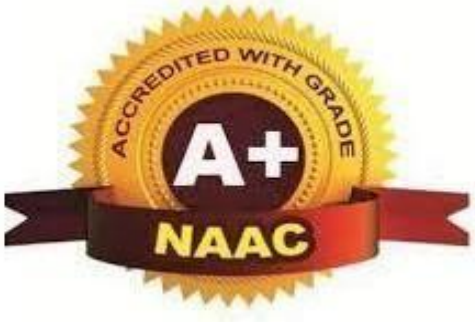
TULSIRAMJI GAIKWAD-PATIL
College of Engineering & Technology

Mohgaon, Wardha Road, Nagpur - 441 108

An Autonomous Institution



DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

M.Tech.in Electric Vehicle Technology

Teaching Scheme

From

Academic Year 2023-24

Vision of Institute

To emerge as a learning Center of Excellence in the National Ethos in domains of Science, Technology and Management.

Mission of Institute

M1- To strive for rearing standard and stature of the students by practicing high standards of professional ethics, transparency and accountability.

M2- To provide facilities and services to meet the challenges of Industry and Society.

M3- To facilitate socially responsive research, innovation and Entrepreneurship.

M4- To ascertain holistic development of the students and staff members by inculcating knowledge and profession as work practices.

Program Outcomes (PO)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. He should be able to inculcate research quality among himself.

Tulsiramji Gaikwad-Patil College of Engineering & Technology, Nagpur

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Scheme of Examination and Syllabus

Scheme of Instructions for First Year M.Tech. Course in Electric Vehicle Technology

Semester–I (w. e. f.: AY2023-24)

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs/week	Credits	Exam Scheme		
									CIE	ESE	TOTAL
1.	PCC	MEV1101	Power Electronic Converters for EV	4	-	-	4	4	40	60	100
2.	PCC	MEV1102	Electrical Drives for EV	3	-	-	3	3	40	60	100
3.	PCC	MEV1103	Electric Vehicle Structure Design	3	-	-	3	3	40	60	100
4.	PCC	MEV1104	Power Electronic Converters for EV Lab	-	-	2	2	1	25	25	50
5.	PCC	MEV1105	Computer Aided Design for EV Lab	-	-	2	2	1	25	25	50
6.	PEC	MEV11**06-09**	Professional Elective -I	3	-	-	3	3	40	60	100
7.	PEC	MEV11**10-13**	Professional Elective -II	3	-	-	3	3	40	60	100
8.	MCC	MAU1102	Disaster Management	2	-	-	2	Audit	-	-	-
			Total	**18**	**1**	**4**	**22**	**18**	**250**	**350**	**600**

L-Lecture T-Tutorial P-Practical CIE- Continuous Internal Evaluation

ESE-End Semester Examination (For Laboratory: End Semester Performance)

*-Program Elective/Audit Course/Open Elective (list is provided at the end of structure)

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Scheme of Examination and Syllabus

Scheme of Instructions for First Year M. Tech. Course in Electric Vehicle Technology

Semester–II (w. e. f.: AY2023-24)

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs/week	Credits	Exam Scheme		
									CIE	ESE	TOTAL
1.	PCC	MEV1201	Battery Management Systems	3	-	-	3	3	40	60	100
2.	PCC	MEV1202	Advanced Control Systems for EV	3	-	-	3	3	40	60	100
3.	PCC	MEV1203	Battery Management Systems Lab	-	-	2	2	1	25	25	50
4.	PCC	MEV1204	Advanced Control System for EV Lab	-	-	2	2	1	25	25	50
5.	PCC	MEV1205	Vibration & Acoustic Lab	-	-	4	4	2	25	25	50
6.	FC	MEV1206	Research Methodology	2	-	-	2	2	25	25	50
7.	PEC	MEV12**07-10**	Professional Elective-III	3	-	-	3	3	40	60	100
8.	PEC	MEV12**11-14**	Professional Elective –IV	3	-	-	3	3	40	60	100
9.	MCC	MAU1202	IPR Patent Drafting	2	-	-	2	Audit	-	-	-
			Total	**16**	**-**	**8**	**24**	**18**	**260**	**340**	**600**

L-Lecture T-Tutorial P-Practical CIE- Continuous Internal Evaluation

ESE-End Semester Examination (For Laboratory: End Semester Performance)

*-Program Elective/Audit Course/Open Elective (list is provided at the end of structure

PROGRESSIVECREDITS=18+18=**36**

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Scheme of Examination and Syllabus

Scheme of Instructions for Second Year M.Tech. Course in Electric Vehicle Technology

Semester–III (w. e. f.: AY 2023-24)

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs/week	Credits	Exam Scheme		
									CIE	ESE	TOTAL
1	PROJ	MEV2301	Dissertation Phase-I	-	-	20	20	10	100	100	200
2	PEC	MEV2302	MOOC course(8-12) $	-	-	-	-	3	-	-	-
3	OEC	M**$$**XX**01-06**	Open Elective-I	3	-	-	3	3	40	60	100
			Total	**3**	**-**	**20**	**23**	**16**	**100**	**100**	**200**

*$$-CS,SE,IP,MB

Note:

1. MEV2302will be decided by respective Guide in Consultation with Program Coordinator. Course is mandatory for student and his dissertation phase I will be considered incomplete without this Mandatory MOOC Course.

2. $ Programme coordinator will provide list of 03 MOOC courses of minimum 08 weeks duration (as per availability). Students are expected to complete any one out of three courses in order to get the required credits.

