FACULTY OF ENGINEERING

SYLLABUS FOR

M E Mechanical
Automotive Engineering

UNIVERSITY OF PUNE
# University of Pune

## Course Structure

### M.E. Mechanical (Automotive Engineering)

(Wef 2009-2010)

## SEMESTER I

<table>
<thead>
<tr>
<th>Code</th>
<th>Subject</th>
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### University of Pune

**Course Structure**

**M.E. Mechanical (Automotive Engineering)**

(Wef 2009-2010)

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#### SEMESTER– III

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**CODE**

**Elective – I**

- 502302 A Advanced Heat Transfer
- 502302 B Finite Element Method
- 502302 C Advanced Hydraulics and Pneumatic Systems

**CODE**

**Elective – II**

- 502303 A Tribology and Preventive Maintenance
- 502303 B Automotive Safety and Regulations
- 502303 C Automobile Air Conditioning

**CODE**

**Elective – III**

- 502309 A Noise Vibrations and Harshness
- 502309 B Automotive Materials
- 502309 C Vehicle Aerodynamics

**CODE**

**Elective – IV**

- 502310 A Computational Fluid Dynamics
- 502310 B Automotive Chassis Design
- 502310 C **Open Elective (self study)**

**Open elective subjects- BOS Mechanical Engineering will declare the List Of subjects which can be taken under open elective.**
# Mathematical Modeling and Analysis

(502201)

<table>
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## 1. Concept of State
System, Environment and Variables. The state of a system, mathematical models of continuous line linear lumped parameter time invariant systems, Discrete time systems, linear approximation of non-linear systems, Topological Models of system, Block diagram representation, signal flow graph, Mason's rule.

## 2. A Generalized Approach to Modeling
The principles of conservation and continuity. Physical laws. Mechanical systems, Electrical and Electro mechanical systems, Fluid systems, Thermal systems.

## 3. Modeling of Physical systems
The linear graph approach. Linear Graph Terminology, Formulation of system equations, systems with multi terminal components. Linear Graph Models: Skeletal structures, Mass transfer processes.

## 4. Input output approach
Discrete Signal Models, Discrete time-convolution, response of linear Discrete time systems, continuous (Analogue) signal models, continuous time convolution. Response of linear continuous time state equation - Discrete time systems, computation of state transition matrix by canonical Transformation, Computation of state transition matrix by technique based on Caley-Hamilton theorem, the solution of state equation-continuous time systems,

## 5. Numerical Analysis

## 6. The Laplace Transform:
Application of Laplace transforms to differential equations, stability in s domain. Linear system, Laplace transform analysis of causal periodic input to linear systems. Relationship of the ZTransform to the Fourier and Laplace transforms.

## 7. The Fourier Transform
Fourier spectra of power signals, Fourier transform of periodic functions - Fourier series, Fourier analysis of sampled signals, modulation, discrete Fourier transforms.

## 8. The Z Transform

## 9. Wavelet Transform
Multi resolution Analysis and construction of wavelets. Representation of functions by wavelets. The characterization of MRA wavelets.
10 Simulation:

Text Books

Reference Books
Technology and Financial Management
(502103)

Teaching Scheme:
Lecture: 3 hrs/week

Examination Scheme
Paper: 100 Marks
Credits: 03
Paper Duration: 3hrs

Finance:
- Functions
- Source of finance
- National & International finance
- Benefits & Limitations
- Budgets & Budgeting Control

Costing:
- Significance of engineers
- Traditional absorption costing
- Marginal costing
- Contract costing
- Activity based costing
- Process costing

Engineering Economic Analysis:
- Basic concepts & price theory
- Supply & Demand
- Consumer behavior
- Law of reducing returns
- Competition- types, equilibrium
- Inflation & unemployment
- Foreign trade
- Balance of payment

Quality Management:
- Fundamentals of TQM, Deming, Juran
- Kaizen
- JIT
- ISO 9000
- ISO 14000

Project Management:
- Project life cycle
- CPM
- PERT
- BOT
- Public Private Participation
HR Management:

- Difference between personnel management & HR management
- Role of HR Manager
- Manpower planning
- Merit rating
- Training & Development
- Retirement & Separation
- Organizational Development & Behaviour
- Management by objectives

Reference Books

1) S C Kuchal, Indian Economics
2) Prasad N K, Cost Accounting, Book Syndicate Pvt. Ltd., Kolkata 700 009
4) E Dessler, Human Resource Management
5) R S Dwivedi, Managing Human Resources
6) Chase Operations Management for Competitive Advantage
7) B S Sahay, World Class Manufacturing
8) Juran, Quality Control Handbook
9) K Ishikawa, Guide to Quality Control
Automotive Engine Design
(502301)

Teaching Scheme: Lecture: 3 hrs/week
Examination Scheme Paper: 100 Marks
Credits: 03
Paper Duration: 3hrs

