Sona College of Technology (Autonomous), Salem – 636 005

Department of Electrical and Electronics Engineering

Advanced Diploma in ELECTRIC MOBILITY AND SMART SYSTEMS

CURRICULUM & SYLLABI

Academic year – 2021-22

I Year / I Semester

S. No.	Course Code	Course Title	L	T	P	C
Theory						
1.		Basic Electrical Technology	3	0	0	3
2.		Mechanical course	3	0	0	3
3.		Embedded based Smart System Design (ECE)	3	0	2	4
		Total Credits				10

I Year / II Semester

S. No.	Course Code	Course Title	L	T	P	C
Theory						
1.		EV Motors	3	0	0	3
2.		Vetronics (MCT)	3	0	0	3
3.		Modeling and Simulation of EV (Lab Integrated)	3	0	2	4
		Total Credits				10

II Year / III Semester

S. No.	Course Code	Course Title	L	T	P	C
Theory						
1.		Electric Vehicle Technology	3	0	0	3
2.		Automotive Embedded System (ECE)	3	0	0	3
3.		EV charging station Installation and Safety	3	0	0	3
Laboratory						
		Mechanical course lab	0	0	4	2
					Total Credits	11

II Year / IV Semester

S. No.	Course Code	Course Title	L	T	P	C
Theory						
1.		EV charging Infrastructure and BMS	3	0	0	3
2.		Power Converters for EV	3	0	0	3
3.		Government Rules, Opportunities, Testing and Certification of EV	3	0	0	3
					Total Credits	09

BASIC ELECTRICAL TECHNOLOGY

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UNIT I DC FUNDAMENTALS 9

Electrical components and parameters – Resistance, Conductance – Ohm's law, limitations of Ohm's law – – Kirchhoff's law – Power – Energy – resistors in series and parallel – comparison of series and parallel circuits – Star-Delta transformation – simple problems.

UNIT II AC FUNDAMENTALS 9

AC waveforms – standard terminologies – RMS and average value of Sinusoidal, Triangular and Square waveforms – form factor, peak factor – Resistance, Inductance, Capacitance in AC circuits – Impedance – RL, RC, RLC series circuits – series resonance – simple problems.

UNIT III ELECTRICAL MACHINES 9

DC Generator: construction of DC Machine – working principle of DC Generator – EMF equation – Types of DC Generator.

DC Motor: Working principle of DC Motor – Types of DC Motor.

Transformer: Working principle of Transformer – EMF equation – Transformation ratio.

UNIT IV SEMICONDUCTOR DEVICES 9

Introduction to power semiconductors – SCR, MOSFET – V-I characteristics and applications.

BJT: Operations of NPN and PNP Transistors – Characteristics of Transistors in CE, CB and CC configuration.

UNIT V OPERATIONAL AMPLIFIERS & POWER SUPPLY 9

Operational Amplifier: Ideal characteristics of Op-Amp – Inverting amplifier, Non-Inverting amplifier – voltage follower – summing amplifier.

Rectifiers: working principle of half wave rectifier, full wave rectifier, bridge rectifier.

UPS: components of UPS – working principle of UPS.

TOTAL : 45 HOURS

REFERENCE BOOKS

1. B.L. Theraja, "Fundamentals of Electrical Engineering & Electronics", S. Chand & Co Ltd, 2015.
2. Muthusubramanian R, Salivahanan S, "Basic Electrical and Electronics Engineering", 3rd Edition 2007,Tata McGraw-Hill publishing company limited.
3. D. Roy Choudhury and Shail Jain, "Linear Integrated Circuits", First edition, New age international, 2011.
4. S. Padma, "Basic Electrical and Electronics Engineering", Sonaversity, Revised edition 2016.

AUTOMOTIVE ENGINES AND TRANSMISSIONS

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UNIT-I INTRODUCTION 9

Types of Automobiles - Types of vehicle bodies & chasses - Basic layouts of automotive vehicles Components of Engine - Review of Cooling and Lubrication systems in Engine - Electronic Engine Management System.

UNIT-II ENGINE AUXILIARY AND ELECTRICAL SYSTEMS 9

Carburetor - working principle - Electronic fuel injection system - Electrical systems - Starting Motor and Drives – Lighting and Ignition (Battery, Magneto Coil and Electronic Type)-Regulators-cut outs.

