# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
## SCHEME OF TEACHING AND EXAMINATION - 2014
### M.TECH. AUTOMOTIVE ENGINEERING (MAU)
#### I Semester

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Name of the Subject</th>
<th>Teaching hours / week</th>
<th>Marks for</th>
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<td>Lecture</td>
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<td>Applied Mathematics</td>
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<td>14MAU12</td>
<td>Finite Element Method</td>
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### Elective - I

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<td>Automotive Materials</td>
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<td>14MAU152</td>
<td>Automotive Air-conditioning</td>
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<td>14MAU153</td>
<td>Advanced Theory of Vibrations</td>
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<td>14MAU154</td>
<td>Theory of Elasticity</td>
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### VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
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### M.TECH. AUTOMOTIVE ENGINEERING (MAU)

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**Total:** 20 19 15 300 550 850 23

**Between the II Semester and III Semester, after availing a vacation of 2 weeks.

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<td>14MAU252</td>
<td>Multi Body Dynamics</td>
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<tr>
<td>14MAU253</td>
<td>Automotive Control System</td>
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<td>14MAU254</td>
<td>Automotive Embedded System</td>
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### VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
### SCHEME OF TEACHING AND EXAMINATION
### M.TECH. AUTOMOTIVE ENGINEERING (MAU)

#### III SEMESTER : INTERNSHIP

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**ELECTIVE-III**

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<tr>
<td>14MAU 421</td>
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<tr>
<td>14MAU 422</td>
<td>Alternate Energy Sources for Automobiles</td>
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<td>14MAU 423</td>
<td>Automotive Simulation</td>
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<td>14MAU424</td>
<td>Hybrid Technology.</td>
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Grand Total (I to IV Sem.) : 2400 Marks; 94 Credits
NOTE

1) Project Phase – I: 6 weeks duration shall be carried out between II and III Semesters. Candidates in consultation with the guides shall carryout literature survey / visit to Industries to finalize the topic of dissertation.

2) Project Phase – II: 16 weeks duration. 3 days for project work in a week during III Semester. Evaluation shall be taken during the first two weeks of the IV Semester. Total Marks shall be 25.


Marks of Evaluation of Project: I.A. Marks of Project Phase – II & III shall be sent to the University along with Project Work report at the end of the Semester. During the final viva, students have to submit all the reports.

4) The Project Valuation and Viva-Voce will be conducted by a committee consisting of the following:
   a) Head of the Department (Chairman)
   b) (b) Guide
   c) Two Examiners appointed by the university, (out of two external examiners at least one should be present).
APPLIED MATHEMATICS

Sub Code : 14MAU11
IA Marks : 50
Hrs/ Week : 04
Total Hrs. : 50
IA Marks : 50
Exam Hours : 03
Exam Marks : 100

Course Objectives:
The main objectives of the course are to enhance the knowledge of various methods in finding the roots of an algebraic, transcendental or simultaneous system of equations and also to evaluate integrals numerically and differentiation of complex functions with a greater accuracy. These concepts occur frequently in their subjects like finite element method and other design application oriented subjects.


Text Books:

Reference Books:
Course Outcomes:
The Student will be able to
1) Model some simple mathematical models of physical Applications.
2) Find the roots of polynomials in Science and Engineering problems.
3) Differentiate and integrate a function for a given set of tabulated data, for
4) Engineering Applications
Course Objectives

1) To present the Finite element method (FEM) as a numerical method for engineering analysis of continua and structures.

2) To present Finite element formulation using variational and weighted residual approaches.

3) To present Finite elements for the analysis of bars & trusses, beams & frames, plane stress & plane strain problems and 3-D solids, for thermal and dynamics problems and Usage of FEA software.

1. **Introduction to Finite Element Method:** Basic Steps in Finite Element Method to solve mechanical engineering (Solid, Fluid and Heat Transfer) problems: Functional approach and Galerkin approach, Displacement Approach: Admissible Functions, Convergence Criteria: Conforming and Non Conforming elements, C0, C1 and Cn Continuity Elements. Basic Equations, Element Characteristic Equations, Assembly Procedure, Boundary and Constraint Conditions. 10 Hours.

2. **Solid Mechanics : One-Dimensional Finite Element Formulations and Analysis** – Bars- uniform, varying and stepped cross section- Basic(Linear) and Higher Order Elements Formulations for Axial, Torsional and Temperature Loads with problems. Beams- Basic (Linear) Element Formulation-for uniform, varying and stepped cross section- for different loading and boundary conditions with problems. Trusses, Plane Frames and Space Frame Basic(Linear) Elements Formulations for different boundary condition - Axial, Bending, Torsional, and Temperature Loads with problems. 9 Hours.

3. **Two Dimensional Finite Element Formulations for Solid Mechanics Problems:** Triangular Membrane (TRIA 3, TRIA 6, TRIA 10) Element, Four-Noded Quadrilateral Membrane (QUAD 4, QUAD 8) Element Formulations for in-plane loading with sample problems. Triangular and Quadrilateral Axi-symmetric basic and higher order Elements formulation for axi-symmetric loading only with sample problems. 9 Hours.

4. **Three Dimensional Finite Element Formulations for Solid Mechanics Problems:** Finite Element Formulation of Tetrahedral Element (TET 4, TET 10), Hexahedral Element (HEXA 8, HEXA 20), for different loading conditions. Serendipity and Lagrange family Elements 9 hours.


