FACULTY OF ENGINEERING & TECHNOLOGY

BACHELOR OF ENGINEERING

MINOR DEGREE IN ELECTRIC VEHICLES (DRAFT SYLLABUS)

Course Structure

Sr. No.	Semester	Temp. Course Code	Course Title	L	T	P	Credits
1.	3	EV-1	Automotive Systems	3	0	2	4
2.	4	EV-2	Energy Systems and Electric Machines	3	0	2	4
3.	5	EV-3	Control ofElectric Drives	3	0	2	4
4.	6	EV-4	Electric Vehicles: Design, Dynamics & Testing	3	0	2	4
5.	6	EV-5	Mini-project	0	0	4	2
TOTAL				12	0	12	18

Detailed Syllabus

Course code:	**EV-1**
Name of the course:	**Automotive Systems**
Semester:	**3**
Category of Course:	**EV**

Course objectives:

This course aims to study about the evolution of the car, classification and terminologies related to the internal combustion engine and automotives. This course also aims to build working fundamental of various automotive systems and subsystems.

Teaching & Examination Scheme:

Teaching Scheme			Credits	Examination Marks (Maximum/Passing)		Total
				External		
L	T	P	C	ESE(T)	ESE(P)	
3	0	2	4	50/25	50/25	100 /50

ESE(T): End Semester Examination(Theory)

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ESE(P): End Semester Examination(Practical)

Course Contents:

Unit	Contents	Hours
1	**History & Classification:**Brief History: The Car: from dream to necessity, The pioneer years, into the 20th century, Birth of a legend, Birth of the mass market, Design refinements, years of innovation. Vehicle Classification, Vehicle layout with reference to Power Plant Location and drive systems, Types of chassis, Body styles, Classification of vehicle based on body types. Types of car bodies: Integral body construction details, Ladder, Conventional control, full forward control, semi-forward control.	5
2	**Internal Combustion Engine:**Engine: fundamentals, operation, construction and function of parts. Classification of engine, engine terminology, 2-sroke & 4-stroke engine, working and constructional feature of 2-wheeler, automotive engine fuels and fuel rating, Fuel injection systems: petrol and diesel, exhaust systems, Limitations of I.C Engines. Exhaust Emission and Global warming: Engine exhaust treatment devices. Cooling system: Necessity, Types of cooling system.	5
3	**EV: Opportunities and challenges:** Need for alternative energy sources, CNG, LPG, Biogas, Bio-diesel, solar, Hybrid technology, advantages and disadvantages of EV.	5
4	**Steering &Suspension System:** Steering system: Introduction, principle of Ackerman steering, turning circle radius, steering gears, steering ratio, Hydraulic & electronic steering systems, steering geometries. Suspension system: Introduction, solid axles, four link rear suspension, coil spring, leaf spring, torsion bar, dampers, shock absorbers, Independent suspension: front, Mac-Pherson strut, rigid axle suspension, SLA suspension. Air suspension system, Hydro-plastic, Hydra-gas suspension.	10
5	**Braking System:** Purpose of brakes, Principle of brakes, Co-efficient of friction. Types of brake: internal expanding, Hydraulic and Pneumatic brake, function of parts, brake fluid. Properties of friction lining, friction pad materials, power brakes.	5

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30%	30%	30%	5%	5%	0

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Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Automotive mechanics by Crouse and Anglin, - TMH.
2. Automobile Engineering Vol-I & II Dr. K.M. Gupta
3. A Textbook of Automobile Engineering-I and II, P.S.Gill, S.K.Kataria& Sons.
4. Fundamentals of Automobile Body Structure Design, Donald E. Malen, SAE International.
5. Internal combustion engine, S. S. Thipse, Jaico Publishing House, 2010

Course Outcomes (CO):

Sr. No.	Course Outcome Statements	% weightage
1	Understand the automotive revolution.	**15**
2	Comprehend the various vehicle classification and IC engine..	**25**
3	Know about the Electric vehicle challenges and opportunities.	**15**
4	Explain the steering and suspension systems.	**30**
5	Demonstrate the braking operation.	**15**

List of Practicals /Tutorials:

1. To demonstrate and understand the importance of Automotive Chassis.
2. To identify major components of different automobile engines.
3. Demonstration of automotive driveline systems.
4. To demonstration about the steering systems.
5. To demonstration about the suspension systems.
6. To demonstrate the various automobile systems.
7. Demonstration of the Electric vehicles.
8. To study about the cooling systems of automotive engine.
9. Demonstration about the different automotive braking systems.
10. Performance of Brake bleeding.
11. Demonstration of the different suspension systems for two and four-wheeler vehicle.
12. To review technical specifications of electric vehicles.