L-Lecture T-Tutorial P-Practical

CIE- Continuous Internal Evaluation ESE-End Semester Examination (For Laboratory End Semester performance)PROGRESSIVECREDITS=36+16=**52**

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Scheme of Examination and Syllabus

Scheme of Instructions for Second Year M.Tech. Course in Electric Vehicle Technology

Semester–IV (w. e. f.: AY 2023-24)

Sr.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs/week	Credits	Exam Scheme		
									CIE	ESE	TOTAL
1.	PROJ	MEV2401	Dissertation Phase-II	-	-	32	32	16	100	200	300
			Total	**-**	**-**	**32**	**32**	**16**	**100**	**200**	**300**

CIE- Continuous Internal Evaluation

ESE-End Semester Examination (For Laboratory End Semester Performance)

TOTAL CREDITS=52+16=**68**

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Scheme of Examination and Syllabus

Scheme of Instructions for Second Year M.Tech. Course in Electric Vehicle Technology

List of Professional Elective Courses

Semester-I			Semester-II	
Professional Elective-I	**Professional Elective-II**		**Professional Elective-III**	**Professional Elective-IV**
MEV1106: Switching Power Supplies	MEV1110: Control Techniques for EV Converters		MEV1207: EV Battery Charging Systems	MEV1211: Electric Vehicle Sensors Technology
MEV1107: Plug-In ElectricVehicles	MEV1111: Microprocessor Applicationin Automobile		MEV1208: Digitally basedConverters for EV	MEV1212:Electric Vehicle Maintenance
MEV1108:Vehicle Body Engineering	MEV1112: Energy Conversion Systems for EV		MEV1209: Automotive Chassis & Suspension	MEV1213:Smart Grid Interface of EV
MEV1109:Vehicle Aerodynamics	MEV1113: Automotive Safety		MEV1210: Internet of Things (IoT)	MEV1214: Economics of Electric Vehicles

List of Audit Courses and Open Electives

Semester–I	Semester–II	Semester-III
Audit Course-I	**Audit Course-II**	**Open Electives**
MAU1101: Research Paper Writing	MAU1201:Constitution of India	MCSXX01: Business Analytics
MAU1102:Disaster Management	MAU1202: IPR &Patent Drafting	MSEXX02: Cost Management of Engineering Projects
MAU1103:Sanskrit for Technical Knowledge	MAU1203:Stress Management by Yoga	MSEXX03:CompositeMaterials
MAU1104:Value Education	MAU1204:Personality Development through Life Enlightenment Skills	MIPXX04:Waste to Energy
		MEDXX05:IndustrialSafety
		MMBXX06: Operation Research

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Principal
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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

M.Tech.in Electric Vehicle Technology

Syllabus

First Semester

From

Academic Year 2023-24

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Program: M. Tech. Electric Vehicle Technology (EVT)

Semester-I | MEV1101:Power Electronic Converters for EV

Teaching Scheme		Examination Scheme	
Theory	3 Hrs/week	**CT-I**	15 Marks
Tutorial	1 Hrs/week	**CT-II**	15 Marks
Total Credits	**4**	**CA**	10 Marks
Duration of ESE :3Hrs		**ESE**	60 Marks
		Total Marks	**100 Marks**

Course Contents

Unit I	**Power Semiconductor Switches:** Desired Characteristics in Controllable Switches, Comparison of Controllable Switches, Power MOSFET – Structure, Characteristics, Operation, Switching characteristics, Operation Limitation and Safe Operating Area, IGBT – Structure, Characteristics, Latchup in IGBT, Operation, Switching characteristics, Operation Limitation and Safe Operating Area, Comparison of Power MOSFET and IGBT, SiCMOSFET.
Unit II	**AC/DC Rectifiers:** Operation of Single-Phase Uncontrolled Rectifier, Single Phase Fully Controlled Rectifiers, Three Phase Uncontrolled Rectifier, Three Phase Fully Controlled Rectifier with RL and RLE load. Performance Parameters of controlled converters – Input Displacement Factor, Distortion Factor, Power Factor and Total Harmonic Distortion Power Factor Improvement Techniques, Multipulse Converters.
Unit III	**Pulse Width Modulated Inverters:** Concept of Switched Mode Inverters, Pulse-Width-Modulated Switching Scheme, Square-Wave Switching Scheme, PWM Of Single-Phase Inverters, PWM of Three Phase Inverter, Effect of Blanking Time on Voltage in PWM Inverters, Concept of Zero Vector in PWM, Space Vector PWM, Hysteresis Current Control, Rectifier Mode of Operation of PWM Inverter Matrix Converter – Principle, Operation and Modulation Schemes of Matrix Converter.
Unit IV	**Switched Mode Power Supply** Step-Down (Buck) Converter, Step-up (Boost) Converter, Buck-Boost Converter, Cuk dc-dc Converter, Full Bridge dc-dc Converter, Isolated Converters - Forward Converter, Flyback Converter.
Unit V	**Modeling and Control of Power Electronic Converters** Types of models – Switched model, average model, large signal and small signal model, Switched model of power electronic converter, Classical average model of converter, generalized average model, Control Principles of Power Electronic Converters used in Electric Vehicles, Linear Control Approaches for Power Converters – A case study.

Text Books	
T.1	Mohan, Ned, and Tore M. Undeland. Power electronics: converters, applications, and design. John wiley& sons, 2007.
T.2	Rashid, Muhammad H., ed. Power electronics handbook. Butterworth-Heinemann, 2017.
T.3	Bose, Bimal K. Modern power electronics and AC drives. Vol. 123. Upper Saddle River, NJ: Prentice hall, 2002.
Reference Books	
R.1	Mohan, Ned. Power electronics: a First Course. Wiley, 2011.
R.2	Sen, Paresh Chandra. Thyristor DC drives. John Wiley & Sons, 1981.
Useful Links	
1	https://nptel.ac.in/courses/108106170
2	https://onlinecourses.nptel.ac.in/noc23_ee01/preview

	Course Outcomes	PO's	CL	Class Sessions
MEV1101.1	**Differentiate** between operational behavior of IGBT and MOSFET and applications of devices.	PO1 &PO3	4	9
MEV1101.2	**Analyze** performance parameters of uncontrolled and controlled rectifiers.	PO1 &PO3	4	9
MEV1101.3	**Evaluate** different PWM schemes of Voltage Source Inverters.	PO1 &PO3	5	9
MEV1101.4	**Design** different switched mode power supplies.	PO1 &PO3	6	9
MEV1101.5	**Develop** a typical driver for power electronic switch.	PO1 &PO3	6	9

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Program: M. Tech. Electric Vehicle Technology (EVT)

Semester-I	MEV1102:Electrical Drives for EV

Teaching Scheme			**Examination Scheme**	
Theory	3 Hrs/week		**CT-I**	15 Marks
Tutorial	0 Hrs/week		**CT-II**	15 Marks
Total Credits	**3**		**CA**	10 Marks
Duration of ESE :3 Hrs			**ESE**	60 Marks
			Total Marks	**100 Marks**