**Dynamic Analysis:** Finite Element Formulation for point/lumped mass and distributed masses system. Finite Element Formulation of one dimensional dynamic analysis: bar, truss, frame and beam element. Finite Element Formulation of Two dimensional dynamic analysis: triangular membrane and quadrilateral membrane. Evaluation of eigen values and eigen vectors applicable to bars, shaft, beams, plane and space frame.

**Simulation of case studies of Automotive components by using Commercial FE Software such as MSC Nastran / MSC Patran and etc.** 12 Hours.
**Text Books:**

**Reference Books:**

**Course Outcome:**

On completion of the course the student will be

1) Knowledgeable about the FEM as a numerical method for the solution of solid mechanics, structural mechanics and thermal problems

2) The skills required to use a commercial FEA software should be acquired in the accompanying laboratory course using tools such as MSC/PATRAN, MSC/Nastran and etc..
# Automotive Engines and Auxiliary Systems

**Course Objective:**
The main objective of this course is to impart knowledge in automotive engines and its auxiliary systems. The detailed concept, construction, and principle of operation of engine and various engine components, combustion, subsystems of engines, and recent developments will be imparted to the students.

1. **Introduction and Engine Performance Testing:** Definition of a heat engine; external and internal combustion engine; basic engine components and nomenclature; working principles of engines; classification of IC engines; application of IC engines; engine performance parameters; Morse Test - Numerical Problems in Engine Testing, Engine Performance Mapping

2. **Fuel Supply Systems**
   - **SI Engine:** Carburettor principal, Properties of air-petrol mixtures, Mixture requirements for steady state and transient operation, design of elementary carburettor, Chokes, Effects of altitude on carburetion, Carburettor for 2-stroke and 4-stroke engines, carburettor systems for emission control. Gasoline Fuel Injection, Numerical Problems in simple carburettor design
   - **CI Engine:** Fuel injection pump principle, Types, constructional features and operation, Factors influencing fuel spray atomization, penetration and dispersion of diesel, Inline Fuel Injection Pumps, Filters, Governors – Types of Governors, fuel feed pumps and Types, injectors and nozzles – types, functions and necessities, injection lag, pressure waves in fuel lines.

3. **Combustion in SI engines:** Essential features of ignition timing and ignition voltage, MBT timing, knock detection and control strategies, thermodynamic analysis of SI engine combustion, analysis of cylinder pressure data.
   - **Combustion in CI engines:** Essential features of injection timing and delay period, correlations for ignition delay in engines, effect of fuel properties, types of combustion chambers and merits of the different types, analysis of cylinder pressure data, fuel spray behavior.

4. **Cooling and Lubrication System:**
   - **Cooling System:** Necessity, variation of gas temperature, Areas oh heat flow, heat transfer, piston and cylinder temperature, Heat rejected to coolant, quantity of water required, cooling system, air cooling, water cooling, thermodynamics of forced circulation, thermostats, pressurized water cooling, regenerative cooling, comparison of air and water cooling, radiators types, cooling fan – power requirement, antifreeze solution
   - **Lubrication System:** Lubricants, lubricating systems, Lubrication of piston rings, bearings, oil consumption, Oil cooling. Heat transfer coefficients, liquid and air cooled engines, coolants, additives and lubricity improvers, oil filters, pumps, and crankcase ventilation – types


**TEXT BOOKS:**
2. Introduction to Internal Combustion Engines - Dr. KK Ramalingam, Scitech Publications, 2004

**REFERENCE BOOKS:**
1. Tom Denton, "Automotive Electrical and Electronics", SAE, 2000
Course Outcome: At the end of the course students will have the understanding of automotive engines and working principles and the recent development in the automotive engines.
VEHICLE DYNAMICS

Sub Code : 14MAU14
IA Marks : 50
Hrs/ Week : 04
Exam Hours : 03
Total Hrs. : 50
Exam Marks : 100

Course Objective: To understand basics and Vehicle Dynamics and its influence on the vehicle handling characteristics

1. BASICS OF VIBRATION
   10 Hours

2. TYRES
   Braking Performance: Basic equations, Braking forces, Brakes, Brake Proportioning, Anti-lock Brake system, Braking efficiency, Rear wheel lockup, Standards and Legislations, Numerical Examples.
   10 Hours

   10 Hours

4. Steady State Handling Characteristics of Road Vehicles
   Performance Characteristics of Off-Road Vehicles: Drawbar Performance - Drawbar Pull and Drawbar Power, Tractive Efficiency, Coefficient of Traction, Weight-to-Power Ratio for Off-Road Vehicles; Fuel Economy of Cross-country Operations, Transport Productivity and Transport Efficiency, Mobility Map and Mobility Profile, Selection of Vehicle Configurations for Off-Road, Numerical Problems
   12 Hours

5. Suspension Mechanisms: Solid Axle Suspension, Independent Suspension, Roll Center and Roll Axis, Car Tire Relative Angles, Toe, Caster Angle, Camber, Trust Angle, Suspension Requirements and Coordinate Frames, Kinematics Requirements, Dynamic Requirements, Wheel, wheel body, and tyre Coordinate Frames, Caster Theory, Numerical examples
   8 Hours

TEXT BOOKS:

REFERENCE BOOKS:
1. "Tyre and Vehicle Dynamics" - Hans B Pacejka, SAE
3. Aerodynamics of Road Vehicles, Hucho W. H. SAE.
Course Outcome: Students get the better understanding of vehicle dynamics and able to implement the concepts in real time applications of automotive vehicle design.
AUTOMOTIVE MATERIALS

Course Objective: To understand the various materials used for automotive components and system

1. Aluminium Alloys & Lightweight Magnesium for Automotive Applications: Introduction; Wrought Aluminum alloys; Cast aluminum processes Technologies; Cast aluminum metallurgy and properties; New Lightweight alloys; Process technologies; mechanical and physical properties; Case studies of applications.