Supplementary Learning Material:

1. Massive Online Open Courses on Swayam/NPTEL portal (https://swayam.gov.in/)
2. MIT OpenCourseware (https://ocw.mit.edu/courses/)

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Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 13	PSO 14	PSO 15
CO1	3	-	-	-	2	3	3	3	3	2	2	3	3	3	3
CO2	3	-	-	-	2	3	3	3	3	3	2	3	3	3	3
CO3	3	-	-	-	3	3	3	3	3	3	2	3	3	3	3
CO4	3	-	-	-	3	3	2	3	3	2	2	3	2	3	3
CO5	3	-	-	-	3	3	2	3	3	2	2	3	2	3	3

1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High) '–' No correlation

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Detailed Syllabus

Course code:	**EV-2**
Name of the course:	**Energy Systems and Electric Machines**
Semester:	**4**
Category of Course:	**EV**

Course objectives:

Thiscourseemphasis onenergy systems used for electric vehicles.Students will learn aboutwidely used automotive batteries and basic definitions &material considerations. Thekey battery management technologies and BMSs have also beenintroduced.This course also focuses on comprehensive discussion on various machines used for electric vehicles.

Teaching & Examination Scheme:

Teaching Scheme			Credits	Examination Marks (Maximum/Passing)		Total
				External		
L	T	P	C	ESE(T)	ESE(P)	
3	0	2	4	50/25	50/25	100 /50

ESE(T): End Semester Examination(Theory)

ESE(P): End Semester Examination(Practical)

Course Contents:

Unit	Contents	Hours
1	**Batteries and Fuel Cells:** Batteries:Introduction to Batteries: Batteries Types and Battery Packs, Basic Battery Operation, Basic Electrochemistry, Units of Battery Energy Storage,	**8**

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	Capacity Rate, Battery Parameters and Comparisons, Lifetime and Sizing Considerations: Examples of Battery Sizing, Battery Pack Discharge Curves and Aging, Battery Models: Curve Fit Model for BEV Batteries, Voltage, Current, Resistance, and Efficiency of Battery Pack, Curve-Fit Model for HEV Batteries, Charging, Example: Fast Charging a Battery Pack, Determining the Cell/Pack Voltage for a Given Output\Input Power, Example: Battery Discharge, Example: Battery Charge, Cell Energy and Discharge Rate, Example: Cell Capacity, Example: The Fuel Economy of a BEV Vehicle with a FixedGear Ratio. Fuel Cells:Introduction to Fuel Cells, Basic Operation: Fuel Cell Model and Cell Voltage, Example: No-Load and Load Voltages of a PEM Fuel Cell, Power and Efficiency of Fuel Cell and Fuel Cell Power Plant System, Fuel Cell Characteristic Curves	
2	**Battery Charging and Battery Management Systems:**Basic Requirements for Charging System, Charger Architectures, Grid Voltages, Frequencies, and Wiring, Charger Functions, Real Power, Apparent Power, and Power Factor, Charging Standards and Technologies: SAE J1772, VDE-AR-E 2623-2-2, CHAdeMo, Tesla, Wireless Charging, Boost Converter for Power Factor Correction: The Boost PFC Power Stage, Sizing the Boost Inductor, Average Currents in the Rectifier, Switch and Diode Average Currents, Switch, Diode, and Capacitor RMS Currents, Power Semiconductors for Charging, Examples. Battery Management Systems:Background of Battery Management Systems, Typical Structure of BMSs, Representative Products, Key Points of BMSs in Future Generation.	**7**
3	**DC Machines**: DC Machine Structure, DC Machine Electrical Equivalent Circuit, DC Machine Circuit Equations, Power, Losses, and Efficiency in the DC Machine, Machine Operating as a Motor or Generator in Forward or Reverse Modes, Saturation and Armature Reaction, Using DC Machine for EV Powertrain	**5**
4	**Induction Machines:**Induction Machines: Stator Windings and the Spinning Magnetic Field, Induction Machine Rotor Voltage, Current, and Torque, Machine Model and Steady-State Operation, Variable-Speed Operation of Induction Machine, Machine Test	**5**
5	**Permanent Magnet Brushlessand Switched Reluctance Motor:** PM Brushless Machines: PM Materials, Structure of PM Brushless Machines, Principle of PM Brushless Machines, Modeling of PM Brushless Machines SR Machines: Structure of SR Machines, Principle of SR Machines, Modeling of SR Machines	**5**

