B. Tech with

HONORS

in

ELECTRIC VEHICLES

Academic Regulations, Course Structure and Syllabus

Effective from 2023-24 admitted batches

Offered by

Department of Electrical and Electronics Engineering

KSRM College of Engineering (A) – Kadapa

(Approved by AICTE, Accredited by NAAC with A+ Grade and NBA and Affiliated to JNTUA, Anantapuramu)

ELIGIBILITY / REGISTRATION / AWARD OF HONORS

The objective of introducing B.Tech. (Hons.) is to facilitate the students to choose additionally the specialized courses of their choice and build their competence in a specialized area in the UG level. The program is a best choice for academically excellent students having good academic record and interest towards higher studies and research.

i) Honors is introduced in the curriculum of all B. Tech. programs offering a major degree and is applicable to all B.Tech (Regular and Lateral Entry) students admitted in Engineering & Technology.

ii) Those students with **at least 7.0 CGPA without any course backlogs up to III Semester in the major degree are only eligible to register for Honor degree**.

iii) A student shall earn **additional 18 credits for award of Honors** from same branch / department / discipline registered for major degree. This is in addition to 163 credits by a regular student and 123 Credits by a Lateral Entry student for the award of Major degree.

iv) A student is permitted to register for Honors in IV Semester after the results of III Semester are declared. Students shall register and pass in all the courses prescribed and being offered from V semester under the respective Honor degree.

v) Students have to attend classwork for courses under Honor degree beyond regular academic hours meant for major degree. Students can also undergo the courses under Honor through any proctored online platforms with the prior approval of the BoS Chairman and the HoD of the respective department offering Honor degree.

vi) The attendance for the registered courses under Honors and regular courses offered for Major degree in a Semester will be considered separately.

vii) A student shall have an aggregate of 75% attendance in all courses registered under Honors in that particular semester to become eligible for attending Semester-End examinations.

viii) The registration for the Honor will be cancelled, if the student is detained due to lack of attendance in Major,

ix) The registration for the Honor will be cancelled, if the student fails in any course of either Honor / Major in any semester from V to VIII Semester.

x) A student registered for Honors shall pass in all subjects that constitute the requirement for the Honors degree program. No class/division (i.e., second class, first class and distinction, etc.) will be awarded for Honors degree program.

xi) A separate grade sheet will be issued for the Honor degree courses semester-wise.

xii) If a student drops or is terminated from the Honors program, the additional credits so far earned cannot be converted into open or core electives; they will remain extra.

xiii) The Honors will be mentioned in the degree certificate as Bachelor of Technology (Honors) in XYZ. For example, B.Tech. (Honors) in Mechanical

Engineering.

xiv) There shall be a minimum enrolment of 20% OR 20 enrollments from the list of eligible students to offer Honors program.

xv) There is no fee for registration of courses for Honors program offered.

xvi) A student can register for either Minor / Honor but not both.

xvii) Student shall submit an application for either Minor / Honor at least one week before the commencement of the V Semester.

HONORS PROGRAMS OFFERED

Offering Department	Title	Who can Register
Civil Engineering	Civil Engineering	B.Tech. CE
	Tunnel Engineering	
	Interior Design	
Mechanical Engineering	Mechanical Engineering	B.Tech. ME
Electrical and Electronics Engineering	Electric Vehicles	B.Tech. EEE
Electronics and Communication Engineering	VLSI	B.Tech. ECE
	Embedded Systems and IoT	
Computer Science and Engineering	Computer Science and Engineering	B.Tech. CSE, B.Tech. AIML, B.Tech. CSE(DS), B.Tech. CSE(AIML)
	Artificial Intelligence and Machine Learning	
	Data Science	
	CSE-Artificial Intelligence and Machine Learning	

COURSE STRUCTURE

for

HONORS

in

ELECTRIC VEHICLES

S.No	COURSE CODE	COURSE TITLE	Semester Offered	L	T	P	IM	EM	CR
1	2302571H	E–Mobility	V	3	0	0	30	70	3
2	2302572H	Battery Management Systems	V	3	0	0	30	70	3
3	2302671H	Special Machines for Electric Vehicles	VI	3	0	0	30	70	3
4	2302672H	Grid Interface of Electric Vehicles	VI	3	0	0	30	70	3
5	2302771H	EV Charging Technologies	VII	3	0	0	30	70	3
6	2302772H	Applied Project Work	VII	0	0	6	60	140	3
			Total	**15**	**0**	**6**	**210**	**490**	**18**

2302571H	HONORS IN ELECTRIC VEHICLES E-MOBILITY (EEE)	L	T	P	C
		3	0	0	3

Pre-requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

CO1. illustrate the differences between electric and gasoline vehicles and interpret vehicle dynamics and drivetrain elements.
CO2. assess the working principles, components, and losses in EV batteries and battery management systems.
CO3. classify and compare different EV charging technologies including smart charging and V2X applications.
CO4. outline future trends in EV charging such as wireless, solar-based, and battery swap methods.
CO5. examine the challenges and policy implications of integrating EVs with infrastructure and smart grids in India.