   Testing Automotive Materials: Evaluation of materials under realistic loading and environmental conditions; different test methods for evaluation of properties for specific applications.

   10 Hours

2. Composite Materials for Automotive Applications: Definition, Classification, Types of matrices & reinforcements, characteristics & selection, Fiber composites, laminated composites, particulate composites, prepeg, sandwich construction.

   Manufacturing Composite Materials: Lay up and curing – open and closed mould processing – Hand lay-up techniques – Bag moulding and filament winding. Pultrusion, pulforming, Thermoforming, Injection moulding, Cutting, Machining and joining, tooling, Quality assurance – Introduction, material qualification, types of defects, NDT methods.

   12 Hours


   8 Hours


   Macro mechanics of a lamina: Hooke’s law for different types of materials, number of elastic constants; Two – dimensional relationship of compliance & stiffness matrix. Hooke’s law for two dimensional angle lamina, engineering constants – angle lamina, Invariants, Theories of failure.

   12 Hours

5. Macro Mechanics of Laminates: Laminates Coding, ABD Matrices, Classical Laminates Theory, Special cases of Laminates, Strength Theories of Laminates.

   8 Hours

REFERENCE BOOKS:


Course Outcome: At the end, Students will be able to make the decision of material selection based on various parameters. Also able to identify the process need to be followed for the production of components.
1. **Introduction:** Definition of air conditioning, historical notes on automotive air conditioning; Thermodynamics of air water vapour mixture; Moist air Properties & Conditioning Processes; Moist air and the standard atmosphere; fundamental parameters; adiabatic saturation; wet bulb temperature; the Psychrometric Chart; Classic moist air processes; Space Air Conditioning – design conditions and off-design conditions

2. **Air-Conditioning Fundamentals:** The basic theory of cooling; vapour compression refrigeration; Alternative cycles; The air conditioning systems; the expansion valve system; the fixed orifice valve system; Variable Orifice System, dual air-conditioning, Heating – Heater Matrix, Heating Requirements, Screen Heater, seat heater

3. **Air Conditioning Components:** The compressor; The condenser; receiver-drier/accumulator; the expansion valve/ fixed orifice valve; the evaporator; Anti-frosting devices; Basic control switches

4. **Air conditioning electrical and electronic control:** Electrical principles; Sensors and actuators; testing sensors and actuators; Oscilloscope wave form sampling; Multiplex wiring systems; OBD and EOBD; wiring diagrams.

5. **Diagnostics and Troubleshooting:** Initial vehicle inspection; temperature measurements; pressure gauge readings and cycle testing; A/C system leak testing; sight glass, Service and Repair: Servicing precautions; refrigerant recovery, recycle and charging; system oil and system flushing; odor removal; retrofitting; adjustment of compressor components; fixed orifice valve replacement

   - **The environment:** Global warming; ozone layer.

**TEXT BOOKS:**

1. “**Automotive Air Conditioning and Climate Control Systems**". Steven Daly, Elsevier, 2007.
2. “**Automotive Heating & Air Conditioning**", Mark Schubel, Thomson Delmar Learning, 3rd edition, NY.

**REFERENCE BOOKS:**

2. “**Automotive Air Conditioning**”-Paul Lung, C.B.S. Publisher & Distributor, Delhi.

**Course Outcome:**

At the end, Students will have the better understanding of HVAC equipments and process to be followed the design of HVAC system in vehicles.
Course Objective:
To teach students about theoretical principles of vibration, and vibration analysis techniques, for the practical solution of vibration problems. The course thus builds on student’s prior knowledge of vibration theory, and concentrates on the applications. Thus the student will fully understand the importance of vibrations in mechanical design of machine parts that operate in vibratory conditions.

1) Review of Mechanical Vibrations: Basic concepts; free vibration of single degree of freedom systems with and without damping, forced vibration of single DOF-systems, Natural frequency. Transient Vibration of single Degree-of freedom systems: Impulse excitation, Arbitrary excitation, Laplace transform formulation, Pulse excitation and rise time, Shock response spectrum, Shock isolation. 12 hours


4) Random Vibrations : Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms, FTs and response. 8 hours

5) Continuous Systems: Vibrating string, longitudinal vibration of rods, Torsional vibration of rods, Euler equation for beams. 6 hours

Text Books
1) Theory of Vibration with Application, - William T. Thomson, Marie Dillon Dahleh, Chandramouli Padmanabhan, 5th edition Pearson Education

Reference Books
2) C Sujatha , “Vibrations and Acoustics – Measurements and signal analysis”, Tata
Course Outcome:
A student who has met the objectives of the course will be able to solve major and realistic vibration problems in mechanical engineering design that involves application of most of the course syllabus.
THEORY OF ELASTICITY

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Course Objective: Students will master concepts of stress and strain tensors, know how to formulate a well posed elasticity problem, and learn several methods for its solution.