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10%	40%	20%	15%	10%	5%

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Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, By John G. Hayes and G. Abas Goodarzi, Wiley Publication.
2. Advanced Battery Management Technologies for Electric Vehicles, By Rui Xiong and Weixiang Shen, Wiley Publication.
3. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, By Mehrdad Ehsani, Yimin Gao, Stefano Longo and Kambiz M. Ebrahimi, CRC Press.
4. Electric Vehicle Machines and Drives: Design, Analysis and Application, By K. T. Chau, Wiley-IEEE Press.
5. Electric Machinery, By E. Fitzgerald and C. Kingsley, McGraw Hill Education.
6. Electric Machines, By I. J. Nagrath and D. P. Kothari, McGraw Hill Education.
7. Analysis of Electric Machinery and Drive Systems, By Scott D. Sudhoff, Paul C. Krause and Oleg Wasynczuk, Wiley Publication.

Course Outcomes (CO):

Sr. No.	Course Outcome Statements	% weightage
1	Explain the energy systems used for theelectric vehicles.	**20**
2	Comprehend the various battery charging systems	**15**
3	Know about the battery management systems.	**15**
4	Understand the construction, working, testing, speed control and applications of DC machines and Induction machines for EVs.	**30**
5	Demonstrate the use of Permanent Magnet Brushless and Switched Reluctance Motors for EVs.	**20**

List of Practicals /Tutorials:

1. Study of Battery parameters and Testing of batteries for electric vehicle.
2. Modeling and Simulating Battery Performance for Design Optimization.
3. Study of fuel cells and their characteristics.
4. Study of different types of battery charging system.
5. Understand battery management systems.
6. Case Studies: Design of a Battery Electric Vehicle (BEV).

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7. To obtain Speed-Torque characteristics of DC Series Motor and DC Shunt Motor.
8. To determine the various losses in a D.C. machine and separation of its core losses
9. To perform no load and blocked rotor test on three phase induction motor to obtain the parameters of equivalent circuit.
10. To obtain the performance parameters of three phase induction motor using direct load test.
11. Modeling and Simulation of Permanent Magnet Brushless Motor with MATLAB/Simulink.
12. Modeling and Simulation of Switched Reluctance Motor with MATLAB/ Simulink.

Supplementary Learning Material:

1. Massive Online Open Courses on Swayam/NPTEL portal (https://swayam.gov.in/)
2. MIT OpenCourseware (https://ocw.mit.edu/courses/)
3. https://www.opal-rt.com/automotive-overview/

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 13	PSO 14	PSO 15
CO1	3	2	3	2	2	2	1	1	2	2	2	3	3	3	3
CO2	3	2	3	2	2	2	1	1	2	-	2	1	3	3	3
CO3	3	2	2	-	2	1	1	1	1	1	-	1	3	2	3
CO4	2	2	2	2	3	2	1	-	1	1	1	2	2	3	3
CO5	2	2	2	2	3	2	1	-	1	1	1	2	3	3	3

1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High) '–' No correlation

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Detailed Syllabus

Course code:	**EV-3**
Name of the course:	**Control ofElectric Drives**
Semester:	**5**
Category of Course:	**EV**

Course objectives:

The objective of this course is to provide a comprehensive discussion on control of electric drives for electric vehicles. This course deals with the theory and performance analysis of various electrical drives for electric vehicles from the existingtypes, namely the DC machines, induction machines,permanent magnet (PM) brushless, and switched reluctance motor drives, to the advanced types of motor drives. The emphasis is given to the design criteria,performance analyses,

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and application examples. It is anticipated that various EVs will adopt different machines and drives, and this course will bea key reference to make such decisions.

