

# **RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL**

## **New Scheme Based On AICTE Flexible Curricula**

### **Automobile Engineering, VIII-Semester**

#### **AU801 – Vehicle Dynamics**

**Unit-I** Introduction to Vehicle Dynamics: Definition by SAE; vehicle control loop; mathematical modeling methods; multi-body system approach, Newtonian and Lagrangian formulation, method of Investigation, stability concepts.

**Unit-II** Mechanics of Pneumatic Tires: Tires construction; physics of tire; traction on dry and wet surfaces, tire forces and moments, SAE recommended practice; rolling resistance of Tire Model; ride properties of Tires.

**Unit-III** Performance Characteristics of Road Vehicle: Equation of motion; maximum, vehicle power and transmission characteristics; prediction of vehicle performance; operating fuel economy, braking performance.

**Unit-IV** Handling and stability: Characteristics of road vehicle; steering geometry, steady state handling characteristics; steady state response to steering input; transient response characteristics; direction stability effects of tire; effect of mass distribution and engine location on stability and handling.

**Unit-V** Vehicle Ride Characteristics: Human response to vibration, vehicle ride models, road surface profile as a random function, frequency response function, evaluation of vehicle vertical vibration to ride comfort criterion.

**Unit-VI** Two Wheeler Dynamics: Stability & handling, vehicle motion ride control, various vehicle models, gyroscopic effect and effect of Tire and vehicle parameters on stability and handling characteristics.

#### **References:**

1. Wong; Theory of Ground Vehicle; John Wiley & Sons
2. Clark S.K; Mechanics of Pneumatic Tire; NBS Monograph
3. Sothien W; Dynamics of High Speed Vehicles; Springer N.Y.
4. Ellis J.E.R; Vehicle Dynamics; Butterworth London
5. Ramalingam KK; Automobile engineering; Scitech pub
6. Giri N.K.; Automotive Mechanics

#### **List of Experiments :**

1. Study of static and dynamic properties of tires

2. Study of effect of braking system on car speed down, stopping and stability
3. Study effect of vibration and noise on human comfort
4. Study effect of engine location on stability and dynamics

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### **Automobile Engineering, VIII-Semester**

#### **Departmental Elective AU802 (A) - Refrigeration & Air Conditioning**

**Unit-I** Introduction: Principles and methods of refrigeration, freezing; mixture cooling by gas reversible expansion, throttling, evaporation, Joule Thomson effect and reverse Carnot cycle; unit of refrigeration, coefficient of performance, vortex tube & thermoelectric refrigeration, adiabatic demagnetization; air refrigeration cycles- Joule's cycle Boot-strap cycle, reduced ambient cycle and regenerative cooling cycles.

**Unit-II** Vapor compression system: Vapor compression cycle, p-h and t-s diagrams, deviations from theoretical cycle, sub-cooling and super heating, effects of condenser and evaporator pressure on cop; multi-pressure system: removal of flash gas, multiple expansion & compression with flash inter cooling; low temperature refrigeration: production of low temperatures, cascade system, dry ice, production of dry ice, air liquefaction system,.

**Unit-III** (a) Vapor absorption system: Theoretical and practical systems such as aquaammonia, electrolux & other systems; (b) Steam jet refrigeration: Principles and working, simple cycle of operation, description and working of simple system, (c) refrigerants: nomenclature & classification, desirable properties, common refrigeration, comparative study, leak detection methods, environment friendly refrigerants and refrigerant mixtures, brine and its properties

**Unit-IV** Psychometric: Calculation of psychometric properties of air by table and charts; psychometric processes: sensible heating and cooling, evaporative cooling, cooling and dehumidification, heating and humidification, mixing of air stream, sensible heat factor; principle of air conditioning, requirements of comfort air conditioning, ventilation standards, infiltrated air load, fresh air load human comfort, effective temperature & chart, heat production & regulation of human body,

**Unit-V** Air conditioning loads: calculation of summer & winter air conditioning load, bypass factor of coil, calculation of supply air rate & its condition, room sensible heat factor, grand sensible heat factor, effective sensible heat factor, dehumidified air quantity. Problems on cooling load calculation.