1. Introduction: Definition and Notation for forces and stresses. Components of stresses, equations of Equilibrium, Specification of stress at a point. Principal stresses and Mohr's diagram in three dimensions. Boundary conditions. Stress components on an arbitrary plane, Stress invariants, Octahedral stresses, Decomposition of state of stress, Stress transformation. 8 Hours
3. Two Dimensional Problems in Cartesian Co-Ordinates: Airy's stress function, investigation for simple beam problems. Bending of a narrow cantilever beam under end load, simply supported beam with uniform load, Use of Fourier series to solve two dimensional problems. Two Dimensional Problems in Polar Co-Ordinates: General equations, stress distribution symmetrical about an axis. Pure bending of curved bar, Strain components in polar co-ordinates, Rotating disk and cylinder, Concentrated force on semi-infinite plane, Stress concentration around a circular hole in an infinite plate. 14 Hours
5. Elastic Stability: Axial compression of prismatic bars, Elastic stability. Buckling load for column with constant cross section. 6 Hours

TEXT BOOKS:

REFERENCE BOOKS:
5. C. T. Wang."Applied Elasticity"

Course outcome:
1. Become proficient with indicial notation and master manipulation of Cartesian vector and tensor equations.
2. Understand basic tensorial strain and stress measures.
3. Know how to formulate a well posed elasticity boundary value problem.
4. Learn several methods to solve elasticity boundary value problems, including some or all of the following: superposition, Green's functions, separation of variables, transform methods, dimensional analysis, complex variable methods, integral equations, variational methods.
Automotive Engineering Lab -I

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Total Hrs: 50

Note:
1) These are independent laboratory exercises
2) A student may be given one problem (1 to 4) and one more experiment from 5 to 7
3) Student must submit a comprehensive report on the problem solved and give a Presentation on the same.
4) For Numerical Simulation FEA softwares must be used such as MSC Patran/MSC Nastran and etc...

List of Experiments

1. Linear Static (Stress) Analysis of Automotive Engine Components such as Connecting Rod, Piston, Cylinder wall, Crank Shaft using FEA software Such as MSC Patran / MSC Nastran and etc.
2. Modal Analysis of Automotive Engine Components using FEA software
3. Dynamics Analysis of Automotive Engine Components using FEA Software
4. Heat Transfer Analysis of Automotive Engine Components using FEA Software
5. Random Vibration analysis
6. Testing of Single Cylinder, Twin Cylinder and multi cylinder SI/CI engines for performance, Calculate BP, Thermal, volumetric efficiencies, and BSFC with emission testing
7. Conduct Morse test for finding FP, IP, Indicated thermal efficiency and Mechanical efficiency and tuning the engine parameters
8. Performance test on computerized IC engine test rig using conventional fuels and Alternate Fuels.
9. Study and tuning of CRDI engine
10. Performance test on Variable Compression Ratio
II Semester

AUTOMOTIVE ELECTRICAL AND ELECTRONICS SYSTEMS

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Course Objective: The student will have to know about all theoretical information and about electrical components used in a vehicle.

1. Storage Battery:
   - Principle of lead acid cells, plates and their characteristics containers and separators, electrolyte and their preparation, effect of temperature on electrolyte, its specific gravity, capacity and efficiency, methods of charging from D.C. mains, defects and remedies of batteries, care of idle and new batteries. Recycling Process - Recent development in batteries 8 Hours

2. Charging and Lighting System
   - D.C. Generators and Alternators their Characteristics. Control cutout, Electrical, Electro-mechanical and electronic regulators. Regulations for charging. Wiring Requirements, Insulated and earth return system, details of head light and side light, LED lighting system, head light dazzling and preventive methods. Static and Dynamic Bending lights. Starter Motor & Drives:
   - Battery motor starting system, condition at starting, behaviour of starter during starting series motor and its characteristics, consideration affecting size of motor, types of drives, starting circuit 12 Hours

3. Ignition systems and Engine Management Systems:
   - Ignition fundamentals, Types of solid state ignition systems, components, construction And operating parameters, high energy ignition distributors, Electronic spark timing, Ignition Advance, Types DIS, MBT and control. Combined ignition and fuel management systems. Exhaust emission control, Digital control techniques – Dwell angle calculation, Ignition timing calculation and Injection duration calculation. Complete vehicle control systems, Artificial intelligence and engine management 12 Hours

4. Chassis Electrical systems:
   - Antilock brakes (ABS), Types , Active suspension, Traction control, Electronic control of automatic transmission, other chassis electrical systems, Central locking, Air bags and seat belt tensioners. Microprocessor And Microcomputer controlled devices in automobiles such as instrument cluster, Voice warning system, Travel information system, GPS, AUTO COP, Keyless entry system 8 Hours

5. Electronic Accessories:
   - Warning and alarm instruments : Brake actuation warning system, traficators, flash system, oil pressure warning system, engine over heat warning system, air pressure warning system, speed warning system, door lock indicators, neutral gear indicator, horn design, permanent magnet horn, air & music horns. Wind shield wiper, window washer, instrument wiring system and electromagnetic interference suppression, wiring circuits for instruments, electronic instruments, dash board illumination and MIL. 10 Hours

REFERENCE BOOKS:
1. Tom Denton “Automotive Electrical and Electronics ”- SAE , 2000
5. Bosch, Automotive Hand Book, SAE , 8th Edn
11. Internet search

Course Outcome:
Students will get the knowledge and details of various Automotive Electrical and Electronic Systems like Batteries, Starting System, Charging System, Ignition System, Lighting System, and Dash – Board Instruments, Electronic ignition system, various sensors and the role of ECU.
BODY AND CHASSIS ENGINEERING

Course Objective: The main objective of this course is to impart knowledge in the construction of vehicle, aerodynamic, concept, paneling of passenger car body trim. At the end of the course the student will be well versed in the design and construction of external body of the vehicles

1. Car Body Details: Types of car bodies, visibility, regulations, driver’s visibility, methods of improving visibility, safety design, constructional details of roof, under floor, bonnet, boot, wings etc, Classification of coach work

   Bus Body Details: Types: Mini bus, single Decker, double Decker, two level, split level and articulated bus - Bus body lay out – Floor height - Engine location - Entrance and exit location - Seating dimensions - Constructional details: Frame construction, Double skin construction- types of metal section used - Regulations - Conventional and integral type of construction.