Teaching & Examination Scheme:

Teaching Scheme			Credits	Examination Marks (Maximum/Passing)		Total
				External		
L	T	P	C	ESE(T)	ESE(P)	
3	0	2	4	50/25	50/25	100 /50

ESE(T): End Semester Examination(Theory)

ESE(P): End Semester Examination(Practical)

Course Contents:

Unit	Contents	Hours
1	**Introduction:** Overview of EV Challenges, Pure Electric Vehicle, Hybrid Electric Vehicle, Gridable Hybrid Electric Vehicle, Fuel-Cell Electric Vehicle, Overview of EV Technologies	**4**
2	**DC Motor Drives:** System Configurations, DC–DC Converters: DC–DC Converter Topologies, Soft-Switching DC–DC Converter Topologies, DC Motor Control: Speed Control, Regenerative Braking, Closed loop speed control schemes, Speed and position control scheme using the dynamic model, Design Criteria of DC Motor Drives for EVs, Design Example for EVs, Application Examples of DC Motor Drives in EVs	**7**
3	**Induction Motor Drives:** System Configurations, Inverters for Induction Motors: PWM Switching Inverters, Soft-Switching Inverters, Induction Motor Control: Variable-Voltage Variable-Frequency Control, Field-Oriented Control,Direct Torque Control,Design Criteria of Induction Motor Drives for EVs, Design Example of Induction Motor Drives for EVs, Application Examples of Induction Motor Drives in EVs	**7**
4	**Permanent Magnet Brushlessand Switched Reluctance Motor Drives:** Permanent Magnet Brushless Motor Drives: System Configurations, Inverters for PM Brushless Motors: Inverter Requirements, Switching Schemes for Brushless AC Operation, Switching Schemes for Brushless DC Operation, PM Brushless Motor Control: PM Synchronous Motor Control, PM Brushless DC Motor Control, Design Criteria of PM Brushless Motor Drives for EVs, Design Examples of PM Brushless Motor Drives for EVs, Planetary-Geared PM Synchronous Motor Drive, Outer-Rotor PM Brushless DC Motor Drive, Application Examples of PM Brushless Motor Drives in EVs Switched Reluctance Motor Drives**:** System Configurations, SR Converters: SR Converter Topologies, Soft-Switching SR Converter Topologies, Comparison of SR Converters for EVs, SR Motor Control: Speed Control,	**8**

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	Torque-Ripple Minimization Control, Position Sensorless Control, Design Criteria of SR Motor Drives for EVs: Machine Initialization, Suppression of Acoustic Noise,Examples of SR Motor Drives for EVs, Planetary-Geared SR Motor Drive, Outer-Rotor In-Wheel SR Motor Drive, Application Examples of SR Motor Drives in EVs	
5	Emerging Technologies for Electric Vehicle Drives, Case Studies of Two-Wheeler, Three-Wheeler, and Four-Wheeler Electric Vehicles	**4**

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10%	40%	20%	15%	10%	5%

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Electric Vehicle Machines and Drives: Design, Analysis and Application, By K. T. Chau, Wiley-IEEE Press.
2. Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, By John G. Hayes and G. Abas Goodarzi, Wiley Publication.
3. Electric Vehicle Technology Explained, By James Larminie, John Wiley & Sons Ltd.
4. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, By Mehrdad Ehsani, Yimin Gao, Stefano Longo and Kambiz M. Ebrahimi, CRC Press.
5. Modern Power Electronics and AC Drives, By Bimal K. Bose, Pearson Education.
6. Fundamentals of Electrical Drives , By Gopal K. Dubey, Narosa Publishing House.
7. Analysis of Electric Machinery and Drive Systems, By Scott D. Sudhoff, Paul C. Krause and Oleg Wasynczuk, Wiley Publication.