Course Contents

Unit I	Basics of Power Electronic Drive system and components. Different types of loads, shaft-load coupling systems. Stability of power electronic drive.
Unit II	Conventional methods of D.C. motor speed control, single phase and three phase converter fed D.C motor drive. Four quadrant operations using dual converter fed DC motor drives.
Unit III	Chopper fed drives, input filter design. Braking and speed reversal of DC motor drives using choppers, Multiphase choppers.
Unit IV	Conventional methods of induction motor speed control. Solid state controllers for Stator voltage control, soft starting of induction motors, Rotor side speed control of wound rotor induction motors. Voltage source and Current source inverter fed induction motor drives – Principle of Vector Control.
Unit V	Speed control of synchronous motors, load commutated inverter drives, switched reluctance motors and permanent magnet motor drives, Field Oriented Control of PMSM. Use of DSP for Control of Drives. Use of PLC for Control of Drives. Comparison of DSP based and PLC based drives and its future Applications.

Text Books

T.1	Bimal K Bose, “Modern Power Electronics and AC Drives”, Pearson Education Asia 2002
T.2	Vedam Subramanyam, “Electric Drives – Concepts and Applications”, Tata McGraw Hill, 1994.

T.3	VedamSubramanyam, “Electric Drives – Concepts and Applications”, Tata McGraw Hill, 1994.
T.4	Murphy J.M.D and Turnbull, “Thyristor Control of AC Motors”, Pergamon Press, Oxford, Delhi, 2001.
Reference Books	
R.1	P. Vas – Vector control of ac machines, Clarandon Press, Oxford.
R.2	G. K. Dubey – Power Semiconductor Controlled drives, Prentice-Hall, Eaglewood cliffs.
Useful Links	
1	https://nptel.ac.in/courses/108108077
2	https://nptel.ac.in/courses/108104140

	Course Outcomes	PO’s	CL	Class Sessions
MEV1102.1	**Interpret** the significance of speed- torque characteristics of electrical drivesand methods to modify the characteristics.	PO1 &PO3	3	9
MEV1102.2	**Evaluate** the performance of AC Voltage Controller fed induction motor drive	PO1 &PO3	5	9
MEV1102.3	**Implement** VSI fed v/f controlled AC motor drive	PO1 &PO3	3	9
MEV1102.4	**Analyze** the concept of Field Oriented Control of an induction motor.	PO1 &PO3	4	9
MEV1102.5	**Determine** the speed control methods of synchronous motor based on application	PO1 &PO3	5	9

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Program: M. Tech. Electric Vehicle Technology (EVT)

Semester-I MEV1103: Electric Vehicle Structural Design

Teaching Scheme		Examination Scheme	
Theory	3 Hrs/week	**CT-I**	15 Marks
Tutorial	0 Hrs/week	**CT-II**	15 Marks
Total Credits	**3**	**CA**	10 Marks
Duration of ESE :3Hrs		**ESE**	60 Marks
		Total Marks	**100 Marks**

Course Contents

Unit I	**Introduction To CAD/CAM And Product Cycle:** Representation of Line, Circle, & Other analytic curves, Algorithms & Programs. Drafting of machine elements with dimension and tolerances using 2-D drafting packages. Graphic standards GKS [Graphical Kernal System] IGES [Initial Graphic Exchange Specifications].
Unit II	**CAD of Machine Elements:** Development of interactive design programs [with drafting] for machine elements, incorporating choice of materials and other parameters, Generation of several alternate designs and evaluation.
Unit III	**Geometric Modeling:** Mathematical representation of Hermite cubic, Bezeir & B-spline curves. Introduction to difference type of surfaces and solids generated in surface and solid model respectively. Assembly modeling and interference checking.
Unit IV	**Mechanical Design Analysis and Optimization:** Design analysis for mass properties, Stress, Thermal stress, using CAD/CAE packages, Optimum design of machine components using multivariable non linear optimization techniques using iterative CAD/CAE software tools.
Unit V	**Finite Element Analysis:** Basic concept of the finite element method, comparison of FEM with direct analytical solutions; Steps in finite element analysis of physical systems, Finite Element analysis of 1-D problems like spring, bar, truss and beam elements formulation by direct approach; development of elemental stiffness equations and their assembly, solution and its post processing.

Text Books

T.1	Ranky, P.G. Computer Integrated Manufacturing, Prentice Hall,1986.
T.2	Radhakrishanan,P. and Kothandaraman, C.P. Computer Graphics & Design, Dhanpat Rai & Sons, Delhi,1990.
T.3.	Groover ,M.P. and Zimmers ,E.W CAD/CAM, Computer Aided Design and manufacturing, Prentice Hall of India 1986

Reference Books

R.1	Dimarogons, A.D. Computer Aided Machine Design, Prentice Hall, 1986.
R.2	Ibrahim Zeid, CAD/CAM Theory and Pratice, Mc Graw Hill, 1991.
R.3	Dimarogons, A.D. Computer Aided Machine Design, Prentice Hall, 1986.

Useful Links

1	https://nptel.ac.in/courses/112102101.
2	https://nptel.ac.in/courses/112102102.

Course Code	Course Outcomes	PO/PSO	CL	Class Sessions
MEV1103.1	**Analyze** the modeling, drafting and dimensioning of machine elements by using computer Software.	PO1,PO2,PO3,PO12, PSO1,PSO2	4	9
MEV1103.2	**Apply** Basics of CAD to Generate several alternate design options very easily.	PO1,PO2,PO3,PO5, PO12, PSO1, PSO2, PSO3	3	9
MEV1103.3	**Examine** the requirements of hardware & software for computer aided design process.	PO1,PO2,PO3,PO12, PSO1, PSO2	3	9
MEV1103.4	**Interpret** Mechanical Design Analysis and Optimization	PO1,PO2,PO3, PO12,PSO1,PSO2	3	9
MEV1103.5	**Solve** FEM Technique to analyze the Spring, truss and beam element.	PO1,PO2,PO3, PO5, PO12, PSO1, PSO2, PSO3.	3	9

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Program: M.Tech. Electric Vehicle Technology (EVT)

Semester-I | MEV1104: Power Electronic Converters Lab

Teaching Scheme	
Practical	2 Hrs/week
Total Credit	1

Examination Scheme	
CA	25 Marks
ESE	25 Marks
Total	50 Marks
Duration of ESE:02Hrs	

Course Outcomes (CO)

Students will be able to

1	**Differentiate** between operational behavior of IGBT and MOSFET and applications of devices.
2	**Analyze** performance parameters of uncontrolled and controlled rectifiers.
3	**Evaluate** different PWM schemes of Voltage Source Inverters.
4	**Design** different switched mode power supplies.
5	**Develop** a typical driver for power electronic switch.