SYLLABUS:

UNIT - I: INTRODUCTION (09 Periods)

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

UNIT - II: BATTERY TECHNOLOGY (09 Periods)

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 (09 Periods)

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 (09 Periods)

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

UNIT - V: E-MOBILITY (09 Periods)

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.

Total Periods: 45

TEXTBOOKS:

T1. Electric & Hybrid Vehicles – Design Fundamentals, IqbalHussain, CRC Press, 2011, Second Edition.
T2. Electric Vehicle Technology Explained, James Larminie, John Wiley & Sons, 2003.

REFERENCE BOOKS:

R1 Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, MehrdadEhsani, YiminGao, Ali Emadi, CRC Press, 2010.
R2 Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Sheldon S. Williamson, Springer, 2013.
R3 Electric Vehicle Battery Systems, SandeepDhameja, Newnes, 2000
R4 The automobile, In Electric Vehicles: Prospect AndChallenges,TariqMuneer and Irene Illescas García, Elsevier, 2017.

WEB RESOURCES:

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

2302572H	HONORS IN ELECTRIC VEHICLES BATTERY MANAGEMENT SYSTEMS (EEE)	L	T	P	C
		3	0	0	3

Pre-requisites: Chemistry

Course Outcomes:

On successful completion of the course, student will be able to

CO1. analyze the fundamentals of electric vehicles and vehicle dynamics, choose suitable motors and analyze different power electronics in EVs.
CO2. analyze Battery Technologies for Electric Vehicles**.**
CO3. evaluate charging technologies for Electric Vehicles**.**
CO4. explore future trends and innovations in Electric Vehicles**.**
CO5. assess E-Mobility, Policy and integration with Smart Grids.

SYLLABUS:

UNIT - I: INTRODUCTION (09 Periods)

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 (09 Periods)

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 (09 Periods)

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: MODELING AND SIMULATION (09 Periods)

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

UNIT V: DESIGN OF BATTERY MANAGEMENT SYSTEM (09 Periods)

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

Total Periods: 45

TEXTBOOKS:

T1. Battery management systems, Volume I: Battery modeling, Plett, Gregory L, Artech House, 2015.
T2. Battery management systems, Volume II: Equivalent-circuit methods, Plett, Gregory L, Artech House, 2015

REFERENCE BOOKS:

R1 Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "Battery Management Systems -Design by Modelling" Philips Research Book Series 2002.
R2 Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs" Artech House, 2010
R3 Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery- powered applications. Vol. 9. Springer Science & Business Media, 2008.

2302671H	HONORS IN ELECTRIC VEHICLES SPECIAL MACHINES FOR ELECTRIC VEHICLES (EEE)	L	T	P	C
		3	0	0	3

Pre-Requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

CO1. assess 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. design Magnetic-Gear Motor Drives.
CO5. explore Advanced Magnetless and Multiphase Motor Drives.

SYLLABUS:

UNIT - I: PERMANENT MAGNET (PM) BRUSHLESS MOTOR DRIVES (09 Periods)

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 (09 Periods)

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 (09 Periods)

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-GEAREDMOTORDRIVES (09 Periods)

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

UNIT - V: ADVANCED MAGNETLESS MOTOR DRIVES AND MULTIPHASE MOTOR DRIVES (09 Periods)

Introduction of 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

Total Periods: 45

TEXTBOOKS:

T1. Modern Electric, Hybrid Electric and Fuel cell vehicles: Fundamentals, Theory and Design, MehrdadEhsani, YiminGao, Sebatien Gay and Ali Emadi, CRC Press, 2004.
T2. Electric Vehicle Technology – Explained, James Larminie and John Loury, John Wiley & Sons Ltd, 2003.

REFERENCEBOOKS:

R1 Electric Vehicle Battery Systems, SandeepDhameja, Butterworth – Heinemann, 2002.
R2 Electric and Hybrid – Electric Vehicles, Ronald K Jurgen, SAE, 2002.
R3 Light Weight Electric/Hybrid Vehicle Design, Ron Hodkinson and John Fenton, Butterworth – Heinemann, 2001.
R4 Electric and Hybrid Vehicles- Design Fundamentals, Iqbal Husain, CRC Press, 2011.