   12 Hours

2. Commercial Vehicle Details: Types of body – Flat platform, drop side, fixed side, tipper body, tanker body, Light commercial vehicle body types, Dimensions of driver’s seat relation to controls - Drivers cab design

   8 Hours


   8 Hours


   Design of Vehicle Bodies: Vehicle Layout design, preliminary design, safety, Load distribution on vehicle structure, Calculation of loading cases, stress analysis of bus body structure under bending and torsion, stress analysis in integral bus body, Design of chassis frame, Rules and regulations for body, Recent safety measures, Testing of body.

   12 Hours


   10 Hours

TEXT BOOK:


REFERENCE BOOKS:

1. The Automotive Chassis : Engineering Principles – Reimpell J.

Course Outcome:

At the end of the course

i) Different body layouts, Materials used in body constructions like Composite materials, GRP, FRP Etc.

ii) Importance of Aerodynamics and Aesthetics for the exteriors and interiors of the vehicle.

iii) Importance of Vehicle ergonomics to provide at most comfortable positions for driver and passengers.

iv) Aerodynamics and Aesthetics for the exteriors and interiors of the vehicle.

v) Structural analysis, Load distribution, Types of vehicle body constructions, Body system mechanisms
AUTOMOTIVE POWERTRAINS

Course Objective: The main objective of this course is to impart knowledge in automotive transmission. The detailed concept, construction and principle of operation of various types of mechanical transmission components, hydrodynamic devices, hydrostatic devises and automatic transmission system will be taught to the students. The design of clutch and gearbox will also be introduce to the students


Matching engine and transmission: Road loads and axle loads, Deriving condition diagram, Ideal transmission and engine-transmissions matching, Total ratio and overall gear ratio- Selecting the largest power- train ratio, Selecting the smallest power- train ratio, Selecting the intermediate gears- saw tooth profile, Geometrical gear steps, Progressive gear steps, Numerical problems.


Gear shifting mechanisms, Layout and design of Synchronizers: Internal shifting mechanisms and External shifting mechanisms, Classification of shifting elements, synchronizer functional requirements, synchronizing process, design of synchronizers, alternative transmission synchronizers


Design of other Transmission elements: Design of slip joint, universal joint, dead & live axle, constant velocity joints, Bearing Design, Selection of ball and roller bearing, Gear box housing design.

REFERENCE BOOKS:

Course Outcome: At the end of the course the students will have command over manual and automotive transmission concepts and application.

NOISE, VIBRATION AND HARSHNESS

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Course Objective:
1. To understand the basic principles of the design aspects for NVH in cars.
2. To know the most dominant sources of noise and vibration in cars, the dominant transmission paths including their relative importance at different driving conditions.
3. To understand the critical design issues and their relations for NVH, in particular the aspects of objective and subjective design.

1. Fundamentals of sound:
   - Definition of NVH, Vehicle noise - Direct sound generation mechanism: airborne sound; Indirect sound generation mechanism: structure borne sound; Subjective response sound. Acoustic variables, basic attributes of sound such as wavelength, period, frequency, speed of sound. Decibel scale, Wave equation, types of sound fields. Measures of sound: Sound pressure, sound intensity and sound power. Combining sources: dB arithmetic, Standing wave, Beating. Impedance. Human hearing: frequency. Versus sound pressure level, Loudness: phones and sones as noise descriptors. Weighting networks, $L_{eq}$ and various noise metrics for road noises.
   - 8 Hours

2. Noise measurements and instrumentation:
   - Measuring microphones, Sound level meter, time and frequency weighting. Sound spectra – Octave band analysis, Order analysis and waterfall plot. Various types of acoustic testing chambers. Sound power measurement from Sound pressure: Free field method, Reverberant field method, Semi-Reverberant field method and Comparison method (using calibrated Sources). Two- microphone probe for measuring; Sound power measurement from Sound Intensity.
   - 8 Hours

3. Sound fields and Room Acoustics:
   - Characterizing sound sources; Directivity; Sound Fields; Various approaches to modeling sound sources; Transmission loss (TL) and Insertion loss (IL); Reverberation time and Acoustic Absorption Coefficient; Effects of leaks on barrier and TL of composite barriers; measurement Absorption Coefficient and Transmission loss (TL).
   - Vehicle Interior and Exterior noise:
     - Internal noise sources in vehicles such as engine noise; road noise; aerodynamic (wind) noise; brake noise; squeak, rattle and tizz noises; sound package solution to reduce the interior noise: acoustic isolation, acoustic absorption and damping material solutions; Exterior noise sources in vehicles such as air intake systems and exhaust systems; Tyre noise.
   - 12 Hours

4. Sources of Vehicle vibration:
   - Power train and Engine vibrations; driveline vibrations; chassis and suspension vibrations; Control strategies; Human response to vehicle vibrations, concept of harshness; subjective and objective evaluation of vehicle harshness.
   - Vibration Isolation and Control:
     - Introduction; damping of vibrations; vibration isolation and absorption; design of a Vibration Absorbers, unconstrained and constrained layer damping treatment, add on dampers and stiffeners, Introduction to Active Vibration Control.
   - 12 Hours

