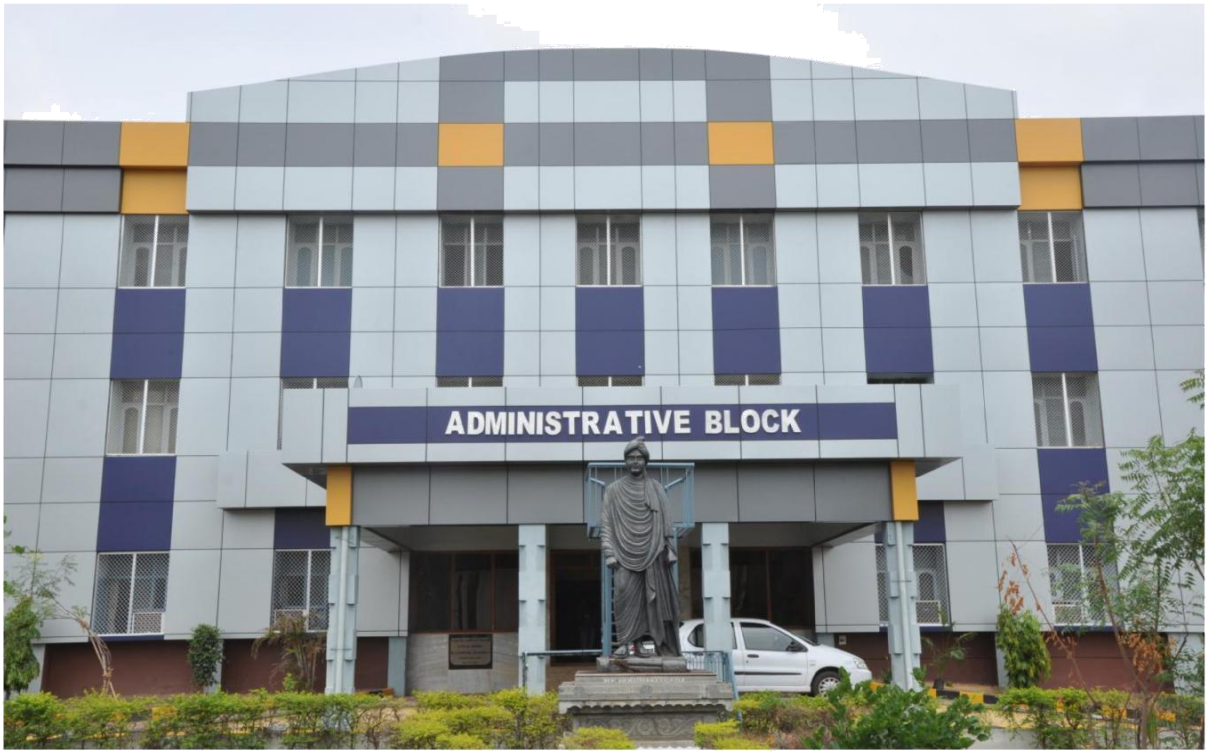

Scheme – 2023

Electrical & Electronics Engineering Department

G. Pulla Reddy Engineering College (Autonomous): Kurnool

Accredited by NBA of AICTE and NAAC of UGC

Affiliated to JNTUA, Anantapuramu

Scheme and Syllabus for

HONORS in ELECTRICAL & ELECTRONICS ENGINEERING

(With Effect from the Batch Admitted from 2023-24)

G. PULLA REDDY ENGINEERING COLLEGE (Autonomous): KURNOOL
Accredited by NBA of AICTE & NAAC of UGC
Affiliated to Jawaharlal Nehru Technological University Anantapur, Ananthapuramu
Department of Electrical & Electronics Engineering
HONORS in ELECTRICAL AND ELECTRONICS ENGINEERING
Scheme of Instruction and Examination
Scheme-2023

HONORS in ELECTRICAL AND ELECTRONICS ENGINEERING

S.No.	Course Code	Course Name	Contact Hours per week		Credits
			L	P	
1	HEE01	E - Mobility	3	-	3
2	HEE02	Battery Management Systems	3	-	3
3	HEE03	Special Machines for Electric Vehicles	3	-	3
4	HEE04	Grid Interface of Electric Vehicles	3	-	3
5	HEE05	EV Charging Technologies	3	-	3
6	HEE06	Project on Electric Vehicles	-	6	3
Total					**18**

E – MOBILITY (EM)								
EEE						**Scheme: 2023**		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
HEE01	**Honours**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**
		3	**0**	**0**	**3**	**30**	**70**	**100**
Sessional Exam Duration:2 Hrs						**End Exam Duration: 3 Hrs**		

Course Outcomes: At the end of the course the student will be able to

CO1: Understand the fundamentals of Electric Vehicles, Vehicle Dynamics, Selection of Motors, and Power electronics in EVs.