2302672H	HONORS IN ELECTRIC VEHICLES GRID INTERFACE OF ELECTRIC VEHICLES (EEE)	L	T	P	C
		3	0	0	3

Pre-Requisites: Power System Analysis

Course Outcomes:

On successful completion of the course, student will be able to

CO1. assess the fundamentals of smart grids and electric vehicle integration, and analyze the impact of EVs on the smart grid.
CO2. analyze the impact of EVs and V2G/G2V operations on the smart grid and renewable energy systems.
CO3. apply power conversion technologies and communication systems for smart grids and electric vehicles.
CO4. design control and management strategies for planning and operating PEV parking lots.
CO5. evaluate the role of PEVs as ancillary services in smart grids, including optimization and control algorithms.

SYLLABUS:

UNIT - I: INTRODUCTION TO SMART GRID AND PEV (12 Periods)

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 (08 Periods)

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 (10 Periods)

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 (08 Periods)

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 (07 Periods)

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

Total Periods: 45

TEXT BOOKS:

T1. Vehicle-to-grid: linking electric vehicles to the smart grid, Lu, J. and Hossain, J, Institution of Engineering and Technology, 2015.

T2. Plug In Electric Vehicles in Smart Grids: Integration Techniques,Rajakaruna, S., Shahnia, F. and Ghosh, A. eds, Springer, 2014.

REFERENCE BOOKS:

R1 Plug in electric vehicles in smart grids: charging strategies. Rajakaruna, S., Shahnia, F. and Ghosh, A. eds, Springer, 2014.

R2 Introduction to the Smart Grid: Concepts, Technologies and Evolution (Vol. 94). Salman, S.K, IET, 2017.

WEB RESOURCES:

1 https://ocw.tudelft.nl/course-readings/3-1-2-lecture-notes-grid-integration-of-electrics-vehicles/

2 https://www.coursera.org/learn/bridging-the-gap-ev-grid-integration--v2g-systems

2302771H	HONORS IN ELECTRIC VEHICLES EV CHARGING TECHNOLOGIES (EEE)	L	T	P	C
		3	0	0	3

Pre-Requisites: Power Electronics

Course Outcomes:

On successful completion of the course, student will be able to

CO1. assess 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. evaluate Power Electronics in EV Charging Systems.

SYLLABUS:

UNIT - I: BATTERY BASICS (09 Periods)

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 (09 Periods)

The Purpose of Battery Modeling, Electrochemical model, black box model, equivalent circuit model - Battery Equivalent Circuit, Modeling 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 (10 Periods)

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 (09 Periods)

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 (09 Periods)

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.

Total Periods: 45

TEXT BOOKS:

T1. Electric Vehicle Technology Explained, James Larminie, John Lowry, Wiley, 2012

T2. Advanced Battery management Technologies for Electric Vehicle, RuiXiong, WeixiangShen, Wiley, 2018.

REFERENCE BOOKS:

R1 Handbook of Electric Vehicle Charging Infrastructure Implementation, NITI Aayog, Government of India.

R2 Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, Chris Mi, M. AbulMasrur, Wiley, 2017.

R3 Advances in Battery Technologies for Electric Vehicles, Bruno Scrosati, JurgenGarche, Werner Tillmetz, Wood head Publishing Series in Energy, 2015.

R4 Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Sheldon S. Williamson, Springer, 2013

WEB RESOURCES:

1. https://nptel.ac.in/courses/108106182
2. https://nptel.ac.in/courses/108102121
3. https://nptel.ac.in/courses/108106170

2302772H	HONORS IN ELECTRIC VEHICLES APPLIED PROJECT WORK (EEE)	L	T	P	C
		0	0	6	3

Pre-Requisites: E–Mobility and Special Machines for Electric Vehicles

Course Outcomes:

On successful completion of the course, student will be able to

CO1. analyze electric vehicle systems, architectures, and energy flows including grid interfaces and charging technologies.

CO2. design and evaluate Battery Management Systems for monitoring, control, and safe operation of EV batteries.

CO3. select and apply suitable electric machines and drive systems for efficient EV propulsion.

CO4. apply appropriate tools and techniques to understand and analyze the problems following professional ethics with focus on societal and environmental aspects.

CO5. work as a team and communicate results in an effective way.

CO6. make decisions as an individual or as a team member to manage tasks and also engage in independent and life-long learning with ability to adapt to new and technological changes.