5. Vibration Measurement and Instrumentation:
   - Definition of Modal Properties, Modal analysis theory, FE & Experimental modal analysis, Transducers and accelerometers Excitation sources Impact Excitation, Shaker excitation, Excitation signals, applications of Modal Analysis, laser based vibration measurements; analysis and presentation of vibration data.
   - 10 Hours

REFERENCE BOOKS:
Course Outcome: At the end of the course, student will have

i) An overview of state-of-the art in Computer Aided engineering applied to NVH together with examples of NVH issues treated by CAE and to understand the limitations of the models used.

ii) A basic understanding of the difference between objective and subjective (human response) design criteria and how they influence the design process.

iii) An overview of modern design solutions in NVH, the materials used and their principle function, together with the current trends in the development of new solutions.
MANUFACTURING TECHNIQUES IN AUTOMOTIVE ENGINEERING

Course Objective: Students will gain a basic understanding of manufacturing systems management, including work organization, work measurement, basic scheduling mechanisms, and current theories of manufacturing management, and different process of manufacturing techniques being used in Automotive Industry

1. **Sheet Metal Forming:** Introduction, Forming methods, shearing and Blanking, Bending, stretch forming, Deep drawing, redrawning operations, Defects in formed products.


3. **Forging:** Classification, various stages during forging, Forging equipment, brief description, deformation in compression, forging defects. Residual stresses in forging.


7. **Joining of Plastics:** Heated tool welding or hot bar welding, Hot gas welding or pendulum welding, High frequency welding, Ultrasonic welding, Friction welding, Induction welding.

REFERENCE BOOKS:
2. ASM Handbook on Powder Metallurgy, Volume 17, ASM publications
3. AWS Hand Book on welding
4. Welding Technology by O.P. Khanna
5. Welding for Engineers by Udin, funk & Wulf

Course Outcome:
1. Students will recognize manufacturing organizations, including job shops, flow lines, assembly lines, work cells.
2. Students will have a basic understanding of different manufacturing process of automotive components
MULTI BODY DYNAMICS

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Course Objective: To know different dynamics of Automotive system and basics behind the multi body dynamics.


2. Conservative and non-conservative force and torque elements. Spring, damper, bushing, force elements with inner dynamics. Constraint forces. Impacts. The problem with play and dry friction


4. Structure and functionality of multi-body codes. Kinematics equilibrium points (static), dynamics, inverse dynamics.

5. Linearization, modal analysis, and optimization. Usage of Software such as MSC ADAMS for multi body dynamics simulation for automotive system.

TEXT BOOKS:


REFERENCE BOOKS:

7. *MSC ADAMS user Manual*

Course Outcome: At the end of the course, student will know about rigid body dynamics and simulation of multi body dynamics using software tools. Also able to compute the forces acting on bodies numerically and correlate with the simulation results.
AUTOMOTIVE CONTROL SYSTEM

Sub Code: 14MAU253
IA Marks: 50
Hrs/ Week: 04
Exam Hours: 03
Total Hrs.: 52
Exam Marks: 100

Course Objective: To understand the basics and different types of control system required for the Automotive vehicle for improvement of performance of vehicle

1. Chassis and Drive Line Control
Components of chassis management system – role of various sensors and actuators pertaining to chassis system – construction – working principle of wheel speed sensor, steering position, tyre pressure, brake pressure, steering torque, fuel level, Engine and vehicle design data

Drive Line Control: Speed control – cylinder cut - off technology, Gear shifting control – Traction / braking control, brake by wire – Adaptive cruise control, throttle by wire. Steering - power steering, collapsible and tiltable steering column – steer by wire

2. Engine Management System:
Basic Engine Operations – Fuel Control, Ignition control, Lambda Control, Idle Speed Control, Knock Control , Open Loop and Closed Loop Control

Sensors: 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

3. Safety and Security Systems :
Airbags, seat belt tightening system, collision warning systems, child Lock, anti lock braking systems, Vision enhancement – Static and Dynamic bending of Head light, road recognition system, Anti theft technologies, smart card system, number plate coding, central locking system.

4. Comfort and Vehicle Control System:
Active suspension systems, requirement and characteristics, different types, Vehicle Handling and Ride characteristics of road vehicle, pitch, yaw, bounce control, power windows, adaptive noise control. ABS Control System – Torque Balance at Wheels road contact – Control cycle of ABS System – Advantages – Traction control system - Combination of ABS with Traction control system

5. Intelligent Transportation System:
Traffic routing system - Automated highway systems - Lane warning system – Driver Information System, driver assistance systems - Data communication within the car, Driver conditioning warning - Route Guidance and Navigation Systems – vision enhancement system - In-Vehicle Computing – Vehicle Diagnostics system. VANET usage in Automobiles

TEXT BOOKS:

REFERENCES:
4. Internet References.
Course Outcome:
At the end of the course students will have understanding of control system required for vehicles and basics of control system development. Also gets the knowledge of control system being used in automotive vehicle.
### Course Objective:
To know the basic of Automotive Embedded system concepts, application of Embedded system in automotive and usage software and hardware in Automotive Embedded System

   10 Hours

   10 Hours

3. **HARDWARE MODULES:** MC9S12XD family features -Modes of operation-functional block diagram overview-programming model. Memory Map Overview Pulse Width Modulator (PWM) –On-chip ADC- Serial Communication Protocol: SCI, SPI, IIC, CAN.  
   10 Hours