Sr. No.	List of Experiment	COS
1	Obtain dynamic characteristics of IGBT and MOSFET under different loading Conditions.	**CO1**
2	Design an opto-coupler based driver circuit for IGBT/MOSFET	**CO1**
3	Analyze the effect of snubber in the operation of IGBT based converter	**CO2**
4	Evaluate performance parameters of three phase converter with RL load.	**CO2**
5	Demonstrate the operation of 12-pulse converter.	**CO3**
6	Compare the performance of unipolar PWM and bipolar PWM scheme in single phase VSI	**CO3**
7	Develop sine PWM scheme for Three Phase VSI.	**CO4**
8	Develop Space Vector PWM scheme for Three Phase VSI.	**CO4**
9	Simulate Venturing modulation scheme of Matrix Converter.	**CO5**

Text Books

1	Mohan, Ned, and Tore M. Undeland. Power electronics: converters, applications, and design. John wiley& sons, 2007.
2	Rashid, Muhammad H., ed. Power electronics handbook. Butterworth-Heinemann, 2017.
3	Bose, Bimal K. Modern power electronics and AC drives. Vol. 123. Upper Saddle River, NJ: Prentice hall, 2002.

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2.	https://onlinecourses.nptel.ac.in/noc23_ee01/preview

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Program: M.Tech. Electric Vehicle Technology (EVT)

Semester-I | MEV1105: Computer Aided Design EV Lab

Teaching Scheme		Examination Scheme	
Practical	2 Hrs/week	**CA**	25 Marks
Total Credit	1	**ESE**	25 Marks
		Total	50 Marks
		Duration of ESE: 02Hrs	

Course Outcomes(CO)

Students will be able to

1	**Develop** the C-Programs to generate basic entities, Curves and Transformation.
2	**Apply** the Concept of 2D Geometric modeling of an engineering object.
3	**Apply** the Concept of 3 D Geometric modeling of an engineering object.
4	**Apply** finite element method to analyze structure like bar, trusses and CST Element.
5	**Create** 2-D and 3-D geometrical model and its assembly by modeling software.

Sr. No.	List of Experiment	COS
1	**Development** of a Program for generation of Circle using Bressenham's Algorithms.	**CO1**
2	**Development** of a Program for generation Ellipse using Bressenham's algorithms.	**CO1**
3	**Design** a Program for 2-D & 3-D transformations algorithms.	**CO2**
4	**Apply** the concept of 2-D Geometric modeling of an Engineering object to demonstrating Boolean operations.	**CO2**
5	**Apply** the concept of 3-D Geometric Modeling of an Engineering object to demonstrating extrude, revolve and loft commands.	**CO3**
6	**Calculate** Stress, strain using finite element method for 1-D bar element.	**CO3**
7	**Calculate** Stress, strain using finite element method for 1-D truss element.	**CO4**
8	**Apply** Finite element method to calculate Stress, strain of 2-D CST element.	**CO4**
9	**Design** two simple solid models showing geometric properties using CAD software.	**CO5**
10	**Prepare** any Assembly model.	**CO5**

Text Books

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.

Reference Books	
1.	Allen Fuhs, “Hybrid Vehicles and the future of personal transportation”, CRC Press, 2009.
Useful Links	
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/

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Program: M. Tech. Electric Vehicle Technology (EVT)

Semester-I | MEV1106:Switching Power Supplies

Teaching Scheme		Examination Scheme	
Theory	3 Hrs/week	**CT-I**	15 Marks
Tutorial	0 Hrs/week	**CT-II**	15 Marks
Total Credits	**3**	**CA**	10 Marks
Duration of ESE :3Hrs		**ESE**	60 Marks
		Total Marks	**100 Marks**

Course Contents

Unit I	Introduction to Non-isolated dc-dc converter: Buck Converter, Boost Converter, Buck-Boost Converter, Cuk Converter, SEPIC converters. Continuous conduction mode and discontinuous conduction mode analysis. Non-idealities in the SMPS. Isolated dc-dc converters: Flyback Converter, Forward Converter, Push-Pull Converter, Half bridge Converter and Full bridge Converter topologies.
Unit II	Resonant Converters: Classification of Resonant Converters, Basic Resonant Circuit Concepts, Load Resonant Converters, Resonant-Switch Converters, Zero-Voltage-Switching, Clamped-Voltage Topologies, Resonant-dc-Link Inverters with Zero-Voltage Switchings, High-Frequency-Link Integral-Half-Cycle Converters.
Unit III	Reactive Elements in Power Electronic Systems: Introduction, Electromagnetic, Design of Inductor, Design of Transformer, Capacitors for Power Electronic Application, Types of Capacitors
Unit IV	Modeling and control of SMPS: Introduction, Duty cycle and current model control, canonical model of the converter, Averaged Model of the Converter, Generalized State Space Model of the Converter, Dynamic Model of Converters Operating in DCM.
Unit V	Control of Switched Mode Converters (SMPS): Introduction, Closed Loop Control, Closed Loop Performance Functions, Effect of Input Filter on the Converter Performance, Design Criteria for Selection of Input Filter.

