EV201N: FUNDAMENTAL OF ELECTRIC VEHICLES AND SIMULATIONS

Teaching Scheme : 01 L + 2PR; **Total:** 03 hours/week **Credits** : 02
Evaluation Scheme : 30 ICA+20 ESE **Total Marks** : 50
ESE Duration : 03 Hrs.

COURSE DESCRIPTION

This course aims to familiarize students with the concept of simulation on software for electric vehicles, electric drives used in it.

DESIRABLE AWARENESS / SKILLS

Desirable awareness/skills: Basic knowledge Basic Electrical Engineering and Electrical Machine

COURSE OUTCOMES

On the successful completion of this course, the students shall be able to -

1. understand standard functions from e.g. MATLAB library for calculation, visualization and efficient programming
2. recognize different e-vehicle technologies
3. demonstrate various power connection types for motor control and battery discharge circuits
4. appraise the practically available e vehicle systems

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CORRELATION)

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2					2			2						3
2		2			2							2	2		
3		2			2				3		2		2		3
4						2								2	

1-Weakly correlated **2 – Moderately correlated** **3 – Strongly correlated**

COURSE CONTENT

Theory lectures should be based on the theory related to practicals
The laboratory work should consist of experiments based on basic of electrical vehicle and software used for that. Experiments should involve programs on MATLAB/any software etc, result and conclusion based on it. The sample list given below is just a guideline. Course co-coordinator can add or remove the practicals in the course as per the latest trends.

List of Experiment:

1. Introduction of MATLAB software and tools.
    - Introduction to basic block sets of simulation platforms.
    - Basic matrix operations, Generation of standard test signals
    - SIMSCAPE Introduction
    - SIM Fundamentals
2. Introduction of Electric-vehicles.
3. Introduction to Power Converter Circuit required for Electric Vehicle
    - Power Converter Design -1 phase Rectifier /3 Phase Rectifier
    - Inverter Design MATLAB Simulink
    - Simulation for AC-DC converter.
    - Simulation for DC-DC converter
4. Introduction to Electric Motor and MATLAB Simulink for Electric Vehicle
    - DC Motor Speed Control MATLAB Simulink
    - BLDC Motor Control MATLAB Simulink
    - AC Induction Motor Control MATLAB Simulink
    - PMSM Motor Control MATLAB Simulink.
5. Introduction to Battery Modeling MATLAB Simulink
    - Study of Battery Management Systems.
    - Study and verification of active and passive cell balancing (using suitable simulation).
    - Battery connections for discharge system (using suitable simulation)
6. Industry visit

Evaluation Methodology:

- **ICA –** It shall support regular performance of minimum 8 practical and its regular assessment. In addition it shall be based on knowledge/skill acquired and record submitted by the student (journal) based on practical performance by him/her. The performance shall be assessed experiment wise using the prescribed internal continuous assessment format.

- **ESE –** It shall be based on performance in one of the experiments performed by the student in the semester followed by sample questions to judge the depth of understanding/knowledge or skill acquired by the student. It shall be evaluated by two examiners, out of which one examiner shall be external examiner

EV202N- BATTERY AND CHARGING SYSTEM

Teaching Scheme : 02 L + 00 T; Total: 02 hours/week **Credits** : 02
Evaluation Scheme : 10 ISA + 30 MSE + 60 ESE **Total Marks** : 100
ESE Duration : 3 Hrs.

COURSE DESCRIPTION

The objective of this course is to introduce learner to batteries, its parameters, modelling and charging requirements. The course will help learner to develop battery management algorithms for batteries.

DESIRABLE AWARENESS / SKILLS

EE101N: Basic Electrical Engineering.

COURSE OUTCOMES

On the successful completion of this course, the students shall be able to -

1. Classify different energy storage technologies.
2. Illustrate various type of circuit breakers.
3. Interpret the concept associated with battery charging / discharging process.
4. Calculate the various parameters of battery and battery pack
5. Design the Electric vehicle charging system.

RELEVANCE OF COURSE OUTCOMES (COs) WITH POs AND PSOs (WITH STRENGTH OF CO-RELATION)

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1				2										3	
2					2									2	
3						3								1	
4							3							2	
5							2								3

1-Weakly correlated **2 – Moderately correlated** **3 – Strongly correlated**

COURSE CONTENT

Energy Storage Technologies: [6 Hrs.]

Classification of Storage Technologies by Energy type- Thermal Energy: Heat Storage; Chemical Energy: Organic and Non- Organic; Mechanical Energy: Kinetic and Potential Energy; Electrical Energy: Electrical Potential.

Energy Storage Systems in Modern Electrical Systems: [5 Hrs.]

Lead-acid battery, Nickel-cadmium battery, Lithium-ion battery, Sodium-sulfur battery, Nickel metal hydride battery, Fuel cells, Capacitors and Super capacitors. Solid state Batteries. Differences amongst different ESS.

Typical ESS and Battery Chemistry: [4 Hrs.]

Electrodes, Electrolytes, Collectors, Thermal management, Packaging of battery pack Lithium based batteries: Lithium manganese oxide, Lithium iron phosphate, Lithium nickel manganese cobalt oxide, Lithium nickel cobalt aluminum oxide and Lithium titanate; Silicon based Batteries, Sodium-sulfur Batteries, Proton Batteries, Graphite Dual-Ion Batteries, Salt-water Batteries and Potassium-Ion Batteries

Battery Management Systems (BMS): [4 Hrs.]

Introduction to BMS, Objectives of the BMS: Discharging and Charging control, State-of-Charge Determination, State-of-Health Determination, Cell Balancing; BMS topologies: Distributed Topology, Modular Topology and Centralized Topology, Firmware development, Certification, Aging.

Charging Systems: [5 Hrs.]

EV Charging, AC Charging, DC Charging, Inductive Charging, Charging Connectors, Charging Standards and regulations, charging connector standards, Charging stations overview

Text Books

1. Alfred Rufer, “Energy Storage systems and components”, CRC Press, 2017
2. Tom Denton, “Automotive Electrical and Electronic Systems”, 5th Edition, Routledge, 2018
3. Mehard Ehsani, Yiming Gao, Stefano longo and Kambiz Ebrahimi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles”, CRC Press, 3rd Edition, 2019

Reference Books

1. Iqbal Husain, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 2021
2. K. T. Chau, “Energy Systems for Electric and Hybrid Vehicles,” IET Transportation Series 2, 2016
3. Jiuchun Jiang and Caiping Zhang, “Fundamentals and Applications of Lithium–Ion Batteries in Electric Drive Vehicles,” John Wiley & Sons, 2015