4. **Software Development Tools:** Introduction to HCS12XDT512 Student Learning Kit & PBMCU (Project Board) – Introduction to Code Warrior IDE-Editing-Debugging-Simulating simple programs. Flashing code into HCS12XDT512 SLK board and testing  
   10 Hours

5. **Integration of Software and Hardware:** Downloading the Software from Host Machine to Target Machine. Implementing application prototype: Power Window and Automotive Lighting System  
   10 Hours

### TEXT BOOKS
2. Freescale MC9S12XDP512 data sheet

### Course Outcome:
Student will have the understanding of embedded system concepts and how it is being used in automotive vehicles. Also they will have understanding of designing of Automotive Embedded system using software and hardware.
Automotive Engineering Lab - II

Sub Code : 14MAU26       IA Marks : 25
Hrs/ Week : 6              Exam Hours : 03
Total Hrs:50                Exam Marks : 50

Note:
1) These are independent laboratory exercises
2) A student may be given one or two problem
3) Student must submit a comprehensive report on the problem solved and give a Presentation on the same.
4) For Numerical Simulation, FEA softwares must be used such as MSC Patran/MSC Nastran and etc...
5) For Multi body Dynamics simulation, MSC Adams or equivalent software can be used

List of Experiments

1. Study of Suspension systems used in low, medium and Heavy vehicle
2. Simulation of Suspension system using commercial software for LCV and HCV
3. Study of Drive line systems and Simulation using Commercial MBD software
4. Stress Analysis of Chassis components using FE Software
5. Testing Two Wheeled Vehicles on Chassis Dynamometer
6. Study and practice of wheel alignment (computerized) and wheel balancing
7. Head light focusing test and visibility test
8. Simulation of Static and Dynamic head light bending
9. Study of MPFI and CRDI
IV SEMESTER
VEHICLE CRASHWORTHINESS AND OCCUPANT SAFETY

Sub Code : 14MAU41  IA Marks : 50
Hrs/ Week : 04  Exam Hours : 03
Total Hrs. : 50  Exam Marks : 100

Course Objective: To understand the vehicle crashworthiness and various occupant safety system being incorporated in the automotive vehicle.


2. Vehicle Collision Models: Impulsive models- central head on collision, oblique collision, collision against fixed obstacle, non-central head on collision, lateral collision, simplified approach. Second approximation models - head on collision against fixed obstacle, Head-on collision between vehicles, and oblique collision between vehicles, Motion after the Collision with locked wheels and free wheels.


REFERENCE BOOKS:

Course Outcome: At the end of the course will understand the requirements of crashworthiness and modeling, various techniques are being used in the safety of the occupants in automotive vehicle such as Air bags, seatbelt and ABS.
AUTOMOTIVE AIR POLLUTION AND CONTROL

Sub Code : 14MAU421  IA Marks : 50
Hrs/ Week : 04  Exam Hours : 03
Total Hrs. : 52  Exam Marks : 100

Course Objective:
The main objective of this course is to impart knowledge in automotive pollution control. The detailed concept of formation and control techniques of pollutants like UBHC, CO, NOx, particulate matter and smoke for both SI and CI engine will be taught to the students. The instruments for measurement of pollutants and emission standards will also be introduced to the students.

1. Laws and Regulations:
   Historical background, regulatory test procedure (European cycles), Exhaust gas pollutants (European road limits), particulate pollutants, European statutory values, inspection of vehicle in circulation (influence of actual traffic conditions and influence of vehicle maintenance)

   6 Hours

2. SOURCE OF EMISSION FROM AUTOMOBILES:

   10 Hours

3. EMISSION FROM AUTOMOTIVE ENGINES
   S.I. ENGINE EMISSIONS AND ITS CONTROL
   Emission formation in SI Engines- Carbon monoxide & Carbon di oxide - Unburned hydrocarbon, NOx, Smoke — Effects of design and operating variables on emission formation – controlling of pollutants - Catalytic converters, Charcoal Canister, CCS, Positive Crank case ventilation system, Secondary air injection, thermal reactor, Laser Assisted Combustion

   10 Hours

   EMISSION FROM C.I. ENGINE AND ITS CONTROL
   Formation of White, Blue, and Black Smokes, NOx, soot, sulphur particulate and Intermediate Compounds — Physical and Chemical delay — Significance Effect of Operating variables on Emission formation — Fumigation, Split injection, Add Blue, Catalytic Coating, EGR, HCCI, Particulate Traps, SCR

   12 Hours

   Effect of petrol, Diesel Fuel, Alternative Fuels and lubricants on emissions, Effect of air pollution on Human Health, Effect of air pollution on animals, Effect of air pollution on plants

   10 Hours

5. TEST PROCEDURES AND EMISSION MEASUREMENTS:
   Constant Volume Sampling I and 3 (CVS-1 &CVS3) Systems- Sampling Procedures — Chassis dyno - Seven mode and thirteen mode cycles for Emission Sampling — Sampling problems — Emission analysers —NDIR, FID, Chemiluminescent, Smoke meters, Dilution Tunnel, SHED Test, Sound level meters

   12 Hours

TEXTBOOKS:

REFERENCES
Course outcome: Students will have basic understanding the emission regulations and various techniques adopted for reduction of Pollution from Automobile
ALTERNATE ENERGY SOURCES FOR AUTOMOBILES

Course Objective: To know the several of sources of alternate fuels for automotive Engines and study the performance of engine using different fuels.