Text Books

T.1	L. Umanand, "Power Electronics Essentials and Applications", Wiley India Ltd., 2009.
T.2	V. Ramanarayanan, Switched Mode Power Conversion, 2007.
T.3	Abraham Pressman, Switching Power supply Design, McGraw Hill

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Reference Books	
R.1	Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronics – Converters, Applications and Design", John Willey & sons, Inc., 3rd ed., 2003.
R.2	Keith H Billings - Switch mode power supply handbook – 1st edition 1989 Mc-Graw hill Publishing Company.
Useful Links	
1	https://nptel.ac.in/courses/108108036
2	https://archive.nptel.ac.in/courses/108/105/108105180/

Course Code	Course Outcomes	PO	CL	Class Sessions
MEV1106.1	**Analyze** an equivalent circuit model of Switched mode power supply for steady-state analysis.	PO1,PO3	4	9
MEV1106.2	**Design** of magnetic components (i.e., inductor and transformer) for converters used in power supply.	PO1,PO3	6	9
MEV1106.3	**Compare** the operation of resonance switching power converters with traditional converters.	PO1,PO3	3	9
MEV1106.4	**Develop** feedback controller to regulate DC output of power supply and obtain it frequency response.	PO1,PO3	6	9
MEV1106.5	**Analyze** the performance of SMPS with various input filters.	PO1,PO3	4	9

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Program: M.Tech. Electric Vehicle Technology (EVT)

Semester-I | MEV1107: Plug-In Electric Vehicles

Teaching Scheme		Examination Scheme	
Theory	3 Hrs/week	**CT-I**	15 Marks
Tutorial	0 Hrs/week	**CT-II**	15 Marks
Total Credits	**3**	**CA**	10 Marks
Duration of ESE :3Hrs		**ESE**	60 Marks
		Total Marks	**100 Marks**

Course Contents

Unit I	**Introduction to Electric Vehicle (EV) & 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 EV and HV:** Power and Energy management strategies and its general architecture of EV and 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 modeling for energy storage in HV/BEV, hybridization of various energy storage devices, Selection of the energy storage technology.
Unit III	**Power Electronics in EV & HV:** Introduction, various power electronics converter topologies and its comparisons, Control of convertor operations in EV and HV, battery chargers used in EV & HV, emerging power electronic devices.
Unit IV	**Components & Design Considerations of EV & HV:** Design parameters of batteries, ultra-capacitors and fuel cells, aerodynamic considerations, calculation of the rolling resistance and the grade resistance, calculation of the acceleration force, total tractive effort, torque required on the drive wheel, transmission efficiency, consideration of vehicle mass, electric vehicle chassis & body design, general issues in design, specifications and sizing of components
Unit V	**Electric and 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 EV and HV, BEE standards, Indian and Global scenario, case studies.

Text Books	
T.1	Iqbal Hussain, “Electric and Hybrid Vehicles Design Fundamentals”, 1st Edition, CRC Press, 2003.
T.2	James Larminie, John Lowry “Electric Vehicle Technology Explained”, 1st Edition, John Wiley and Sons, 2003
T.3	Chris Mi, M. Abul Masrur, David Wenzhong Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, Wiley publication , 2011.
Reference Books	
R1. Allen Fuhs, “Hybrid Vehicles and the future of personal transportation”, CRC Press, 2009.	

Course Code	Course Outcomes	PO	CL	Class Sessions
MEV1107.1	**Understand** the architecture and vehicle dynamics of electric and hybrid vehicles	PO1,PO3	2	9
MEV1107.2	**Analyze** and model the power management systems for electric and hybrid vehicles	PO1,PO3	4	9
MEV1107.3	**Devise** power electronics based control strategies for electric and hybrid vehicle	PO1,PO3	3	9
MEV1107.4	**Analyze and design** various components of electric and hybrid vehicles with environment concern	PO1,PO3	4	9
MEV1107.5	**Investigate** and model the issues in mathematical domain related to grid interconnections of electric and hybrid vehicle.	PO1,PO3	3	9

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Program: M.Tech. Electric Vehicle Technology (EVT)

Semester-I	MEV1108: Vehicle Body Engineering

Teaching Scheme		**Examination Scheme**	
Theory	3 Hrs/week	**CT-I**	15 Marks
Tutorial	0 Hrs/week	**CT-II**	15 Marks
Total Credits	**3**	**CA**	10 Marks
Duration of ESE :3Hrs		**ESE**	60 Marks
		Total Marks	**100 Marks**

Course Contents

Unit I	**Car Bodies :**Car body-purpose-requirements-Types, Dimensional regulations-concept, driver's visibility concept- tests for visibility-Methods of improving visibility, space in cars-concept-methods of improving space, Safety- safety design, safety equipments for car, Car body construction components of car body-purpose of each component, Doors-types, window actuating mechanisms types-construction and working, Door locks-types, central locking-concept- working principle, general unitary body construction process.
Unit II	**Vehicle Aerodynamics**: Aerodynamics-concept-Objectives-Vehicle drag-definition-types-effects, forces and moments acting on vehicle body-types-effects, various body optimization techniques for minimum drag. Wind tunnel testing-concept-types-test setup-testing process-Flow visualization techniques- scale model testing-Component balance to measure forces and moments
Unit III	**Bus and Commercial Vehicle Bodies** :Types, Bus body layouts of each type, Bus Body Lay Out-Floor height-engine location-entrance and exit location-seating dimensions, Constructional details-Frame construction-types-Types of metal section used-Regulations, Double skin construction-concept, Conventional and Integral type construction-concept-merits-demerits, Commercial Vehicle body- Types- illustration of each type, Light commercial vehicle body- types-illustration of each type, Dimensions of driver's seat in relation to controls, driver's cabin design.
Unit IV	**Body material** -Requirements-Steel sheet, timber, plastics, GRP, CRP-properties ofmaterials applications in vehicle body, Interior materials-requirements-types-applications, Glasses-types, laminated glass-concept-purpose, defrosting in glasses-concept-purpose.
Unit V	**Painting-concept-objectives** elements of paint-resins-concept-function, pigment- concept-function, solvent- concept-function -Types, paint drying process-Types-drying principle of each type-merits demerits, composition &functions- primer paint- putty paint- surface-sealer top coat, spray painting- Types, air spray painting-procedure, air less spray painting-procedure, electrostatic painting-procedure, New vehicle painting with a block diagram.