UNIT-III TRANSMISSION SYSTEMS AND AXLE TYPES 9

Clutch – Types – Working Principle - Gear Boxes - Types – Working Principle – Flywheel - Propeller shaft – Slip Joint – Universal Joints – Differential Unit.

UNIT-IV STEERING, BRAKES AND SUSPENSION SYSTEM 9

Wheels and Tyres - Wheel Alignment Parameters - Steering gear box – Power Steering – Braking Systems – Antilock Braking System. Suspension systems.

UNIT-V ALTERNATIVE ENERGY SOURCES AND COMFORT SYSTEMS 9

Use of Natural Gas – LPG – Biodiesel - Gasohol and Hydrogen in Automobiles - Safety systems and HVAC system

TOTAL: 45 HOURS

Reference Books

1. Kirpal Singh “Automobile Engineering Vol. 1& 2”, Standard Publishers 2019, New Delhi
2. Sethi H.M, “Automobile Technology”, Tata McGraw-Hill-2018
3. Crouse and Anglin “Automotive Mechanism”, 9th Edition. Tata McGraw-Hill, 2017.
4. Newton, Steeds and Garet, “Motor vehicles”, Butterworth Publishers, 2015.
5. Srinivasan.S, “Automotive Mechanics” 5th edition, 2012, Tata McGraw-Hill.

EMBEDDED BASED SMART SYSTEM DESIGN

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UNIT 1 MICROCONTROLLER 9

Resources: Architecture of a microcontroller – Microcontroller resources – Resources in advanced and next generation microcontrollers – Atmel 89c51 Microcontroller – Internal and External memories – Counters and Timers – Synchronous serial cum asynchronous serial communication – Interrupts

UNIT 2 MICROCONTROLLER SYSTEM DESIGN 9

Digital and Analog Interfacing Methods: Switch, Keypad and Keyboard interfacings – LED and Array of LEDs – Keyboard-cum-Display controller – Alphanumeric Devices – Display Systems and its interfaces – Printer interfaces – Programmable instruments interface using IEEE 488 Bus – Interfacing with the Flash Memory – Interfaces – Interfacing to High Power Devices – Analog input interfacing – Analog output interfacing – Optical motor shaft encoders.

UNIT 3 EMBEDDED COMMUNICATION PROTOCOLS 9

Introduction to embedded systems- Application Areas- Categories of embedded systems- Architecture of embedded systems- Hardware architecture- Software Architecture-Application Software- Communication Software- Development and debugging Tools. Introduction- Serial/Parallel Communication – Serial communication protocols -RS232 standard –RS485 Synchronous Serial Protocols -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) – PC Parallel port programming -ISA/PCI Bus protocols –CAN bus – USB.

UNIT 4 EMBEDDED HARDWARE PLATFORMS 9

Raspberry pi-Arduino- NodeMCU and Intel Galileo boards. IoT applications in smart vehicles- Hardware interfacing with Arduino UNO- Galileo boards: LEDs- serial communication- key switch- analog linear temperature sensor LM35- Collision Detection Warning System- Stepper Motor Control.

UNIT 5 COMMUNICATION STANDARDS 9

Internet/Web and Networking Basics OSI Model- IP Addressing- Network Topologies- Sub-netting- Introduction to Web Servers-Introduction to Cloud Computing-Wireless Personal Area Networks- Bluetooth- Bluetooth Standards- Bluetooth Protocol Architecture- UWB, IEEE 802.15 standards-ZigBee- GSM- GPS.

Total hours: 45

REFERENCES:

1. Mazidi and Mazidi, “The 8051 Microcontroller and Embedded Systems” – PHI, 2000
2. Raj Kamal, “Microcontrollers Architecture, Programming, Interfacing and System Design”– Pearson Education, 2005.
3. A.V. Deshmuk, “Microcontrollers (Theory & Applications)” – WTMH, 2005.
4. John B. Peatman, “Design with PIC Microcontrollers” – Pearson Education, 2005.
5. Microcontroller Programming, Julio Sanchez, Maria P. Canton, CRC Press.
6. Raj kamal, Embedded systems architecture programming and design, Tata McGraw hill, second edition ,2008.
7. Wireless Communications – Principles and Practice; by Theodore S Rappaport, Pearson Education Pte. Ltd., Delhi