Course Outcomes (CO):

Sr. No.	**Course Outcome Statements**	**% weightage**
1	Understand the power electronic converters used for dc motor speed control	**25**
2	Understand the power electronic converters used for induction motor	**25**

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	speed control	
3	Comprehend the applications of Permanent Magnet Brushless Motor Drives for EVs	**20**
4	Explainthe applications of Switched Reluctance Motor Drives for EVs	**20**
5	Demonstrate the use of advanced technologies for EVs	**10**

List of Experiments/Tutorials:

1. Design and simulation of Buck and Boost regulator.
2. To study the control of DC-DC converter (chopper) fed DC motor.
3. To study open loop control of DC motor using dynamic model.
4. To study closed loop control of chopper fed DC motor drive.
5. To study the operation of single phase PWM inverter.
6. To study the operation of three phase inverters.
7. To study speed control of 3-phase induction motor using V/F control method.
8. Modeling and Simulation of Permanent Magnet Brushless Motor Drives with MATLAB/Simulink.
9. Modeling and Simulation of Switched Reluctance Motor Drives withMATLAB/Simulink.
10. Electric Vehicle Drive Simulation with MATLAB/Simulink.
11. Case study of Electric Vehiclewith DC Machines.
12. Case study of Electric Vehiclewith AC Machines.

Supplementary Learning Material:

1. Massive Online Open Courses on Swayam/NPTEL portal (https://swayam.gov.in/)
2. MIT OpenCourseware (https://ocw.mit.edu/courses/)
3. https://www.opal-rt.com/automotive-overview/

Course Articulation Matrix:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 13**	**PSO 14**	**PSO 15**
CO1	3	1	3	2	2	3	1	1	1	1	2	2	3	3	2
CO2	3	2	3	2	2	3	2	-	2	2	1	1	3	3	2
CO3	3	2	3	2	2	3	2	2	-	-	-	2	3	3	2
CO4	3	3	3	2	1	3	-	-	2	-	-	-	3	3	1
CO5	3	2	3	2	2	2	2	2	2	2	2	2	2	2	3

1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High) '–' No correlation

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Detailed Syllabus

Course code:	**EV-4**
Name of the course:	**Electric Vehicles: Design, Dynamics and Testing**
Semester:	**6**
Category of Course:	**EV**

Course objectives:
This course is emphasis on gaining insight into auto body structural behavior and the relationship to the vehicles. To develop structural topology, constructional details, testing and overall stability of the vehicle.

Teaching & Examination Scheme:

Teaching Scheme			Credits	Examination Marks (Maximum/Passing)		Total
				External		
L	T	P	C	ESE(T)	ESE(P)	
3	0	2	4	50/25	50/25	100 /50

ESE(T): End Semester Examination (Theory)

ESE(P): End Semester Examination (Practical)

Course Contents:

Unit	Contents	Hours
1	**Design and Manufacturing Criteria:** Introduction to body loads: Load cases and load factor, road loads. Driving dynamics and comfort, strength and stiffness of chassis, design features, frame sections, types of frames. Material selection, Fabrication, joining methods, types of joints, welding and brazing, pierce riveting and clinching.	**6**
2	**Vehicle Dynamics & Stability**: Wheels and Tyres: Introduction, Types of wheel rims, wheel dimension, properties of tyre, construction, Tread patterns, Types of tyres, Specifications of tyre. Drag, lifts, resistance, body loads and load calculation, Study principles of Rolling, Pitch & Yaw velocity and moments, aesthetics and ergonomics consideration for stability and control.	**5**
3	**Vehicle Testing & Homologation:** Need of vehicle testing and homologation, testing organizations, testing standards (AIS), Hierarchy of testing: Individual component approval/testing, System level approval and Whole vehicle approval/testing. Conformity of production tests, Crash test, side impact test, rollover test, Impact test, Track testing	**5**

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4	**Vehicular Safety and Government norms:** Road and Automotive Safety Systems: Active and passive safety, Safety Regulations for vehicular application, occupant protection, Traffic signs, traffic rules. Government Norms, Regulations and Policies: Motor vehicle act: control of transport, RTO and other regulations, offences, penalties and procedures.	**7**
5	**EV Infrastructure Management:** Comparison between EV and ICE vehicles, Battery management system, Battery swapping, vehicle charging system, Charging stations.	**7**

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	30	30	10	5	5

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create

Note: This specification table shall be treated as a general guideline for students andteachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Vehicle Body Engineering, J. Pawlowski, Business books limited.
2. Fundamentals of Automobile Body Structure Design, Donald E. Malen, SAE International
3. A Textbook of Automobile Engineering-II, P.S.Gill, S.K.Kataria& Sons.
4. Aerodynamics of Road Vehicles, wolf –Heinrich-Hucho, SAE International.
5. Fundamentals of Vehicle Dynamics, Thomas D. Gillespie, Society of Automotive Engineers.
6. Automotive Industrial Standards (AIS).
7. Motor Vehicle Act - Govt. of India Publications.
8. M.V. Act 1988-RTO rules and regulation manual.

