METHODIST COLLEGE OF ENGINEERING & TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

B.E. HONORS PROGRAM IN ELECTRICAL AND ELECTRONICS ENGINEERING

SCHEME OF INSTRUCTION

S. No.	Course Code	Course Name	L	P	T	Credits	Study Semester
1.	EEH01EE	Battery Management Systems	3	0	0	3	V
2.	EEH02EE	Hybrid Electric Vehicles	3	0	0	3	V
3.	EEH03EE	Microgrid and Applications	3	0	0	3	VI
4.	EEH04EE	EV Design and Simulation Lab	0	4	0	2	VI
5.	EEH05EE	AI & ML Applications in Electrical Engineering	3	0	0	3	VII
6.	EEH06EE	Technical Seminar	0	2	0	1	VII
7.	EEH07EE	Project	0	6	0	3	VII
Total Credits						**18**	

Course Code	Course Title	Core/Elective					
EEH01EE	Battery Management Systems	Core					
		L	T	P/D	Credits	CIE	SEE
		3	0	0	3	40	60

Prerequisites: Basics of Electrical Engineering, Control Systems, Electric Circuits,

Course Objectives :The objective of this course is to make the student

1. learn about batteries, its parameters.
2. aware of modelling and charging requirements.
3. Understand the battery management algorithms for batteries

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

1. Interpret the role of battery management system
2. Identify the requirements of Battery Management System
3. Interpret the concept associated with battery charging / discharging process
4. Calculate the various parameters of battery and battery pack
5. Design the model of battery pack

UNIT-I: Introduction: Introduction to Battery Management System, Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging.

UNIT-II: Battery Management System Requirement: Battery pack topology, Types of BMS, BMS Functionality, Voltage Sensing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-of charge estimation, Cell total energy and cell total power.

UNIT-III: Battery Status: Battery State of Charge and State of Health Estimation, Cell Balancing: Battery state of charge estimation (SOC), voltage-based methods to estimate SOC.

UNIT-IV: Modelling of Battery: Model-based state estimation, Battery Health Estimation, Lithium-ion aging: Negative electrode, Lithium ion aging: Positive electrode, Cell Balancing.

UNIT-V : Design of battery BMS: Design principles of battery BMS, Effect of distance, load, and force on battery life and BMS, energy balancing with multi-battery system

TEXTBOOKS:

1. Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 2015.
2. Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuit methods. Artech House, 2015.
3. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "Battery Management Systems -Design by Modelling" Philips Research Book Series 2002.

REFERENCES/ SUGGESTED READING:

1. Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs" Artech House, 2010
2. Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery-powered applications. Vol. 9. Springer Science & Business Media, 2008.

Course Code	Course Title	Core/Elective					
EEH02 EE	Hybrid Electric Vehicles	Core					
		L	T	P/D	Credits	CIE	SEE
		3	0	0	3	40	60

Prerequisites: Basics of Electrical Engineering, Control Systems, Power electronics, RES

Course Objectives :

1.To deliver and discuss the about architecture

2.Power electronics based drive control systems

3.Battery management systems and

4. Grid integration issues of Electric and Hybrid vehicles.

Course Outcomes: After completion of this course, student will be able to Interpret the role of battery management system

1. Understand the architecture and vehicle dynamics of hybrid vehicles

2. Analyze and model the power management systems for hybrid vehicles

3. Devise power electronics based control strategies for hybrid vehicles

4. Analyze and design various components of hybrid vehicles with environment concern.

5. Investigate and model the issues in mathematical domain related to grid interconnections of hybrid vehicle.

UNIT-I: Introduction to Hybrid Vehicle (HV): A brief history of Electric and Hybrid vehicles, basic architecture of hybrid drive train and analysis of series drive train, vehicle motion and the dynamic equations for the vehicle, types of HV and EV, advantages over conventional vehicles, limitations of EV and HV, impact on environment of EV and HV technology, disposal of battery, cell and hazardous material and their impact on environment.

UNIT-II: Power Management and Energy Sources of HV: Power and Energy management strategies and its general architecture of HV, various battery sources, energy storage, battery based energy storage and simplified models of battery, Battery Management Systems (BMS), fuel cells, their characteristics and simplified models, Super capacitor based energy storage, its analysis and simplified models, flywheels and their modelling for energy storage in HV/BEV, hybridization of various energy storage devices, Selection of the energy storage technology.