EMBEDDED BASED SMART SYSTEM DESIGN Lab

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List of Experiments:

1. Study on 89C51 Controller and Keil C-Simulator.
2. Develop experiments to give the display on monitor through the RS232 serial port.
3. Design the circuit for interfacing LED with 89C51.
4. Design the embedded system to interface key switches with the 89C51 controller.
5. Design the embedded system to interface 7-Segment display system with 89C51.
6. Study on Arduino board and Arduino UNO/raspberry Pi/Galileo board.
7. Design the embedded system to interface LEDs with Arduino UNO/raspberry Pi/Galileo board.
8. Design the embedded system to activate serial communication of Arduino UNO/raspberry Pi/Galileo board.
9. Design the embedded system to interface key switch, LED with Arduino UNO/raspberry Pi/Galileo board.
10. Design the embedded system to interface analog linear temperature sensor LM35 with Arduino UNO/raspberry Pi/Galileo board.
11. Design the embedded system for Collision Detection Warning System using Arduino UNO/raspberry Pi/Galileo board.
12. Design the embedded system for Stepper Motor Control using Arduino UNO/raspberry Pi/Galileo board.

TOTAL HOURS: 30

EV MOTORS

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UNIT-I CLASSIFICATIONS OF MOTORS **9**

EV motors introductions – requirements - challenges - comparisons of EV motors and industrial motors - Motors (DC, Induction, BLDC, PMSM) – Types, Principle, Construction, Control - Electric Drive Train and its types.

UNIT-II DC MOTOR OPERATION CHARACTERISTICS 9

DC motor operation and its types - BLDC Motor and Control - Operation of BLDC Motor - Torque and Rotating Field Production – Torque - Speed Characteristics and Typical Technical Parameters - Sensor less BLDC Motor Control.

UNIT-III AC MOTOR OPERATION CHARACTERISTICS 9

AC Induction Motor and Control - Basic Principle of AC Induction Motor Operation - Controls of AC Induction Motor - Selection and sizing of Motor - RPM and Torque calculation of motor - Motor Controllers.

UNIT-IV CONFIGURATION OF MOTORS 9

Configuration and control of DC Motor drives - Configuration and control of Induction Motor drives - configuration and control of Permanent Magnet Motor drives.

UNIT-V SPECIAL ELECTRICAL MOTORS 9

Switched Reluctance Motor: Basic Magnetic Structure, Torque Production - SRM Drive Converter - Modes of Operation - Generating Mode of Operation (Regenerative Braking) - Sensorless Control - Phase Flux Linkage based Method.

TOTAL : 45 HOURS

Reference Books:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2010.

2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2009.

3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

VETRONICS

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UNIT I FUNDAMENTALS OF AUTOMOTIVE MECHATRONICS & CONTROL SYSTEM **9**

Fundamentals of Mechatronics, Electronics Components, Microprocessor, Ports, Memory, Buses, Microcontroller, Fetch-Execute sequence, Programming, Electronic Control Unit, Testing of Microcontroller Systems. Control System: Open and closed loop control strategies, PID control, Look up tables, Modern control strategies: Fuzzy logic and adaptive control.

UNIT II SENSORS & ACTUATORS **9**

Hall Effect, hot wire, thermistor, piezo electric, piezoresistive, based sensors. Introduction, basic sensor arrangement, types of sensors, oxygen concentration sensor, lambda sensor, crankshaft angular position sensor, cam position sensor, Mass air flow (MAF) rate, Manifold absolute pressure (MAP), Throttle plate angular position, engine oil pressure sensor, vehicle speed sensor, detonation sensor, emission sensors, Actuators: solenoid actuator, stepper motors, relays, electrohydraulic actuators.

UNIT III ELECTRONIC ENGINE MANAGEMENT SYSTEM **9**

Electronics Fuel Injection, Types of EFI, TBI, MPFI & GDI, Ignition System, Electronic Ignition System and its advantages, Fuel control maps, CI Engine Management. Fuel injection system, parameters affecting combustion, noise and emissions in CI engines. Pilot, main, advanced, post injection and retarded post injection. Electronically controlled Unit Injection system. Exhaust emission control systems, 2 and 3-way catalytic converter.