#### **References:**

- Arora CP; Refrigeration and Air Conditioning; TMH
- Sapali SN; Refrigeration and Air Conditioning; PHI
- Ananthanarayan; Basic Refrigeration and Air conditioning; TMH
- Manohar Prasad; Refrigeration and Air Conditioning; New Age Pub
- Ameen; Refrigeration and Air Conditioning; PHI

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### **Automobile Engineering, VIII-Semester**

#### **Departmental Elective AU802 (B) - Automotive Air Conditioning**

**Unit-1** introduction to Air conditioning & Refrigeration: Methods of refrigeration. Vapour compression refrigeration system, vapour absorption refrigeration system, applications of refrigeration & air conditioning, Automobile air conditioning, air conditioning for passengers, isolated vehicles, Refrigerated transport vehicles, applications related with very low temperatures

**Unit-2** Refrigerants: Classification, properties, selection criteria, commonly used refrigerants, alternative refrigerants, eco-friendly refrigerants, applications of refrigerants, refrigerants used in automobile air conditioning.

**Unit-3** Air Conditioning Systems: Classification, layouts, central / unitary air conditioning systems. System components like compressor, evaporator, condenser, expansion devices, Receiver dryer, fan blowers, heating system etc. Switch and electrical wiring circuit.

**Unit -4** Air Distribution Systems: Distribution ducting, sizing, supply / return ducts, type of grills, diffusers, ventilation, air noise level, layout of duct systems for automobiles and their impact on load calculations . Objectives of the dashboard re-circulating unit, automatic temperature control, controlling flow, control of air handling systems & air flow through – evaporator core.

**Unit-5** Air Conditioning Control & service -Air conditioner maintenance & service - removing & replacing Components. Compressor service. Testing, Diagnosis & trouble shooting of air conditioning system. Refrigerant gas charging procedure &. Servicing of heater system. Common controls such as thermostats, humidistat, control dampers, pressure cutouts, and relays.

#### **Text & Reference Books:**

1. “Automotive Air-Conditioning”, by Crouse & Anglin – Mc Graw Hill Pub.
2. “Automotive Air-Conditioning”, by Paul Weiser – Reston Publishing Co.
3. “Automatic Heating & Air Conditioning Systems” – Mitchell Information Services.
4. “Air Conditioning”, by Paul Lang, C.B.S. Publisher & Distributor, Delhi.
5. Principles of Refrigeration by Roy J. Dossat – Pearson Publication.
6. “Modern Air Conditioning”, by Harris.

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## **New Scheme Based On AICTE Flexible Curricula**

### **Automobile Engineering, VIII-Semester**

#### **Departmental Elective AU802 (C) - Vehicle Body Engineering**

**Unit I** Car Body Details: Types: Saloon, Convertibles, Limousine, Estate Van, Racing & Sports Car Visibility, Regulation, driver's visibility, test for visibility - method of improving visibility & space in cars -safety design equipments for car; car body construction.

**Unit II** Vehicle Aerodynamics: Objectives - Vehicles drag and types - various types of forces & moments - effect of force & moments - side wind effects on force & moments - various body optimization, technique for minimum drag- Wind tunnel testing: flow visualization techniques, Scale model testing, component balance to measure force & moments.

**Unit III** Bus Body Details: Types: Mini bus, Single Decker, Double Decker, Spirit Level & Articulated bus- bus body Layout - floor height - Engine location - Entrance & Exit location - Sitting dimensions - Construction details: Frame construction, Double skin construction - Types metals sections used - Regulation - Conventional & integral type construction.

**Unit IV** Commercial Vehicle Details: Types of body: Flat platform, Drop side, Fixed Side, Tipper body, tanker body - light commercial vehicle body types - dimension of driver seat in relation to control – Driver's cab design.

**Unit V** Body Materials, Trim & Mechanism: Steel sheet, timber, plastic, GRP, Properties of materials - corrosion - anticorrosion methods - escalation of paint & painting process; Body trim items; body mechanisms. Body Loads: Idealized structure - Structural surface - shear panel method - Symmetric & asymmetrical vertical loads in a car - longitudinal loads - Different Loading situations.

#### **References:**

1. Powloski, J.; Vehicle Body Engg. Business books Ltd
2. Giles J.C; Body construction & Design; Butter worth & Co.
3. Ramalingam KK; Automobile engineering; Scitech pub
4. John Fenton; Vehicle Body Layouts & analysis, Mechanical Engg. Publication ltd. London.
5. Braithwaite, J.V.; Vehicle Body building & Drawing, Heinemanm Edn. Books Ltd. London.

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**Automobile Engineering, VIII-Semester**

**Departmental Elective AU802 (D) - Fault Diagnosis and Trouble Shooting**

**Unit I:** Introduction Fault Diagnosis Introduction To Fault Diagnosis, Safe Working Practices And Techniques, Diagnostics On Paper, Mechanical And Electrical Diagnostic Techniques, Faults Codes, Systems And Standards, On - And - Off Board Diagnostics, Data Sources, Tools And Equipments, Oscilloscopes, Scanners/Fault Code Readers, Engine Analyzers, Application Methods And Procedures.