UNIT-III: Power Electronics in HV: Introduction, various power electronics converter topologies and its comparisons, Control of convertor operations in HV, battery chargers used in HV, emerging power electronic devices.

UNIT-IV: DC and AC Machines & Drives in EV & HV: Various types of motors, selection and size of motors, Induction motor drives and control characteristics, Permanent magnet motor drives and characteristics, Brushed & Brushless DC motor drive and characteristics, switched reluctance motors and characteristics, IPM motor drives and characteristics, mechanical and electrical connections of motors.

UNIT-IV: Hybrid Vehicles and Grid interconnection Issues: Introduction to smart charging: Grid to vehicle and vehicle to grid, smart metering and ancillary services, preliminary discussion on vehicle to vehicle and vehicle to personal communication systems, introduction to battery charging stations and its installation and commissioning, preliminary discussion on estimation on station capacity and associated technical issues, different connectors, policy regulations and standards for HV, BEE standards, Indian and Global scenario, case studies.

TEXTBOOKS:

1. Iqbal Hussain, "Electric and Hybrid Vehicles Design Fundamentals", 1st Edition, CRC Press, 2003.
2. James Larminie, John Lowry "Electric Vehicle Technology Explained", 1st Edition, John Wiley and Sons, 2003.
3. Chris Mi, M. Abul Masrur, David Wenzhong Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", Wiley publication ,2011.
4. Allen Fuhs, "Hybrid Vehicles and the future of personal transportation", CRC Press, 2009.

REFERENCES/ SUGGESTED READING/ Web Resources:

1. Web course on "Introduction to Hybrid and Electric Vehicles" by Dr. Praveenkumar and Prof. S Majhi, IIT Guwahati available on NPTEL at https://nptel.ac.in/courses/108/103/108103009/

2. Video Course on "Electric Vehicles" by Prof. Amitkumar Jain, IIT Delhi available on NPTEL at https://nptel.ac.in/courses/108/102/108102121/

Course code	Course Title	Core/Elective					
EEH03EE	Microgrid and Applications	Core					
		L	T	P/D	Credits	CIE	SEE
		3	0	0	3	40	60

Prerequisites: Knowledge of Power electronics, Power system and Control system

Course Objectives: The objective of this course is to make the student

1.To understand the fundamental concepts of microgrid and its components, types of microgrids, advantages of microgrid compared to the central conventional grid.
2. To understand the general concepts and application, control strategies and principle of operation of microgrid.
3. To know dynamic modelling of microgrids, renewable energy sources, and converters.
4. To analyze the protection in microgrids.

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

1. Understand the fundamental concepts of microgrid and its components, types of microgrids, advantages of microgrid compared to the central conventional grid.
2. Understand the power electronics applications in microgrid systems.
3. Analyze the dynamic modelling of converters, renewable energy sources, microgrids, DC microgrids, and energy storage systems.
4. Understand the principle of operation, control architecture, and energy management in Microgrids.
5. Understand the protection of microgrids

UNIT-I Introduction to Microgrids: Overview of microgrids, concept of microgrids, microgrid and distribution generation, microgrid vs conventional power system, AC and DC microgrid with distributed energy resources.

UNIT-II Power Electronics in Microgrids: Power electronics for microgrid, Power Electronic Converters in Microgrid application, DC Microgrid Topologies, Modelling of converters in microgrid power system (AC /DC, DC/AC and Dc/Dc Converters Modelling), Modelling of Renewable Energy Resources (wind and Photovoltaic systems), Modelling of Energy Storage System.

UNIT-III Microgrid Operation and Control: Microgrid Dynamics and Modelling, Microgrid Operation Modes and Standards, Microgrid Control Architectures, Intelligent Microgrid Operation and Control, Energy Management in Microgrid System.

UNIT IV Modelling and Control of DC microgrid: DC Microgrid System Architecture and AC Interface, DC Microgrid Dynamics and Modelling, Control of DC Microgrid System, Applications of DC Microgrids.

UNIT V Microgrid Protection: Challenges in microgrid protection systems, Classification for microgrid protection: current limiter, centralized protection, distance protection. Islanding: Non-detection zone, Anti-islanding techniques, different islanding scenarios.