UNIT IV AUTOMOTIVE TOOLS, DIAGNOSIS & NETWORKING **9**

Wiring Harness, Limitations of Wiring Harness, Multiplex data bus, Basic principle of Networking-Classification of automotive multiplex bus, Controller Area Network, Local Interconnect Network, FlexRay, Most, Automotive Ethernet, Connected Cars. Diagnosis: tools and equipment, Oscilloscope, on-board diagnosis system, Electromagnetic compatibility & tests for EMC.

UNIT V APPLICATIONS FOR DIFFERENT DOMAINS AND CURRENT TRENDS **9**

Lighting systems: LED, adaptive front lighting system, Comfort systems: Cruise control, adaptive cruise control, central locking, Electric mirrors, windows, multimedia systems, Safety & security systems: Airbag, Chassis Systems: ABS, TC, ESP, TPMS, Active Suspension, Active Steering system, Automatic Transmission, Use of Machine learning and data analytics for the automotive applications (ADAS, vehicle Autonomy, prognostics, health monitoring).

REFERENCE BOOKS:

1. Tim, Gilles, "*Automotive Engines: Diagnosis, Repair, Rebuilding*", 7th Edition, Delmar Publishers, New York, 2015.
2. Ribbens, "*Understanding Automotive Electronics*", 7th Edition (Indian Reprint), Elsevier, 2013.
3. Tom Denton," *Automobile Electrical and Electronics Systems*", 4th Edition, Edward Arnold Publishers, 2012.
4. Barry Hollembeak, "*Automotive Electricity, Electronics & Computer Controls*", 1st Edition, Delmar Publishers, 2001.
5. Ronald. K. Jurgon, "*Automotive Electronics Handbook*", 2nd Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 1999.
6. Robert Bosch GmbH, "*Automotive Hand Book*", 9th Edition, Wiley & Sons Inc., New York, 2014.

MODELING AND SIMULATION OF EHV

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UNIT-I MODELING IN PERFORMANCE PARAMETER 9

Modeling Vehicle Acceleration - Acceleration performance parameters - modeling the acceleration of an electric scooter - modeling the acceleration of a small car.

UNIT-II MODELING OF BATTERY ELECTRIC VEHICLES 9

Electric Vehicle Modeling - Tractive Effort, Rolling resistance force, Aerodynamic drag, Hill climbing force, Acceleration force, Total tractive effort, Modeling Electric Vehicle Range - Driving cycles - Range modeling of battery electric vehicles - Constant velocity range modeling - Range modeling of fuel cell vehicles - Range modeling of hybrid electric vehicles.

UNIT-III DRIVETRAIN CHARACTERISTICS 9

Modeling and Characteristics of EV/HEV Powertrains Components - ICE Performance Characteristics - Electric Motor Performance Characteristics - Battery Performance Characteristics -Transmission and Drivetrain Characteristics - Regenerative Braking Characteristics.

UNIT-IV ENERGY MANAGEMENT 9

Handling Analysis of Electric and Hybrid Electric Vehicles - Simplified Handling Models Energy/Power Allocation and Management - Power/Energy Management Controllers - Rule and optimization based Control Strategies.

UNIT-V VEHICLE DYNAMIC CONTROL 9

Control of Electric and Hybrid Electric Vehicle Dynamics - Fundamentals of Vehicle Dynamic Control (VDC) Systems - VDC Implementation on Electric and Hybrid Vehicles.

TOTAL : 45 HOURS

Reference Books:

1. James Larminie, John Lowry, “Electric Vehicle Technology Explained”, John Wiley & Sons Ltd, 2003.

2. Amir Khajepour, Saber Fallah and AvestaGoodarzi, “Electric and Hybrid VehiclesTechnologies, Modeling and Control: A Mechatronic Approach”, John Wiley & Sons Ltd, 2014.

3. Antoni Szumanowski, “Hybrid Electric Power Train Engineering and Technology: Modeling, Control, and Simulation”, IGI Global, 2013.

MATLAB for EV

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List of Experiments:

1. Develop a simulation model to analyze the effect of Rolling Resistance on vehicle range and performance
2. Develop a simulation model to analyze the effect of vehicle mass on vehicle range and performance
3. Develop a simulation model to analyze the effect of Aerodynamic drag on vehicle range and performance
4. Develop a simulation model to analyze the effect of Hill Climbing force on vehicle range and performance.
5. Develop a simulation model for Series/parallel HEV to analyze the effect of changing of parameters on vehicle range and performance.
6. Develop a simulation model to analyze Electric Motor Performance Characteristics
7. Develop a simulation model to analyze Electric Motor Regenerative Braking Characteristics for different Driving Cycles.