**Unit II:** On and off Board Diagnostics Introduction To Oscilloscope Diagnostics, Sensors And Actuators Associated With Oscilloscope Diagnostics, On-Board Diagnostics Various Perspectives, Petrol/Gasoline On-Board Diagnostics, On Board Sensors And Actuators, Sensors And Actuators Comparative Case Study.

**Unit III:** Engine System Diagnosis Introduction Engine Systems Diagnostics, Engine Operation And Fuel System, Ignition System And Emission System, Fuel Injection, Starting And Charging System, Power Flow Control And Energy Efficiency Analysis, Engine Management And Faultfinding Information, Air Supply, Exhaust System, Cooling And Lubrication System.

**Unit IV:** Chassis and Brake System Diagnosis Introduction To Engine System Diagnostics ,Anti-Lock Braking System Diagnostics ,Traction Control System Diagnostics, Steering And Tires ,Transmission Systems Diagnostics , Diagnostics On Steering And Tires ,Case Study On Diagnostics Of Sub Assemblies.

**Unit V:**Electrical Systems Diagnosis Introduction To Electronic Components And Circuits ,Multiplexing And De Multiplexing ,Lighting System Faults And Auxiliary Faults. In-Car Entertainment Security And Communications Implementation. Body-Electrical Systems, Instruments System Faults Heating Ventilation And Air Conditioning ,Cruise Control, Air Bags And Belt Tensioner .

**Reference Books/Other Reading Material.**

- 1.Tom Denton “Automotive Electronics Handbook”, - - McGraw-Hill Publishing Co.; 2nd Revised edition 1999, ISBN10:0070344531
2. Routledge “Automobile Electrical and Electronic Systems”, 4 edition 2012, ISBN10: 0080969429
3. Newnes “Understanding Automotive Electronics”, 6th Revised edition 2003,ISBN10:0750675993

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## **New Scheme Based On AICTE Flexible Curricula**

### **Automobile Engineering, VIII-Semester**

#### **Open Elective AU803 (A) - Autotronic**

**Unit 1.** Fundamentals of Automotive Electronics: Microprocessor and micro Computer applications in automobiles; components for engine management System; electronic management of chassis system; vehicle motion control; electronic panel meters.

**Unit 2.** Sensors & Actuators: Introduction; Basic sensor arrangement; Types of Sensors such as oxygen sensors, Crank angle position sensors, fuel metering/vehicle speed sensors and detonation sensors, altitude sensors, flow Sensors, throttle position sensors, solenoids, stepper motors, relays.

**Unit 3.** Electronic Fuel Injection & Ignition System: Introduction; feedback carburetor system; throttle body injection and multi point fuel injection System; injection system controls; advantage of electronic ignition systems; types of solid state system and their principle of operation; electronic spark timing. Comfort & Safety: Seats, mirrors and sun roofs; central locking and electronic Windows; cruise control; in-car multimedia; security; airbag and belt tensioners; other safety and comfort systems; new developments.

**Unit 4.** Digital Engine Control System: Open loop and closed loop control system; engine cooling and warm-up control; acceleration, deceleration and idle speed control; integrated engine control system; exhaust emission control engineering; on-board diagnostics; future automotive electronic systems. Electromagnetic Interference Suppression: Electromagnetic compatibility Electronic dash board instruments - Onboard diagnosis system. Security and warning system..

**Unit 5.** Automotive Electrical: Batteries; starter motor & drive mechanism; D.C. generator and alternator; regulation for charging; lighting design; dashboard instruments; horn, warning system and safety devices. The system approach to control & instrumentation: Fundamentals, electronic components and circuits, digital electronics, microcomputer instrumentation and control, sensors and actuators, digital engine control systems, vehicle motion control, automotive instrumentation and telematics, new developments.

#### **Text & Reference Books:**

1. Automotive Electronics Handbook, Ronald K. Jorgen, McGraw Hill Publishing Co., ISBN 0- 07- 034453-1.
2. Automotive Electricity and Electronics, Al Santini, Delmar Publishers, NY, ISBN 0-8273- 6743-0.
3. Automobile Electrical & Electronic Equipments, Young, Griffiths, Butterworth Publication, London.
4. Understanding Automotive Electronics, Bechfold, SAE 1998

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**Automobile Engineering, VIII-Semester**

**Open Elective AU803 (B) - Electrical Vehicle Systems**

**UNIT -1** Review of Conventional Vehicle: Introduction to Hybrid Electric Vehicles: Types of EVs, Hybrid Electric Drive-train, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains,

**UNIT-2** Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains, Electric Propulsion unit, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, switched reluctance motor.