Course Outcomes (CO):

Sr. No.	**Course Outcome Statements**	**% weightage**
1	Understand the design & development of automotive body structure.	**20**
2	Understand the dynamic stability of vehicles.	**17**
3	Understand the testing of vehicles.	**17**
4	Understand the requirement of vehicular safety systems and road regulations.	**23**
5	Understand EV Infrastructure management system.	**23**

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List of Experiments/Tutorials:

1.To demonstrate about different loads acting on the frame and design features of the Chassis.
2. To demonstrate about different types of tyres and wheels
3.To understand the occupant safety provisions in Automotives
4. Understanding road safety and its importance.
5. Demonstration of vehicle battery charging system.
6. Performance test on PUC.
7. To demonstrate and understand the importance of automotive body.
8. Experimental study of mechanism for air flow, drag and lift coefficient over different geometry of vehicles using wind tunnel apparatus.
9. To understand Motor Vehicle Act.
10. Case study on EV Vs ICE vehicles.
11. Case study of government policies on Electric vehicles.
12. To understand the aesthetic and ergonomics consideration of the vehicles.

Supplementary Learning Material:

3. Online Open Courses on Swayam/NPTEL portal (https://swayam.gov.in/)

Course Articulation Matrix:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	3	-	-	3	3	3	3	3	3	3	2	3	3	3	3
2	3	-	-	3	3	3	3	3	3	3	2	3	3	3	3
3	3	-	-	3	3	3	3	3	3	3	3	3	3	3	3
4	3	-	-	2	2	3	3	3	3	3	3	3	3	3	3
5	3	-	-	2	3	3	3	3	3	3	3	3	3	3	3

1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High) '–' No correlation

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Detailed Syllabus

Course code:	**EV-5**
Name of the course:	**Mini -project**
Semester:	**6**
Category of Course:	**EV**

Course objectives:
To apply the theoretical knowledge gained in the lecture courses forreal-life practical applications in order have effective learning and skill-development, mainly, from the point of view of the employability in industries.

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Teaching & Examination Scheme:

Teaching Scheme			Credits	Examination Marks (Maximum/Passing)		Total
				External		
L	T	P	C	ESE(T)	ESE(P)	
0	0	4	2	00	100/50	100 /50

ESE(T): End Semester Examination (Theory)

ESE(P): End Semester Examination (Practical)

Course Objectives:

The student(s) shall carry out project based on one or more of the following aspects: prototype design, productpreparations, working models, fabrication of set-ups, laboratory experiments, processmodification/development, simulation, software development, integration of software and hardware, dataanalysisetc.The student is required to submit project report based on the work.

Course Outcomes (CO):

Sr. No.	Course Outcome Statements
1	Practice acquired knowledge within the chosen area for project
2	Identify, discuss and justify the technical aspects of the project with a comprehensive andsystematic approach
3	Reproduce, improve and refine technical aspects of project
4	Work as an individual or in a team in development of technical projects
5	Report project related activities effectively to peers and mentors

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 13	PSO 14	PSO 15
CO1	3	3	3	3	3	3	3	2	2	-	3	3	3	3	3
CO2	3	3	3	2	2	2	2	-	3	-	2	2	3	2	2
CO3	3	3	3	2	2	3	1	-	2	-	2	2	3	3	2
CO4	2	3	3	2	2	-	-	-	3	2	2	2	3	2	3
CO5	-	-	-	-	-	-	-	3	3	3	-	-	-	-	-

1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High) '–' No correlation

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PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1.Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2.Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3.Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4.Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5.Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6.The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7.Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8.Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10.Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

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11.Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12.Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

1. Ability to conceptualize interdisciplinary domain knowledge to specific branch of engineering.
2. Ability to acquire employability skills and deep knowledge in emerging and multidisciplinary areas.
3. Carryout engineering projects in broad areas of engineering.

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