TOTAL : 30 HOURS

ELECTRIC VEHICLES TECHNOLOGY

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UNIT-I INTRODUCTION 9

Overview of EVs and challenges - components of EVs - architecture of EVs - EV market and promotion-infrastructure needs - EV makers - Comparison in reference of: Energy source, Pollution, Energy diversification, Efficiency, Capital & operating cost, Performance.

UNIT-II CLASSIFICATIONS 9

Classification of EVs in reference of: Propulsion devices, Energy sources, Energy carriers, Pure Electric Vehicles (PEV) - Hybrid Electric Vehicles (HEV) and Plug-in Hybrid Electric Vehicles (PHEV) - Configurations: BEV, FCEV.

UNIT-III EV DRIVES 9

Challenges: BEV, HEV, FCEV, EV motor drive technologies - IC engine vehicle force - speed characteristics (5-gears), BEV force - speed characteristics (fixed gears) - Comparison between ICE vehicles & BEV - Requirement of EV motor compared to industrial motors - classification of EV motors.

UNIT-IV ENERGY STORAGE 9

EV energy source technologies: Energy sources used in EVs & HEVs - Medium of power transfer (conductive and wireless) - wireless power transfer - Battery Management System (BMS).

UNIT-V EV COMMUNICATION 9

V2V, V2G and its applications in power system - power saving & coordinated charging - layout of power converters for V2G operation - EV configurations: converted & purpose built EVs - components of EV system.

TOTAL : 45 HOURS

Reference Books

1. Hybrid Electric Vehicle System Modeling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017.

2. Hybrid Electric Vehicles – Teresa Donateo, Published by ExLi4EvA, 2017

3. Electric and Hybrid Vehicles Power Sources, Models, Sustainability, Infrastructure and the Market Gianfranco Pistoia Consultant, Rome, Italy, Elsevier Publications, 2017.

4. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, MehrdadEhsaniYiminGao Stefano Longo Kambiz M. Ebrahimi, Taylor & Francis Group, LLC, 2018.

AUTOMOTIVE EMBEDDED SYSTEM

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UNIT I AUTOMOTIVE FUNDAMENTALS: 9

Automotive physical configuration, drive train, suspension, brakes, steering system. Systems approach to control and instrumentation: Characteristics of digital electronic system, Instruments, Control system. Vehicle motion control: Cruise control system, Antilock braking system, Electronic suspension system, Electronic steering control, automotive instrumentation, on board and off – board diagnostics, occupant protection systems.

UNIT II FUEL CELL FOR AUTOMOTIVE POWER 9

Fuel cell-Introduction-Proton exchange membrane FC (PEM), Solid oxide fuel cell (SOFC)-properties of fuel cells for vehicles-power system of an automobile with fuel cell based drive, and their characteristics

UNIT III VEHICLE MANAGEMENT SYSTEMS 9

Vehicle cruise control- speed control anti-locking braking system-electronic suspension - electronic steering, wiper control; Vehicle system schematic for interfacing with EMS, ECU. Energy Management system for electric vehicles- for sensors, accelerators, brake Battery management, Electric Vehicles-Electrical loads, power management system-electrically assisted power steering system.

UNIT IV AUTOMOTIVE TELEMATICS 9

Role of Bluetooth, CAN, LIN and flex ray communication protocols in automotive applications; Multiplexed vehicle system architecture for signal and data / parameter exchange between EMS, ECUs with other vehicle system components and other control systems; Realizing bus interfaces for diagnostics, dashboard display, multimedia electronics.

UNIT V ELECTRONIC DIAGNOSTICS FOR VEHICLES 9

System diagnostic standards and regulation requirements –On board diagnosis of vehicles electronic units & electric units-Speedometer, oil and temperature gauges, and audio system.