CO2: Analyze Battery Technologies for Electric Vehicles.

CO3: Understand Charging Technologies for Electric Vehicles.

CO4: Explore future trends and Innovations in Electric Vehicles.

CO5: Understand E-Mobility, Policy, and Integration with Smart Grids.

UNIT – I

Introduction

Introduction to electric vehicles: EV verses gasoline vehicles, vehicle dynamics fundamentals, e-drive train, Electric motor, Power electronic in electric vehicles, Regenerative braking.

UNIT – II

Battery Technology

Battery Technology for EVs: Storage technologies for EV, Battery working principles, Battery losses, Li-ion batteries, Battery pack and battery management system.

UNIT – III

Charging Technology

Charging Technology of EVs: AC charging - Type 1,2,3, DC charging, Fast charging and its limitations, Smart charging and applications, Vehicle to X(V2X), X2V technology.

UNIT – IV

Future Trends in EVs

Future trends in e-Vehicles: Wireless charging of EV, On-road charging of EV, Battery swap technology, Solar powered EVs, Charging EVs from renewable.

UNIT – V

E-Mobility

E-mobility: electrification challenges, business, connected mobility and autonomous mobility case study in Indian Roadmap Perspective, Policy- EVs in infrastructure system, integration of EVs in smart grid, social dimensions of EVs.

Text Books:

1. IqbalHussain, ―Electric & Hybrid Vehicles – Design Fundamentals‖, Second Edition,

CRC Press, 2011.

2. James Larminie, ―Electric Vehicle Technology Explained‖, John Wiley & Sons, 2003.

Reference Books:

1. MehrdadEhsani, YiminGao, Ali Emadi, ―Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals‖, CRC Press, 2010.
2. Sheldon S. Williamson, Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer, 2013.
3. SandeepDhameja, ―Electric Vehicle Battery Systems‖, Newnes, 2000.
4. Tariq Muneer and Irene IllescasGarcía, ―The automobile, In Electric Vehicles: Prospects and Challenges‖, Elsevier, 2017.

Web References:

1. https://nptel.ac.in/courses/108106170

Question Paper Pattern:

Sessional Exam:

The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall answer any one of them. Each of these questions may contain sub-questions.

End Examination:

The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall answer any one of them. Each of these questions may contain sub-questions.

BATTERY MANAGEMENT SYSTEMS (BMS)

EEE						Scheme: 2023		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	Total
HEE02	Honours	3	0	0	3	30	70	100
Sessional Exam Duration: 2 Hrs						End Exam Duration: 3 Hrs		

Course Outcomes: At the end of the course the student will be able to

CO1: Understand the role of battery management system.

CO2: Identify the requirements of Battery Management System.

CO3: Interpret the concept associated with battery charging / discharging process.

CO4: Analyze various parameters of battery and battery pack.

CO5: 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

Introduction and BMS functionality, Battery pack topology, 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 State of Charge and State of Health Estimation

Battery state of charge estimation (SOC), voltage-based methods to estimate SOC, Model-based state estimation, Battery Health Estimation, Lithium-ion aging: Negative electrode, Lithium ion aging: Positive electrode, Cell Balancing, Causes of imbalance, Circuits for balancing

UNIT – IV

Modelling and Simulation

Equivalent-circuit models (ECMs), Physics-based models (PBMs), Empirical modelling approach, Physics-based modelling approach, Simulating an electric vehicle, Vehicle range calculations, Simulating constant power and voltage, Simulating battery packs

UNIT – V

Design of Battery Management Systems

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

Text Books:

1. Plett, Gregory L. Battery management systems, Volume I: Battery modelling. Artech House, 2015.
2. Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuit methods. Artech House, 2015.

Reference Books:

1. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L ―Battery Management Systems -Design by Modelling‖ Philips Research Book Series 2002.
2. Davide Andrea,‖ Battery Management Systems for Large Lithium-ion Battery Packs‖ Artech House, 2010.
3. Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery- powered applications. Vol. 9. Springer Science & Business Media, 2008.

Web References:

1. https://nptel.ac.in/courses/108106170
2. https://nptel.ac.in/courses/113105102

Question Paper Pattern:

Sessional Exam:

The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall answer any one of them. Each of these questions may contain sub-questions.

End Examination:

The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall answer any one of them. Each of these questions may contain sub-questions.

SPECIAL MACHINES FOR ELECTRIC VEHICLES (SMEV)								
EEE						**Scheme: 2023**		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
HEE03	**Honours**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**
		3	**0**	**0**	**3**	**30**	**70**	**100**
Sessional Exam Duration:2 Hrs						**End Exam Duration: 3 Hrs**		

Course Outcomes: At the end of the course the student will be able to

CO1: Understand the Fundamentals of Permanent Magnet (PM) Brushless Motor Drives.