1. Introduction

2. Solar energy & Fuel Cell

   FUEL CELL:

3. Gaseous alternative fuels & Bio-Diesel
   Bio-Diesel: Straight vegetable oil, Biodiesel – Production of Bio-Diesel, Bio-Diesel as Fuel, Performance and emission of Bio-Diesel

4. Biomass energy and Reformulated Conventional Fuel
   Biogas or Biomethane. History, properties and production of Biogas, classification of biogas plants, biogas storage and dispensing system. Advantages of biogas, hazards and emissions of biogas
   Reformulated conventional fuels

5. Introduction to alternative power trains
   Components of an EV, EV batteries, chargers, drives, transmission and power devices. Advantages and disadvantages of EVs. Hybrid electric vehicles, HEV drive train components, advantages of HV. History of dual fuel technology. Applications of DFT. Dual fuel engine operation. Advantages and disadvantages of dual fuel technology.

TEXT BOOKS

REFERENCES
1. Alternative fuels for vehicle book by M.poulton
4. A Primer on Hybrid Electric vehicles

Course Outcome: At the end of the course, students will know the different fuels available for Automotive engines and also knows the influence various parameters affecting the performance and emission characteristics of engine using alternate fuels.
# AUTOMOTIVE SIMULATION

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**Course Objective:** To know the various numeric techniques being used in the Automotive system and sub system simulations.

1. **Principle Of Computer Modeling And Simulation:** Monte Carlo simulation, Nature of computer modeling and simulation, limitations of simulation, areas of application.
   - **System And Environment:** components of a system — discrete and continuous systems. Models of a system—a variety of modeling approaches.

   **10 Hours**

2. **Design And Evaluation Of Simulation Experiments:** Variance reduction techniques—antithetic variables—variables—verification and validation of simulation models.

   **8 Hours**


   **10 Hours**

4. **C.I. Engine Simulation:** Simulation of Diesel cycle and Diesel cycle at full throttle, part throttle and supercharged conditions. Progressive combustion, Exhaust and intake process analysis.

   **10 Hours**

5. **Simulation Exercises:** Case studies of Simulation for 2 stroke and 4 stroke engine. Simulation exercises using computers – MATLAB/SimuLink, Pro-E/ICEM, CFD Analysis, FE Analysis procedures, Advantages of FEA, Simple Exercise using MSC Nastran.
   - **Multi-body Simulation Exercises:** Simple Multi-body Suspension, Four Bar mechanisms, Handling Analysis Of simple Bogie using MSC Adams.

   **10 Hours**

**TEXT BOOKS:**

3. System Simulation with digital Computer, NARSINGH DEO, prentice Hall Of India, 1979

**REFERENCE BOOKS:**

3. MSC Nastran / Adams User Manual
4. MATLAB User manual

**Course Outcome:** At the end the course, students will have the knowledge of the various techniques used for simulation of Automotive Systems and able to do the simulation using suitable software such as MATLAB, MSC Nastran and Msc Adams
HYBRID TECHNOLOGY

Sub Code : 14MAU424  IA Marks : 50
Hrs/ Week : 04  Exam Hours : 03
Total Hrs. : 50  Exam Marks : 100

Course Objective: To understand the basics, working principles, types and Hybrid Vehicle and technology involved in Hybrid Vehicles

1. **Hybrid Vehicles:** Introduction to HVs, Performance characteristics of road vehicles; calculation of road load, predicting fuel economy, grid-connected hybrids.
   - **Hybrid architecture:** Series configuration- locomotive drives, series parallel switching, load tracking architecture. Pre transmission parallel and combined configurations-Mild hybrid, power assist, dual mode, power split, power split with shift, Continuously Variable transmission (CVT), wheel motors
   - 10 Hours

2. **Propulsion methods:** DC motors-series wound, shunt wound, compound wound and separately excited motors. AC motors-Induction, synchronous, brushless DC motor, switched reluctance motors.
   - 8 Hours

3. **Hybrid power plant specifications:** Grade and cruise targets, launching and boosting, braking and energy recuperation, drive cycle implications, engine fraction-engine downsizing and range and performance, usage requirements.
   - **Sizing the drive system:** Matching electric drive and ICE, sizing the propulsion motor, sizing power electronics.
   - 10 Hours

4. **Energy storage technology:** Battery basics; lead-acid battery, different types of batteries; battery parameters, Battery Recycling
   - **Fuel cells:** Fuel cell characteristics, fuel cell types – alkaline fuel cell, proton exchange Membrane; direct methanol fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, hydrogen storage systems, reformers, fuel cell EV, super and ultra capacitors
   - 12 Hours

5. **Non-electric Hybrid Propulsion Systems:** Short-Term Storage Systems- Flywheel Accumulators. Continuously Variable Transmissions Hydraulic Accumulators Hydraulic Pumps/Motors, Pneumatic Hybrid Engine Systems-Operation Modes.
   - 10 Hours

TEXT BOOKS:
2. Electric and Hybrid Vehicles, Robin Hardy, Iqbal Husain, CRC Press.

REFERENCE BOOKS:
2. Handbook of Electric Motors, Hamid A Toliyat, Gerald B Kliman, Marcel Decker Inc.

Course Outcome:
At the end of the course, students will understand
i) the working the hybrid vehicles,
ii) improvement of performance of HEVs,
iii) Concept of design of HEVs.
iv) Also knows the methodology to be adopted for selection of batteries and motors for HEVs.