Total Hours: 45

TEXT BOOKS:

1. William B. Ribbens,"Understanding Automotive Electronics", Elseiver,2012
2. Ali Emedi, Mehrdedehsani, John M Miller , "Vehicular Electric power system- land, Sea, Air And Space Vehicles" Marcel Decker, 2004.
3. L.Vlacic, M.Parent, F.Harahima,"Intelligent Vehicle Technologies", SAE International,2001.
4. Jack Erjavec,Jeff Arias,"Alternate Fuel Technology-Electric ,Hybrid & Fuel CellVehicles",Cengage ,2012
5. Electronic Engine Control technology – Ronald K Jurgen Chilton's guide to Fuel Injection – Ford

REFERENCES:

1. Tom Denton, "Automotive Electricals / Electronics System and Components", 3rd Edition, 2004.
2. Uwe Kiencke, Lars Nielsen, "Automotive Control Systems: For Engine, Driveline, and Vehicle",Springer; 1st edition, March 30, 2000.
3. Automotive Electricals Electronics System and Components, Robert Bosch Gmbh, 4thEdition,2004.
4. Automotive Hand Book, Robert Bosch, Bently Publishers, 1997. 5. Jurgen, R., Automotive Electronics Hand Book

EV CHARGING STATION INSTALLATION AND SAFETY

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UNIT-I INTRODUCTION 9

General safety requirement for electric vehicle charging stations: IS/IEC 62305 - Disconnection of EV locking of the coupler protection against overvoltage at the battery.

UNIT-II CHARGING STATION 9

Solar Powered Electric Vehicle Charging Station - Calculation and Selection - Components of Charging Station - Earth protection system for charging stations - Requirement to prevent fire for EVs Charging Stations.

UNIT-III TESTING 9

Testing of EVs charging stations: All apparatus of EV Charging Station shall have the insulation resistance value as stipulated in the relevant IEC 61851-1

UNIT-IV MAINTENANCE 9

Periodic maintenance and assessment of electric vehicle charging stations - Solar powered electric vehicle charging station Calculation and selection - Components of charging station

UNIT-V STANDARDS 9

International Standard for charging stations: Safety provisions of all A.C. charging stations shall in accordance with IEC 61851-1, IEC 61851- 21, IEC 61851-22 and IEC 61851-24.

TOTAL : 45 HOURS

Reference Books:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2010.
2. Dr.Yogini Dilip Borole, DR.V.Shanmugasundram, 'Electric Vehicle Adoption to Revolutionize Automobile Sector' IIP press, 2021.
3. 2. Michael Plint& Anthony Martyr, "Engine Testing & Practice", Butterworth Heinmenn, 3rd ed, 2007

AUTOMOTIVE LABORATORY

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List of Experiments:

1. Valve timing diagram
2. Port timing diagram
3. IC Engine performance test for 4 stroke - SI Engine
4. IC Engine performance test for 2 stroke - SI Engine
5. Assembling and dismantling of an IC Engine
6. Assembling and dismantling of differential unit
7. Assembling and dismantling of gear box
8. Assembling and dismantling of steering gear box

TOTAL : 30 HOURS

EV CHARGING INFRASTRUCTURE AND BMS

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UNIT-I INTRODUCTION 9

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles - Battery based energy storage - Fuel Cell based energy storage - Super Capacitor based energy storage - Fly wheel based energy storage.

UNIT-II CHARGING METHODS 9

Electric Vehicle Technology and Charging Equipment's - Basic charging Block Diagram of Charger - Difference between Slow charger and fast charger - Slow charger design rating - Fast charger design rating.

UNIT-III TYPES OF CHARGERS 9

AC charging and DC charging - On board and off board charger specification - Type of Mode of charger Mode 2, Mode 3 and Mode 4 - EVSE associated charging time calculation - Selection and sizing of fast and slow charger (AC & DC) - AC Pile Charger, DC Pile Charger.

UNIT-IV EVSE COMMUNCATION 9

EVSE Power Module selection and technical specification - Selection of EVSE Communication Protocol (PLC / Ethernet / Modbus/ CAN Module) - Communication gateway - Specification of open charge point protocol (OCCP 1.6/2.0) - Bharat DC001 & AC001 Charger specification - Communication Interface between charger and CMS (Central Management System) - Payment apps.

UNIT-V CHARGING COMMUNICATION 9

Selection of AC charger type-1 , type -2 and type -3 - Communication between AC charger and EV - Selection of DC charger connector GB/T, CHAdeMO, CCS-1 and CSS-2 - Communication methodology of DC fast chargers.