Text Books

T.1	Automotive Engineering (Heating & Air conditioning) class room manual Mark Schnubel Cengage Learning Cengage Learning.
T.2	Automobile Engineering vol VI(Air Conditioning System) Anil Chhikara Satya Prakashana New Delhi

Reference Books	
R.1	Automobile Engineering (Paint Technology) vol V Anil Chhikara Satya Prakashana New Delhi
Useful Links	
1.	https://nptel.ac.in/courses/107106088

Course Code	Course Outcomes	PO	CL	Class Sessions
MEV1108.1	**Illustrate** the different types and components of car body.	PO1&PO3	3	9
MEV1108.2	**Explain** the concept, importance and testing of aerodynamics in car body design.	PO1 &PO3	3	9
MEV1108.3	**Illustrate** the different types and components of bus and commercial body.	PO1 &PO3	3	9
MEV1108.4	**Explain** different vehicle body materialswith their merits and demerits.	PO1&PO3	3	9
MEV1108.5	**Explain** the concept of painting and painting process in car body also **Describe**the concept and importance of Air conditioning in Automobiles.	PO1 & PO3	3	9

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Program: M.Tech. Electric Vehicle Technology (EVT)

Semester-I | MEV1109:Vehicle Aerodynamics

Teaching Scheme		Examination Scheme	
Theory	3Hrs/week	**CT-I**	15Marks
Tutorial	0Hrs/week	**CT-II**	15Marks
Total Credits	**3**	**CA**	10Marks
Duration of ESE :3Hrs		**ESE**	60Marks
		Total Marks	**100Marks**

Course Contents

Unit I	**Basics of Vehicle Dynamics:** History, vehicle classifications, fundamental approaches to vehicle dynamics modeling; SAE Vehicle axis system, Forces & moments affecting vehicle, Earth Fixed coordinate system, Dynamic axle loads, Equations of motion, transmission characteristics, vehicle performance, Brake proportioning, braking efficiency.
Unit II	**Acceleration Performance** Power train components; power and traction limited acceleration; transverse weight shift; front wheel drive vs rear wheel drive vs. all- wheel drive vehicles. **Braking Performance** Braking force analysis; brake design and analysis; federal regulation on braking performance; antilock braking system; wheel lock-up; tire/road friction; safety and maintenance
Unit III	**Road Loads** Wind drag and car body design, rolling resistance; breakdowns of total road loads; gasmileage analysis and driving styles; Aerodynamics. **Tire and Tire Dynamics** Tire specifications and constructions; tire motion analysis; tire force analysis; tire contact stress analysis; tire vibration analysis; tire models
Unit IV	**Ride & Cornering/steering** Riding comfort; perception of vibration; vibration sources; vibration transmission to the passengers;: lower speed cornering; high speed corner; cornering bicycle model; Quasi-Static Rollover of a Rigid Vehicle, Quasi-Static Rollover of a Suspended Vehicle, Transient Rollover.
Unit V	**Chassis and Suspension** Systems Suspension Kinematics, Suspension types, Solid Axles, Independent Suspensions, Anti-Squat and Anti-Pitch Suspension Geometry, Anti- Dive Suspension Geometry, Roll Center Analysis, Suspension Dynamics, Multi-body vibration, Body and Wheel hop modes, Invariant points, Controllable Suspension Elements: Active, Semi- Active. Choice of suspension spring rate, Calculation of effective spring rate, Vehicle suspension in

Text Books

T.1	Vehicle Dynamics, Theory and Application, Reza N. Jazar, Springer, 2009, ISBN978-0-387-74243-4, e-ISBN 978-0-387-74244-1.
T.2	The Multibody systems Approach to Vehicle Dynamics, Mike Blundell and Damian Harty, Elsevier, 2004.

Reference Books	
R.1	Reimpell, Stoll and Betzler: The Automotive Chassis: Engineering Principles
R.2	Hans Pacejka, Tire and Vehicle Dynamics, Elsevier, 2012
Useful Links	
1	https://nptel.ac.in/courses/107106080
2	https://people.iith.ac.in/ashok/VD2016/VD_0_Course.pdf

Course Code	Course Outcomes	PO/PSO	CL	Class Sessions
MEV1109.1	**Understand** the dynamics of vehicle rideunder different riding condition.	PO1 & PO3	3	9
MEV1109.2	**Present** a problem oriented in depth knowledge of Vehicle Dynamics.	PO1 & PO3	3	9
MEV1109.3	**Address** the underlying concepts and methods behind Vehicle Dynamics	PO1 & PO3	4	9
MEV1109.4	**Calculate** and refer the loads and forces associated to the vehicles.	PO1 & PO3	4	9
MEV1109.5	**Analyze** the behavior of the vehicles under acceleration, ride and braking.	PO1 & PO3	4	9

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Program: M.Tech. Electric Vehicle Technology (EVT)

Semester-I MEV1110:Control Techniques for EV Converters

Teaching Scheme		Examination Scheme	
Theory	3 Hrs/week	**CT-I**	15 Marks
Tutorial	0 Hrs/week	**CT-II**	15 Marks
Total Credits	**3**	**CA**	10 Marks
Duration of ESE :3Hrs		**ESE**	60 Marks
		Total Marks	**100 Marks**

Course Contents

Unit I	Power electronic converters for dc-ac and ac-dc power conversion Electronic switches, dc-dc buck and boost converters, H-bridge, multilevel converters – diode clamp, flying capacitor and cascaded-cell converters; voltage source and current source converters; evolution of topologies for dc-ac power conversion from dc-dc converters, PI & PID Controllers.
Unit II	Applications of voltage source converters Overview of applications of voltage source converter, motor drives, active front-end converters, reactive compensators, active power filters Purpose of pulse width modulation
Unit III	Review of Fourier series, fundamental and harmonic voltages; machine model for harmonic voltages; undesirable effects of harmonic voltages – line current distortion, increased losses, pulsating torque in motor drives; control of fundamental voltage; mitigation of harmonics and their adverse effects Pulse width modulation (PWM) at low switching frequency
Unit IV	Square wave operation of voltage source inverter, PWM with a few switching angles per quarter cycle, equal voltage contours, selective harmonic elimination, THD optimized PWM, off-line PWMT triangle-comparison based PWM Average pole voltages, sinusoidal modulation, third harmonic injection, continuous PWM, bus-clamping or discontinuous PWM Space vector based PWM
Unit V	Space vector concept and transformation, per-phase methods from a space vector perspective, space vector based modulation, conventional space vector PWM, bus-clamping PWM, advancedPWM, triangle comparison approach versus space vector approach to PWM Analysis of line current ripples. Synchronously revolving reference frame; error between reference voltage and applied voltage, integral of voltage error; evaluation of line current ripple; hybrid PWM for reduced line current ripple