**UNIT-3** Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles:- Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices.

**UNIT-4** Sizing the drive system, Design of Hybrid Electric Vehicle and Plug-in Electric Vehicle, Energy Management Strategies, Automotive networking and communication, EV and EV charging standards, V2G, G2V, V2B, V2H. Business: E-mobility business, electrification challenges

**UNIT -5** Business- E-mobility business, electrification challenges, Connected Mobility and Autonomous Mobility- case study E-mobility Indian Roadmap Perspective. Policy: EVs in infrastructure system, integration of EVs in smart grid, social dimensions of EVs. Simulations and case studies in above mentioned areas.

**Text & Reference Books:**

1. Emadi, A. (Ed.), Miller, J., Ehsani, M., "Vehicular Electric Power Systems" Boca Raton, CRC Press, 2003.
2. Husain, I. "Electric and Hybrid Vehicles" Boca Raton, CRC Press, 2010.
3. Larminie, James, and John Lowry, "Electric Vehicle Technology Explained" John Wiley and Sons, 2012.
4. Tariq Muneer and Irene Illescas García, "The automobile, In Electric Vehicles: Prospects and Challenges", Elsevier, 2017.
5. Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Springer, 2013.



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**Open Elective AU803 (C) - Battery Management Systems**

**UNIT-1** Batteries: Lead Acid Battery, Nickel based batteries, Sodium based batteries, Lithium based batteries – Li-ion & Li-poly, Metal Air Battery, Zinc Chloride battery; Ultra capacitors; Flywheel Energy Storage System; Hydraulic Energy Storage System; Comparison of different Energy Storage System  
Suggested reading: Study of different types of batteries

**UNIT -2 BATTERY CHARACTERISTICS & PARAMETERS-** Cells and Batteries- conversion of chemical energy to electrical energy- Battery Specifications: Variables to characterize battery operating conditions and Specifications to characterize battery nominal and maximum characteristics; Efficiency of batteries; Electrical parameters Heat generation- Battery design Performance criteria for Electric vehicles batteries- Vehicle propulsion factors- Power and energy requirements of batteries- Meeting battery performance criteria- setting new targets for battery performance.

**UNIT-3 BATTERY MODELLING-** General approach to modelling batteries, simulation model of a rechargeable Li-ion battery, simulation model of a rechargeable NiCd battery, Parameterization of the NiCd battery model, Simulation examples.

**UNIT-4 BATTERY PACK AND BATTERY MANAGEMENT SYSTEM-** Selection of battery for EVs & HEVs, Traction Battery Pack design, Requirement of Battery Monitoring, Battery State of Charge Estimation methods, Battery Cell equalization problem, thermal control, protection interface, SOC Estimation, Energy & Power estimation, Battery thermal management system, Battery Management System: Definition, Parts: Power Module, Battery, DC/DC Converter, load, communication channel, Battery Pack Safety, Battery Standards & Tests.

**UNIT-5 BATTERY TESTING, DISPOSAL & RECYCLING-** Chemical & structure material properties for cell safety and battery design, battery testing, limitations for transport and storage of cells and batteries , Recycling, disposal and second use of batteries. Battery Leakage: gas generation in batteries, leakage path, leakage rates. Ruptures: Mechanical stress and pressure tolerance of cells, safety vents, Explosions: Causes of battery explosions, explosive process, Thermal Runway: High discharge rates, Short circuits, charging and discharging. Environment and Human Health impact assessments of batteries, General recycling issues and drivers, methods of recycling of EV batteries.

## **References-**

- 1 .Guangjin Zhao, “Reuse and Recycling of Lithium-Ion Power Batteries”, John Wiley & Sons. 2017. (ISBN: 978-1-1193-2185-9)
- 2 Arno Kwade, Jan Diekmann, “Recycling of Lithium-Ion Batteries: The LithoRec Way”, Springer, 2018. (ISBN: 978-3-319-70571-2)
- 3 Ibrahim Dinçer, Halil S. Hamut and Nader Javani, “Thermal Management of Electric Vehicle Battery Systems”, JohnWiley& Sons Ltd., 2016.
- 4 Chris Mi, Abul Masrur& David Wenzhong Gao, “Hybrid electric Vehicle- Principles & Applications with Practical Properties”, Wiley, 2011.
- 5 G. Pistoia, J.P. Wiaux, S.P. Wolsky, “Used Battery Collection and Recycling”, Elsevier, 2001. (ISBN: 0-444-50562-8)”