TEXTBOOKS:

1. Fusheng Li, Ruisheng Li, Fengquan Zhou, Microgrid Technology and Engineering Application, Elsevier.
2. S. Chowdhury, P. Crossley, Microgrids and Active Distribution Networks, Institution of Engineering and Technology, 2009.
3. Nikos Hatziargyriou, Microgrids Architectures and Control John Wiley Sons, 2014.
4. Manuela Sechilariu, Fabrice Locment, Urban DC Microgrid: Intelligent Control and Power Flow Optimization, Butterworth-Heinemann, 2016.

REFERENCES/ SUGGESTED READING:

1. Hassan Bevrani, BrunoFrançois, Toshifumi Ise, Microgrid Dynamics and Control John Wiley Sons, 2017.
2. Gevork B. Gharehpetian, S. Mohammad Mousavi Agah, Distributed Generation Systems: Design, Operation and Grid Integration, Butterworth Heinemann, 2017.

Course Code	Course Title	Core/Elective					
EEH04EE	EV Modelling and Simulation Lab	Core					
		L	T	P/D	Credits	CIE	SEE
		0	0	2	1	40	60

Pre-Requisites: Mathematics, computer knowledge, fundamentals of EV and HEV

Course Objectives: The objectives of this course is to impart knowledge of

1. To understand modelling of EV/HEV
2. To gain thorough knowledge about Simulation of EV/HEV.
3. To understand the performance of EV/HEV

Course Outcomes: Upon completion of this course, students should be able to

1. know the software programming or blocks
2. Apply the equations for modelling the EV
3. Apply the knowledge for Modelling of the HEV
4. Demonstrate the simulation of EV and HEV
5. Compare the performance of EV and HEV

LIST OF EXPERIMENTS

1. Mathematical modelling of Electric Bicycle
2. Mathematical modelling of Electric Tricycle
3. Mathematical modelling of Electric Car
4. Simulation of 2 wheeler Electric Vehicle
5. Simulation of 4 wheeler Electric Vehicle
6. Mathematical model of Series HEV power train
7. Simulation of Series HEV power train
8. Simulation of Hybrid Electric Vehicle
9. Simulation of EV with Fuel cell and super capacitors
10. Design of a Hybrid Electric Vehicle (HEV)
11. Design of a Battery Electric Vehicle (BEV)

Simulation can be done by any software whichever is feasible.

NOTE:AT LEAST 10 EXPERIMENTS SHOULD BE CONDUCTED

SUGGESTED READING:

1. Oxford Brookes University, Oxford, UK John Lowry Acenti Designs Ltd., UK, Electric Vehicle Technology Explained.
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

Course code	Course Title	Core/Elective					
EEH05EE	AI & ML Applications in Electrical Engineering	Core					
		L	T	P/D	Credits	CIE	SEE
		3	0	0	3	40	60

Prerequisites: Knowledge of Power systems operation and control

Course Objectives: The objective of this course is to make the student

1. To be able to understand basics of ANN & Fuzzy based systems.
2. To make the students to understand the ANN based systems for function approximation used in load forecasting.

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

1. Understand how the soft computing techniques can be used for solving the problems of Electrical Engineering.
2. Design of ANN based systems for function approximation used in load forecasting.
3. Design of Fuzzy based systems for load frequency control in power systems
4. Understand the Machine Learning
5. Analyze AI and ML applications in electrical engineering

UNIT-I: Introduction: Definition of AI -difference between soft computing techniques and hard computing systems, expert systems brief history of ANN, Fuzzy, Introduction to ML.

UNIT-II: Artificial Neural Networks: Introduction, Models of Neuron Network-Architectures – Knowledge representation, Artificial Intelligence and Neural networks–Learning process-Error correction learning, Hebbian learning – Competitive learning-Boltzman learning, supervised learning-Unsupervised learning–Reinforcement learning- Learning tasks. Multi-layer perceptron using Back propagation Algorithm (BPA), Self –Organizing Map (SOM), Radial Basis Function Network-Functional Link Network (FLN), Hopfield Network.

UNIT-III: Fuzzy Logic: Introduction –Fuzzy versus crisp, Fuzzy sets-Membership function –Basic Fuzzy set operations, Properties of Fuzzy sets –Fuzzy cartesion Product, Operations on Fuzzy relations – Fuzzy logic –Fuzzy Quantifiers, Fuzzy Inference-Fuzzy Rule based system, Defuzzification methods .