Text Books

T.1	Power System Analysis: Arthur R. Bergen, Vijay Vithal, Pearson Education Asia (1996)
T.2	Generalized Theory of Machine: P. S. Bimbra, Vol. 2, Khanna Publishers (1987)

Reference Books

R1. Pulse Width Modulation for Power Converters: Principles and Practice (Original Price $ 184.95) Hardcover – 1 January 2014 by Thomas A. Lipo D. Grahame Holmes

R2. Fundamentals of Power Electronics Robert W. Erickson (2017)

Useful Links

NPTEL :: Electrical Engineering - Power System Analysis

NPTEL :: Electrical Engineering - NOC: Power System Dynamics, Control and Monitoring

Course Code	Course Outcomes	PO/PSO	CL	Class Sessions
MEV1110.1	**Distinguish** Converter topologies for AC/DCand DC/AC power conversion	PO1 & PO3	4	9
MEV1110.2	**Judge** the pulse width modulation techniques for 1-phase and 3-phase bridge converters	PO1 & PO3	4	9
MEV1110.3	**Calculate** the switching and conduction losses and compensation for dead time and DC voltage regulation	PO1 & PO3	5	9
MEV1110.4	**Apply** extension of modulation methods to Multilevel inverters.	PO1 & PO3	4	9
MEV1110.5	**Design** sine-triangle PWM, bus clamping PWM, space vector based PWM, advanced PWM techniques	PO1 & PO3	6	9

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Program: M.Tech. Electric Vehicle Technology (EVT)

Semester-I | MEV1111: Microprocessor Application in Automobile

Teaching Scheme		Examination Scheme	
Theory	3 Hrs/week	**CT-I**	15 Marks
Tutorial	0 Hrs/week	**CT-II**	15 Marks
Total Credits	**3**	**CA**	10 Marks
Duration of ESE :3Hrs		**ESE**	60 Marks
		Total Marks	**100 Marks**

Course Contents

Unit I	**Architecture**: General 8 bit microprocessor and its architecture 8085,Z-80 and MC 6800 MPU and its pin functions-Architecture-Functions of different sections
Unit II	**Instruction Set:** Instruction format-addressing modes-instruction set of 8085 MPU-T-STATE-Machine cycle and instruction cycles-Timing diagrams-Different machine cycles-Fetch and execute operations-estimation of execution times.
Unit III	**Assembly Language Programming:** Construct of the language programming-Assembly format of 8085-Assembly Directive-Multiple precision addition and subtraction-BCD to Binary and Binary to BCD Multiplication, Division, Code conversion using look up tables-stack and subroutines
Unit IV	**Data Transfer Schemes:** Interrupt structure-Programmed I/O, DMA-Serial I/O. Interfacing Devices: Types of interfacing devices-Input/ Output ports 8212, 8255,8251,8279. Octal latches and tri state buffers-A/D and D/A converters-Switches, LED's ROM and RAM interfacing
Unit V	**Applications:** Data acquisitions-Temperature control-Stepper motor control-Automotive applications engine control, Suspension system control, Driver information systems, Development of a high speed, high precision learning control system for the engine control.

Text Books

T.1	Ramesh, Goankar.S., Microprocessor Archietecture Programming and Applications, Wiley Eastern Ltd.,New Delhi,1986.
T.2	Aditya .P. Mathur, Introduction to Microprocessors, III Edition Tata McGraw Hill Publishuing Co Ltd New Delhi, 1989.

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Course Code	Course Outcomes	PO's	CL	Class Sessions
MEV1111.1	**Illustrate** the Architecture of different typesof Microprocessor	PO1 &PO3	4	9
MEV1111.2	**Analyze** the different types of Instruction setsused in Microprocessor	PO1 &PO3	5	9
MEV1111.3	**Create** the Assembly Language Programming	PO1 &PO3	5	9
MEV1111.4	**Demonstrate** the various types of datatransfer scheme	PO1 &PO3	3	9
MEV1111.5	**Develop** the application of Microprocessor inAutomobile	PO1 &PO3	6	9

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Program: M.Tech. Electric Vehicle Technology (EVT)

Semester-I | MEV1112: Energy Conversion System for EV

Teaching Scheme		Examination Scheme	
Theory	3 Hrs/week	**CT-I**	15 Marks
Tutorial	0 Hrs/week	**CT-II**	15 Marks
Total Credits	**3**	**CA**	10 Marks
Duration of ESE : 3 Hrs		**ESE**	60 Marks
		Total Marks	**100 Marks**

Course Contents

Unit I	**Gas Turbines:** Classification of gas turbine, simple open cycle gas turbine Ideal and actual cycle (Brayton Cycle) for gas turbine, optimum pressure ratio for maximum specific output in actual gas turbine regeneration, reheat and inter cooling and effect of these modification on efficiency and output, closed cycle gas turbine
Unit II	**Propulsion Devices:** Types of jet engines, Ram Jet, Pulse jet, Turbojet, Turbo propulsion, principle and operation, energy flow through jet and variation of pressure and temperature, thrust equation, specific thrust and velocity of fluid, thermodynamics of turbojet, efficiency & performance, parameters affecting performance, after burn, injection of water & alcohol mixture. **Rocket Propulsion:** Classifications, Types of rocket engines, liquid propellant rockets, efficiency and performance.
Unit III	**Renewable Energy Resources**: Introduction to world energy scenario, renewable energy resources, solar energy, earth sun angles, resolution, solar measurement, collection of solar energy, flat plate and focusing collector analysis, calculations and same design parameters, applications of solar energy. **Solar Photovoltaic System:** photovoltaic effect, efficiency of solar cells, semiconductor materials for solar cells, solar photovoltaic system.
Unit IV	**Bio Mass:** gasifiers, gobar gas plant, types of applications, biomass conversion technologies, biogas generation. **Wind Energy:** basic principles of wind energy conversion, wind energy estimation, site selection consideration, basic components of wind energy conversion system, classification, advantages & disadvantages of WECS.
Unit V	**Additional Renewable Energy Resources:** Tidal energy and OTEC - principle, resources and availabilities, energy conversion technologies. Fuels cell technology, principle of MHD power system, types of MHD system, advantages, and materials for MHD system. Geothermal energy, nature of geothermal fields, geothermal sources, prime movers for geothermal energy.