CO2: Analyze Switched Reluctance Motor (SRM) Drives.

CO3: Evaluate Stator-Permanent Magnet (PM) Motor Drives.

CO4: Understand and Designing Magnetic-Gear Motor Drives.

CO5: Explore Advanced Magnetless and Multiphase Motor Drives.

UNIT – I

Permanent Magnet (PM) Brushless Motor Drives

Structure of PM Brushless Machines, Principle of PM Brushless Machines Modeling of PM Brushless Machines, Inverters for PM Brushless Motors Motor Control, Design Criteria of PM Brushless Motor Drives for EVs, Design Examples of PM Brushless Motor Drives for EVs, Application, Advantages and Limitations for EVs.

UNIT – II

Switched Reluctance Motor Drive

Structure of SR Machines, Principle of SR Machines, SR Converters Topologies, SR Motor Control, Design Criteria of SR Motor Drives for EVs, Examples of SR Motor Drives for EVs, Application, Advantages and Limitations for EVs

UNIT – III

Stator-PM Motor Drives

Doubly-Salient PM Motor Drives, Flux-Reversal PM Motor Drives, Flux-Switching PM Motor Drives, Hybrid-Excited PM Motor Drives, Flux-Mnemonic PM Motor Drives, Design Criteria of Stator-PM Motor Drives for EVs, Application, Advantages and Limitations for EVs

UNIT – IV

Magnetic-Geared Motor Drives

Principle of MG Machines, Modeling of MG Machines, Inverters for MG Motors, MG Motor Control, Design Criteria of MG Motor Drives for EVs, Application, Advantages and Limitations for EVs

UNIT – V

Advanced Magnetless Motor Drives and Multiphase Motor Drives

Introduction to Advanced Magnetless technology, Synchronous Reluctance Motor Drives, Doubly- Salient DC Motor Drives, Flux-Switching DC Motor Drives, Design Criteria of

Advanced Magnetless Motor Drives for EVs, Application, Advantages and Limitations for EVs.
Multiphase Induction Motor drives – principle, operation and control
Multiphase PMSM machine – principle, operation and control, Fault tolerant operation of multiphase drives

Text Books:

1. Mehrdad Ehsani, Yimin Gao, Sebatien Gay and Ali Emadi, ―Modern Electric, Hybrid Electric and Fuel cell vehicles: Fundamentals, Theory and Design‖, CRC Press, 2004.
2. James Larminie and John Loury, ―Electric Vehicle Technology – Explained‖, John Wiley & Sons Ltd, 2003

Reference Books:

1. Sandeep Dhameja, ―Electric Vehicle Battery Systems‖, Butterworth – Heinemann, 2002
2. Ronald K Jurgen, ―Electric and Hybrid – Electric Vehicles‖, SAE, 2002
3. Ron Hodkinson and John Fenton, ―Light Weight Electric/Hybrid Vehicle Design‖, Butterworth – Heinemann, 2001
4. Iqbal Husain, ―Electric and Hybrid Vehicles- Design Fundamentals‖ CRC Press, 2011

Web References:

1. https://nptel.ac.in/courses/108106170
2. https://archive.nptel.ac.in/courses/108/103/108103009/

Question Paper Pattern:

Sessional Exam:

The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall answer any one of them. Each of these questions may contain sub-questions.

End Examination:

The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall answer any one of them. Each of these questions may contain sub-questions.

GRID INTERFACE OF ELECTRIC VEHICLES(GIEV)								
EEE						**Scheme: 2023**		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
HEE04	**Honours**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**
		3	**0**	**0**	**3**	**30**	**70**	**100**
Sessional Exam Duration:2 Hrs						**End Exam Duration: 3 Hrs**		

Course Outcomes: At the end of the course the student will be able to

CO1: Understand the fundamentals of Smart Grid and Electric Vehicle Integration and impact of EV on smart grid.

CO2: Analyze the Impact of EVs and V2G on the Smart Grid and Renewable Energy Systems.

CO3: Apply Power Conversion Technologies for Smart Grids and Electric Vehicles.

CO4: Design Control and Management Strategies for PEV Parking Lots.

CO5: Evaluate the Role of PEVs as Ancillary Services in Smart Grids.

UNIT – I

Introduction to Smart Grid and PEV

Introduction to smart grid and microgrid, Impact of PEVs on Distributed Energy Resources in the Smart Grid, V2G Technology and PEVs charging Infrastructures.

UNIT – II

Impact of V2G and G2V on the Smart Grid and Renewable Energy Systems

Types of Electric Vehicles, Motor Vehicle ownership and EV Migration, Impact of Estimated EVs on Electrical Network, Impact on Drivers and the Smart Grid, Standardization and Plug-and-Play.

