EEPE3007 ELECTRIC VEHICLE (3-0-0)

Course Learning Objectives: This course will enable students to:

- Understand the fundamental architecture of electric vehicles, including major subsystems such as electric motors, batteries, converters, chargers, and control units.
- Analyze the performance characteristics of EV powertrains, including torque–speed behavior, efficiency, regenerative braking, and energy management strategies.
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- Assess the challenges and opportunities in EV deployment, including charging infrastructure, grid integration, standards, safety, and sustainability.

Module I (4 Hours)

Introduction to EV: Past, Present & Future of EV, Current Major Issues, Recent Development Trends, EV Concept, Key EV Technology, State-of-the Art EVs, Comparison of EV Vs IC Engine.

EV System: EV Configuration: Fixed & variable gearing, single & multiple motor drive, In-wheel drives EV Parameters: Weight, size, force, energy & performance parameters.

Module II (5 Hours)

EV Propulsion- Electric Motor: Choice of electric propulsion system, block diagram of EV propulsion system, concept of EV Motors, single motor and multi-motor configurations, fixed & variable geared transmission, In wheel motor configuration, classification of EV motors, Electric motors used in current vehicle applications, Recent EV Motors, Comparison of Electirc Motors for EV applications.

Module III (6 Hours)

Required Power Electronics & Control: Comparison of EV power devices, introduction to power electronics converter, four quadrant DC chopper, three-phase full bridge voltage-fed inverter, soft-switching EV converters, comparison of hard-switching and soft-switching converter, three-phase voltage-fed resonance dc link inverter, Basics of Microcontroller & Control Strategies.

Module IV (6 Hours)

EV Motor Drives: DC Motor: Type of wound-field DC Motor, Torque speed characteristics DC-DC Converter, Two quadrant DC Chopper, two quadrant zero voltage transition converter-fed dc motor drive, speed control of DC Motor.

Induction Motor Drive: Basics of induction motor; open-loop v/f control; basics of DC-AC power converters; basic pulse width modulation techniques; vector control of IM drives; advanced control techniques.

SRM and PMSM Drives: Basics of magnetic circuits and principle of reluctance; basics of switched reluctance motor; modelling and control of switched reluctance motor; modelling and control of PMSM drive; advanced control techniques for PMSM drive.

Module V (9 Hours)

Energy Sources & Charging: Different Batteries and Ultra-capacitors, Battery characteristics (Discharging &Charging) Battery Chargers: Conductive (Basic charger circuits, microprocessor based charger circuit. Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication Methods Charging Infrastructure: Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move and-charge zone.

Course Outcomes (CO): On completion of this course, students are able to:

CO1 Identify EV concepts, EV configurations and various EV parameters for better understanding of the EV technology.

CO2 Analyse the EV propulsion system and electric motors for vehicular applications & power electronics converters required for their control.
CO3 Analyse DC motor & induction motor drives and discuss methods for controlling them.
CO4 Elaborate various hybrid electric vehicle configurations and explain the power flow control in all HEV configurations.
CO5 Identify different energy sources used in EV and analyse the various methods used in charging these energy sources.

Text Book(s):

1. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004

Reference Book(s):

1. Ali Emadi, “Advanced Electric Drive Vehicles”, CRC Press; 2015.
2. Iqbal Husain, “Electric and Hybrid Vehicles – Design Fundamentals”, Second Edition, CRC Press. 2011
3. W. Leonard, “Control of Electric Drives”, Springer Press 2007
4. R Krishnan, “Permanent Magnet Synchronous and Brushless DC Motor Drives”, CRC Press 2010
5. Berker B., James W. J. & A. Emadi, “Switched Reluctance Motor Drives”, CRC Press 2019
6. Bin Wu, “High-Power Converters and Ac Drives”, IEEE WILEY Press 2017
7. Bimal K. Bose, “Modern Power Electronics and AC Drives”, Prentice Hall PTR 2001