UNIT-IV: Machine Learning: Definition of ML, Different types of Learning, Hypothesis Space, Inductive Bias, Evaluation, Cross-Validation, Linear Regression, Decision Trees, K-nearest Neighbour, Intro to Clustering, K- means Clustering, Agglomerative Hierarchical Clustering, Semi-Supervised, Reinforcement Learning, Deep Learning.

UNIT-V: Applications of AI and ML: Fuzzy logic and ML in power systems and electrical drive control. one Case study of ML in Electrical Engineering field.

TEXTBOOKS:

1. S. Rajasekaran, G. A. Vijayalakshmi,Neural Networks, Fuzzy logic and Genetic Algorithms, Pai PHI publication,
2. Kalyanmoy De, Optimization for Engineering Design, PHI publication.
3. Rober J. Schalkoff, Artificial Neural Networks, Tata McGraw Hill Edition, 2011.
4. John D. Kelleher, Brian Mac Namee, and Aoife D'Arcy, "Fundamentals of Machine Learning for Predictive Data Analytics"

REFERENCES/ SUGGESTED READING:

1. Kalyanmoy Deb, Multi-objective Optimization using Evolutionary Algorithms, Willey Publications.
2. D. E. Goldberg,” Genetic Algorithms”- Addison Wesley 1999.
3. Bart Kosko, ”Neural Network & Fuzzy System” Prentice Hall, 1992

Course Code	Course Title	Core/Elective					
EEH06EE	Technical Seminar	Core					
		L	T	P/D	Credits	CIE	SEE
		0	0	2	1	50	-

Pre requisites : Knowledge EV Technology

Course Objectives: The objectives of this course is

1. To encourage the students to study advanced engineering developments.
2. To prepare and present technical reports.
3. To encourage the students to use various teaching aids such as overhead projectors, power point presentation and demonstrative models.

Course Outcomes: After Completion of the course the student will be able to

1. Review, prepare and present technological developments.
2. Enhance communication skills
3. Enhance presentation skills
4. Improve the behaviour skills and ethics
5. Face the placement interviews.

Method of Evaluation:

During the seminar session, each student is expected to prepare and present a topic on current trends in Electrical Engineering and Technology (25 Marks), for a duration of about 30 minutes.

In a session of two periods per week, all students are expected to present during the seminar.

Each student is expected to present atleast twice during the semester and the student is evaluated based on that.

At the end of the semester, he / she shall submit a report on his / her topic of seminar (for 25 Marks).A Faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also.

Evaluation is 100% internal.

Course Code	Course Title	Core/Elective					
EEH07EE	Project	Core					
		L	T	P/D	Credits	CIE	SEE
		0	0	6	3	50	100

Course Objectives :

1. The student(s) shall explore the technological needs of society.
2. The student(s) shall understand the technological problems of society.

Course Outcomes: After Completion of the course the student will be able to

1. Provide a solution to the technological problems of society.
2. Suggest technological changes which suits current needs of society.
3. Explain new technologies available for problems of the society
4. Enhance communication and presentation skills

nprove leadership qualities and presentation skills.

Preamble:

There is lot of scientific and technological changes in the nation during last few decades in almost all the sectors. The state and central governments are introducing many schemes to all classes of people of the nation to increase the productivity in various sectors. India is a rural centric nation and the fruits of the scientific inventions and new technology shall be shared among all remote corners of the nation. With this aim, a socially relevant project is newly introduced in the curriculum with an objective of taking up the projects relevant to the societal needs.

General guidelines:

- A socially relevant project shall be a community service based project and it shall be innovative.
- A student has to pursue the socially relevant project to solve real life and pressing problems of society.
- The pursued socially relevant projects shall contribute to national development goals and priorities.
- Socially relevant project can be carried out by an individual student or by a team of maximum five (05) of the department.
- The student(s) shall visit the society (Villages/Hospitals/Social Service Organizations etc.) to identify the problem, conduct literature survey, and provide a feasible solution through fabricated models.
- The socially relevant project selected shall be in the broad area of concerned discipline of course. Preference shall be given to rural societal problems.
- Each team shall work under the supervision of a faculty member of the concerned department.
- The attendance shall be maintained by the respective supervisor.
- The developed solutions will be assessed by the Department and shall be evaluated for 40 Marks.
- Additional 10 Marks will be awarded for the outcome based (Patents, Journal Publications, Conference Proceedings, Technical Seminar Presentations, Design Registrations, etc.) Projects.
- External examination will be conducted by an outside expert and project panel for 100 marks