UNIT – III

Power Conversion Technology in the Smart Grid and EV

Impacts of EV Penetration on Grid Power Profile, Requirements of its Control and Monitoring, Hybrid EV Powertrain Architectures, Control, Monitoring and Management Strategies of EV, V2G Communication System, System model of EV, Case study of three phase fault and its impact.

UNIT – IV

Planning, Control and Management Strategies for Parking Lots for PEVs

Introduction to PEV Charging Facility, Long-Term Planning for PEV Parking Lots, Control and Management of PEV Parking Lots - stages of implementation.

UNIT – V

PEV as Ancillary Service in Smart Grid

Introduction to Ancillary Services, PEV Charger Optimization, PEV as ancillary source, Control Strategies for PEVs to Follow the Individual Operation Values, Systems and Control Algorithm

for Smart PEV Chargers, Avoiding the Harmonic Propagation Within the Grid, Case study.

Text Books:

1. Lu, J. and Hossain, J., Vehicle-to-grid: linking electric vehicles to the smart grid. Institution of Engineering and Technology, 2015.
2. Rajakaruna, S., Shahnia, F. and Ghosh, A. eds., Plug In Electric Vehicles in Smart Grids: Integration Techniques. Springer, 2014.

Reference Books:

1. Rajakaruna, S., Shahnia, F. and Ghosh, A. eds., Plug in electric vehicles in smart grids: charging strategies. Springer, 2014.
2. Salman, S.K., Introduction to the Smart Grid: Concepts, Technologies and Evolution (Vol. 94). IET., 2017.

Web References:

1. https://nptel.ac.in/courses/108106170

Question Paper Pattern:

Sessional Exam:

The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall answer any one of them. Each of these questions may contain sub-questions.

End Examination:

The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall answer any one of them. Each of these questions may contain sub-questions.

EV CHARGING TECHNOLOGIES (EVCT)

EEE						Scheme: 2023		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	Total
HEE05	Honours	3	0	0	3	30	70	100
Sessional Exam Duration: 2 Hrs						End Exam Duration: 3 Hrs		

Course Outcomes: At the end of the course the student will be able to

CO1: Understand Battery Basics and Key Parameters.

CO2: Analyze Battery Modeling Techniques and Capacity Estimation.

CO3: Explore Charging Infrastructure and Regulatory Frameworks.

CO4: Evaluate Battery Charging Techniques and Performance.

CO5: Understand Power Electronics in EV Charging Systems.

UNIT – I

Battery Basics

Battery parameters- Cell and Battery Voltages, Charge (or Amp hour) Capacity, Energy Stored, Specific Energy, Energy Density, Specific Power, Amp hour (or Charge) Efficiency, Energy Efficiency, Self-discharge Rates, Battery Geometry, Battery Temperature, Heating and Cooling Needs, Battery Life and Number of Deep Cycles Types of batteries- lead-acid, nickel based sodium based, lithium batteries, metal-air batteries. Refilled Batteries.

UNIT – II

Battery Modeling

The Purpose of Battery Modelling, Electrochemical model, black box model, equivalent circuit model - Battery Equivalent Circuit, Modelling Battery Capacity, Simulating a Battery at a Set Power, Calculating the Peukert Coefficient, Approximate Battery Sizing, Battery state of charge estimation.

UNIT – III

Charging Infrastructure

EV supply equipment, charging standards, classification of charging infrastructure, connecting EVs to the electricity grid, regulatory framework for EV charging connections, communication protocols for smart charging, Battery Management System.

UNIT – IV

Battery Charging Techniques

Basic Terms for Evaluating Charging Performances, Charging Algorithms for Li-Ion Batteries, Optimal Charging Current Profiles for Lithium-Ion battery, Lithium Titanate Oxide Battery with Extreme Fast Charging Capability. Super Capacitors for battery charging.

UNIT – V

Power Electronics in EV Charging

Active front end rectifiers - Forward converters, half and full bridge DC-DC converters, power factor correction converters, decreasing impact on the grid and switches, bidirectional battery chargers, wireless charging.

Text Books:

1. James Larminie, John Lowry, ―Electric Vehicle Technology Explained‖, Wiley, 2012
2. RuiXiong, WeixiangShen, ―Advanced Battery management Technologies for Electric Vehicle‖, Wiley, 2018.

Reference Books:

1. Handbook of Electric Vehicle Charging Infrastructure Implementation, NITI Aayog, Government of India.
2. Chris Mi, M. AbulMasrur, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, Wiley, 2017.
3. Bruno Scrosati, JurgenGarche, Werner Tillmetz, Advances in Battery Technologies for Electric Vehicles, Wood head Publishing Series in Energy, 2015.
4. Sheldon S. Williamson , Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer, 2013.

Web References:

1. https://nptel.ac.in/courses/108106170

Question Paper Pattern:

Sessional Exam:

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End Examination:

The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall answer any one of them. Each of these questions may contain sub-questions.