Approved in 50th BoA Meeting(14.07.2023)

IIT Mandi
Proposal for a New Course

Course number : **EE 542**
Course Name : **Modelling, Simulation and Control of Hybrid Electric Vehicle**
Credit Distribution : **3-0-0-3**
Intended for : **3rd and 4th year UG, PG, PhD**
Prerequisite : **Linear Algebra**
Mutual Exclusion : **Content of this course does not overlap with others** (*courses with high similarity not allowed to credit by the students after or along with this course*)

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1. Preamble:

Increasing concerns for environmental protection and new stringent laws for emissions have principally driven recent innovations in the field of transportation. Electric vehicles (EV) are emerging as the ultimate transportation solution but there are still many challenges to overcome such as short driving range, significant costs, and lack of ready infrastructure. While electrification of powertrain with higher and cleaner power-output seems to be the most practical and feasible approach, achieving the same requires sophisticated modelling processes and complex control techniques. This course focusses on teaching fundamentals of modelling, simulation and control techniques for developing advanced and more energy efficient components such as electrical machines, multi-body dynamics of vehicle, batteries and fuel cells of higher energy and power density etc.

2. Course Modules with quantitative lecture hours:

Unit 1: Modelling in performance parameter (5 hours)

Topics: Modelling Vehicle Acceleration-Acceleration performance parameters, modeling the acceleration of an electric scooter, modeling the acceleration of a small car

Unit 2: Modelling of Battery Electric Vehicles (8 hours)

Topics: Electric Vehicle Modelling Tractive Effort, Rolling resistance force, Aerodynamic drag, Hill climbing force, Acceleration force, Total tractive effort, Modelling Electric Vehicle Range-Driving cycles, Range modeling of battery electric vehicles, Constant velocity range modelling, Range modelling of fuel cell vehicles, Range modelling of hybrid electric vehicles

Unit 3: Drive Train Characteristics (8 hours)

Topics : Modelling and Characteristics of EV/HEV Power trains Components-ICE Performance Characteristics, Electric Motor Performance Characteristics- Battery

Performance, Characteristics-Transmission and Drive train Characteristics- Regenerative Braking Characteristics-Driving Cycles Modelling and Analysis of Electric and Hybrid Electric Vehicles Propulsion and Braking- Longitudinal Dynamics Equation of Motion-Vehicle Propulsion Modelling and Analysis-Vehicle Braking Modelling and Analysis.

Unit 4: Energy Management (8 hours)

Topics: Handling Analysis of Electric and Hybrid Electric Vehicles-Simplified Handling Models Energy/Power Allocation and Management-Power/Energy Management Controllers-Rule-Based Control Strategies- Optimization-Based Control Strategies

Unit 5: Vehicle Dynamic Control (8 hours)

Topics: Control of Electric and Hybrid Electric Vehicle Dynamics-Fundamentals of Vehicle Dynamic Control (VDC) Systems, VDC Implementation on Electric and Hybrid Vehicles Case Studies, Rechargeable Battery vehicles, Hybrid Vehicles, Fuel Cell Powered Bus

Unit 6: Estimation Techniques (5 hours)

Topics: Identification of important state variables and parameters of HEV, Kalman filter-based methods, Least Square based methods.

3. Text books:

(Relevant and Latest, only 2)

1. Wei Liu, "Introduction to Hybrid Vehicle System Modeling and Control", Wiley, 2015.
2. Y. Xu, J. Yan, H. Qian, and T. L. Lam, "Hybrid Electric Vehicle Design and Control", vol. 1, McGraw Hill, 2021.

4. References:

1. James Larminie, John Lowry, "Electric Vehicle Technology Explained", John Wiley & Sons Ltd, 2003.
2. Amir Khajepour, Saber Fallahand Avesta Goodarzi, "Electric and Hybrid Vehicles-Technologies, Modelling and Control: A Mechatronic Approach", John Wiley & Sons Ltd, 2014.
3. Antoni Szumanowski, "Hybrid Electric Power Train Engineering and Technology: Modelling, Control, and Simulation", IGIGlobal,2013.
4. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles_ Fundamentals, Theory, and Design, Second Edition", CRC Press,2010.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.				

6. Justification of new course proposal if cumulative similarity content is >30%: