electric drives used in HEV/EVs, their classifications and general characteristics.
16	DC Motor drives and their principle of operation and performance including multi-quadrant control.
17	Induction motors, their configurations and optimization for HEV/EVs.

18	Induction motor drives, their control and applications in EV/HEVs.
19	Permanent magnet motors, their configurations and optimization.
20	Permanent magnet motor drives, their control and applications in EV/HEVs.
21	Switch reluctance motors, their configurations and optimization.
22	Switch reluctance motor drives, their control and applications in EV/HEVs.
23	Losses in traction motors, inverters and efficiency maps.
24	Energy storage, battery based energy storage and simplified models of battery.
25	Fuel cells, their characteristics and simplified models.
26	Super capacitor based energy storage, its analysis and simplified models.
27	Flywheels and their modeling for energy storage in HEV/BEV.
28	Hybridization of various energy storage devices, its advantages and challenges.
29	Matching the electric drive and ICE, Transmission selection and gear step selection.
30	Sizing the propulsion motor, its torque, constant power speed ratio and machine dimensions.
31	Sizing the power electronics based on Switch Technology, Switching Frequency and Ripple capacitor design.
32	Selecting the energy storage technology.
33	Electrical overlay harness and communications.
34	Supporting system including steering and braking system.
35	Energy management strategies and its general architecture.

36	Rule and optimization based energy management strategies (EMS).
37	EMS based on deterministic rules.
38	EMS based on Fuzzy rule base.
39	EMS based on Global Optimization.
40	EMS based on Real Time Optimization.
41	Case study of design of a HEV.
42	Case Study of design of a BEV.

References:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.