TOTAL : 45 HOURS

Reference Books:

1. "Vehicle Inspection Handbook", American Association of Motor Vehicle Administrators.
2. 4. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles_ Fundamentals, Theory, and Design, Second Edition", CRC Press, 2010.
3. 2. Amir Khajepour, Saber Fallah and AvestaGoodarzi, "Electric and Hybrid VehiclesTechnologies, Modeling and Control: A Mechatronic Approach", John Wiley & Sons Ltd, 2014.

POWER CONVERTERS FOR EV

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UNIT I: BASIC POWER ELECTRONIC DEVICES 9

Diodes – Thyristors - Bipolar Junction Transistors – Metal Oxide Semiconductor Field Effect Transistors - Insulated Gate Bipolar Transistors - Ultra capacitors.

UNIT II: DC/DC CONVERTER 9

Basic Principle of DC–DC Converter - Step-Down (Buck) Converter - Step-Up (Boost) Converter - Buck–Boost Converter - DC–DC Converters Applied in Hybrid Vehicle Systems - Isolated Buck DC–DC Converter - Four-Quadrant DC–DC Converter.

UNIT III: RECTIFIERS AND INVERTERS 9

Single-phase Diode Rectifiers - Three-phase Diode Rectifiers - Poly-phase Diode Rectifiers - Filtering Systems in Rectifier Circuits - High-frequency Diode Rectifier Circuits - Single-phase Voltage Source Inverters - Three-phase Voltage Source Inverters - Current Source Inverters - Closed-loop Operation of Inverters - Regeneration in Inverters - Multistage Inverters.

UNIT IV: ELECTRIC MOTOR DRIVES 9

Dc motor speed control and braking - Chopper control based ac motor drives - cyclo-converter fed ac motor drives - slip power recovery scheme - four quadrant operation of electric drives.

UNIT V: CONTROL OF HYBRID AND FUEL CELL VEHICLES 9

Fuel Cell Vehicles - Power Electronics Requirements - Propulsion Motor Control Strategies - APU Control System in Series Hybrid Vehicles - Fuel Cell for APU Applications.

TOTAL : 45 HOURS

Reference Books:

1. “Power Electronics”, P.S.Bimbhra, Khanna publications, 2020.
2. “Thyristorised Power Controllers”, G.K.Dubey, New Age international publishers, 2019.
3. “Power Electronic Converters Modeling and Control: with Case Studies”, Seddik basha, Springer, 2018.

GOVERNMENT RULES, OPPORTUNITY, TESTING & CERTIFICATION OF HEVS

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UNIT I: INDIAN AND GLOBAL SCENARIO 9

Technology Scenario - Market Scenario - Policies and Regulations - Payback and commercial model - Polices in India - opportunities.

UNIT II: INTRODUCTION 9

Specification & Classification of Vehicles (including M, N and O layout) - Homologation & its Types - Regulations overview (EEC, ECE, FMVSS, AIS, CMVR) - Type approval Scheme.

UNIT III: STATIC TESTING OF VEHICLE 9

CMVR physical verification - Tyre Tread Depth Test - Vehicle Weightment - Horn installation - Rear view mirror installation - External Projection - tell-tale - Wheel Guard - Arrangement of Foot Controls for M1 Vehicle - Angle & Dimensions Measurement of Vehicle - The Requirement of Temporary Cabin For Drive away - Chassis.

UNIT IV: DYNAMICS TESTING OF VEHICLE 9

Speedo-meter Calibration - Range Test - Maximum Speed - Acceleration Test - Coast-down test - Brakes Performance ABS Test - Broad band / Narrow band EMI Test - Electric vehicle – Range Test.

UNIT V: VEHICLE COMPONENT TESTING 9

Horn Testing - Safety Glasses Test - Windscreen laminated and toughened safety glass - Rear View Mirror Test - Hydraulic Brakes Hoses Fuel Tank Test - Metallic & Plastic - Hinges and Latches Test, Tyre & Wheel Rim Test - Bumper Impact Test - Side Door Intrusion - Crash test with dummies - Demist test - Defrost Test.

TOTAL : 45 HOURS

Reference Books:

1. “Vehicle Inspection Handbook”, Indian Association of Motor Vehicle Administrators

3. Proceedings- Automotive Testing & Certification held on 20th to 24th July 2010 at ARAI PUNE

4. Bosch Automotive Handbook, Robert Bosch, 7th Edition, 2007