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Text Books	
T.1	S. P. Sukhatme, Solar Energy - Principles of thermal collection and storage,second edition, Tata McGraw-Hill, New Delhi, 1996.
T.2	Kothari D.P., Renewable energy resources and emerging technologies, Prentice Hall of India Pvt. Ltd.
T.3	G.D. Rai, Non-Conventional Energy Sources, Khanna Publishers.
Reference Books	
R.1	S.M. Yahya, Turbine compressors and Fans, TMH.
R.2	J.K. Jain, Gas Turbine Theory & Jet Propulsion, Khanna Publishers.
Useful Links	
1	https://nptel.ac.in/courses/112105221
2	https://nptel.ac.in/courses/103107125
Reference Books	
R.1	Jabez Dhinagfar .S., Microprocessor Applications in Automobiles.
R.2	L. Bianco and A. Labella., Automotive Micro Electronics, Elsevier science Publishers, 1986.
Useful Links	
1	https://nptel.ac.in/courses/108105102
2	https://www.vssut.ac.in/lecture_notes/lecture1423813120.pdf

Course Code	Course Outcomes	PO's	CL	Class Sessions
MEV1112.1	**Demonstrate** a basic understanding of jet and rocket engine design, function and performance.	PO1,PO3	2	9
MEV1112.2	**Describe** the technology of each of the sources of renewable energy.	PO1,PO3	3	9
MEV1112.3	**Design** renewable energy systems that meet specific energy demands, economically feasible, and have a minimal impact on the environment	PO1,PO3	5	9
MEV1112.4	**Compare** different non-conventional energy resources and choose the most appropriate based on local conditions	PO1,PO3	5	9
MEV1112.5	**Explain** economic issues around renewable energy sources.	PO1,PO3	4	9

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Program: M. Tech. Electric Vehicle Technology (EVT)

Semester-I MEV1113: Automotive Safety

Teaching Scheme		Examination Scheme	
Theory	3 Hrs/week	**CT-I**	15 Marks
Tutorial	0 Hrs/week	**CT-II**	15 Marks
Total Credits	**3**	**CA**	10 Marks
Duration of ESE :3Hrs		**ESE**	60 Marks
		Total Marks	**100 Marks**

Course Contents

Unit I	**Introduction** Design of the body for safety, energy equation, engine location, and deceleration of vehicle inside passenger compartment, deceleration on impact with stationary and movable obstacle, concept of crumble zone, safety sandwich construction.
Unit II	**Safety Concepts** Active safety: driving safety, conditional safety, perceptibility safety, operating safety passive safety: exterior safety, interior safety, deformation behavior of vehicle body, speed and acceleration characteristics of passenger compartment on impact
Unit III	**Safety Equipments** Seat belt, regulations, automatic seat belt tightened system, collapsible steering column, tilt able steering wheel, air bags, electronic system for activating air bags, bumper design for safety.
Unit IV	**Collision Warning And Avoidance** Collision warning system, causes of rear endcollision, frontal object detection, rear vehicle object detection system, object detection system with braking system Interactions.
Unit V	**Comfort And Convenience System** Steering and mirror adjustment, central locking system , Garage door opening system, type pressure control system, rain sensor system, environment information system

Text Books

T.1	Bosch - “Automotive Handbook” - 5th edition - SAE publication - 2000.
T.2	J.Powloski - “Vehicle Body Engineering” - Business books limited, London - 1969.

Reference Books

R.1	Ronald.K.Jurgen - “Automotive Electronics Handbook” - Second edition- McGraw-Hill Inc., - 1999.
R.2	J. Y. Wong, Theory of Ground Vehicles, A wiley Inter science Publications

Useful Links

1.	https://onlinecourses.nptel.ac.in/noc23_de01/preview
2.	https://archive.nptel.ac.in/courses/107/106/107106088/

Course Code	Course Outcomes	PO/PSO	CL	Class Sessions
MEV1113.1	**Comprehend** application of passive and active safety for vehicle	PO1 &PO3	4	9
MEV1113.2	**Describe** importance of ergonomics in automotive safety and human response to impact	PO1 &PO3	5	9
MEV1113.3	**Design** vehicle safety system	PO1 &PO3	5	9
MEV1113.4	**Describe** various regulations of vehicle safety and safety testing methods.	PO1 &PO3	3	9

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Program: M. Tech. Electric Vehicle Technology (EVT)

Semester-II MAU1101: Research Paper Writing

Teaching Scheme		Examination Scheme	
Theory	2 Hrs/week	**CT-I**	-
Tutorial	0 Hrs/week	**CT-II**	-
Total Credits	**0**	**CA**	-
Duration of ESE: 3Hrs		**ESE**	-
		Total Marks	-

Course Contents

Unit I	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness
Unit II	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction
Unit III	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.
Unit IV	Purposes of Writing a Research Paper, Structure of the Manuscript, Title Discussion, Abstract, Introduction, Methodology, Theoretical Framework, Results & Discussions,
Unit V	Conclusions, Acknowledgements, References, Tables and Table Captions, Figures and Captions, Authorship and Originality, Language and Editing, Essentials of A Good Research Paper, validation.

Text Books

T.1	James Lester, “Writing Research Papers: Complete Guide”, Pearson Publication, 2015
T.2	CR Kothari, “Research Methodology”, NewAgeInternationalPublication,2004
T.3	Sher Singh Bhakar, “Hand Book For Writing Research Paper”, Bharati Publications, NewDelhi,2014

Reference Books

R.1	Day R How to Write and Publish a Scientific Paper, Cambridge UniversityPress,2006.
R.2	Goldbort R Writing for Science, YaleUniversityPress2006.
R.3	AdrianWallwork,EnglishforWritingResearchPapers,SpringerNewYorkDordrecht HeidelbergLondon,2011

Useful Links

1	https://www.youtube.com/watch?v=cMJWtNDqGzI
2	https://www.youtube.com/watch?v=Xp2PVO3do34
3	www.digimat.in/nptel/courses/video/110105091/L07.html

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