Principles of design of thermal systems: Principle of similitude, Thermodynamic analysis of reciprocating engine cycles, Engine cycle processes, Heat balance, Engine performance characteristics,

General Engine Design: Selection of bore to stroke ratio, Cycle of operation, Speed, Number of cylinders and cylinder arrangements

Design of Principal Engine Components: Design of piston, piston ring, piston pin, connecting rod, crankshaft, flywheel

Design of Valve gear Train: Effect of valve timing on engine performance, Time selection of valve, Cam profile construction, Design of valve spring, Design of camshaft, Design of valve gear train for variable valve opening

Engine Vibrations and Balancing: Dynamics of crank mechanism, Inertia forces, Torsion vibrations, Vibration damping, Engine balancing, Firing order, Cylinder arrangements for balancing,

Design of Engine Systems: Design of cooling system, radiator, water pump and fan, Computation of air cooling system Design of fuel system for CI engine, Governor design, Design of carburetor, Design of direct cylinder and port injection system for SI engine, Design of intake and exhaust system Engine friction and wear, Selection of lubricant, lubricating system, pump and filters

Reference Books
2. Engine Design – Giles J. G., Lliffe Book Ltd.
3. Engine Design – Crouse, Tata McGraw Publication, Delhi
7. I. C. Engine – Heywood
8. SAE Handbooks
Advanced Heat Transfer
(502302 A)

Teaching Scheme:                        Examination
Lecture: 3 hrs/week                Paper: 100 Marks
Credits: 03                        
Paper Duration: 3hrs


2. **Transient Conduction:** Lumped capacitance and its validity, General lumped capacitance analysis, spatial effects. Problems related with conventional geometries.


4. **Convection**


5. **Boiling and Condensation**

6. **Thermal Radiation**

7. **Cooling of Electronic Equipment**
Introduction: Manufacturing, Chip carrier, PCB’s, the enclosure, Cooling load of electronic equipment, thermal environment, electronics cooling in different applications. Conduction cooling, conduction in chip carriers and PCB’s. Heat frames, Air cooling, Cooling of PC’s, Liquid cooling, Immersion cooling. Ablative, transpiration and high speed cooling

8. **Heat Exchanger**

**Reference books**

6. S.P. Sukhatme, Heat transfer, University Press
9. Heat and Mass Transfer - Prof. Sachdeva
Finite Element Methods
(502302B)

Teaching Scheme:
Lecture: 3 hrs/week
Examination
Paper: 100 Marks
Credits: 03
Paper Duration: 3hrs

Introduction, How FEM works, Brief history, Example case studies, Available solvers

General concepts of FEM, Procedures, Linear Spring element, Assembling spring elements, Element types, Structural, Assembling matrices, Global connectivity, Boundary conditions, Solution methods, Commercial FEA systems

A simple example in FEA, Geometry creation, Mesh generation, Solving and examining the results

Element types and their selection, Basic elements, Types of nodes, Degrees of freedom, Interpolation, Automatic mesh generation, Selection of parameters, Boundary conditions, Specifying loading

Plane stress/strain modeling techniques, Trusses, Definition and stiffness matrix, Verification of results, Some examples, 2D truss, 2D truss with different, two dimensional problems, Plane stress and plane strain, Axisymmetric Plates and shells,

Solving axial member problems, Beam stiffness matrix, Different loading conditions, Formulation using Algor, Verification of results, Frames, Plane frame, Space frame, Verification of results

Post processing, Stresses, Strains, Displacement, Animation, Plotting, Interfacing with CAD and 3D analysis, Modeling techniques, Solid elements, Element refinement, Formulation of problem, Interfacing with CAD systems, Examples with ProEngineer, Inventor

Reference Books

6. Nitin Gokhale, Deshpande-‘Practical Finite Element Analysis, Finite to Infinite Pune.’
Advanced Hydraulic and Pneumatic Systems

502302 C

Teaching Scheme: Examination
Lectures: 3 Hrs/Week
Marks
Credits: 03

Introduction to Hydraulics / Pneumatics

Source of Hydraulic / Pneumatic Power

Hydraulic / Pneumatic Actuators

Valves and Components in Hydraulic / Pneumatic systems

Hydraulic / Pneumatic Systems

Hydraulic / Pneumatic System Design and Analysis

Applications in automotives should be studied in detail. Design and analysis of any hydraulic / Pneumatic system in automotive application with selection of components from manufacturers’ catalogue.

Reference Books
1. H. L. Stewart – 'Hydraulic and Pneumatic Power for Production’
   Industrial Press
2. A. Esposito - 'Fluid Power with application', Prentice hall
6. B. Lall- ‘Oil Hydraulics', International Literature Association
8. Vickers Manual on Industrial Hydraulics
10. ISO - 1219, Fluid Systems and components, Graphic Symbols
12. Majumadar – ‘Pneumatic Systems’
   Arnold
INTRODUCTION
Introduction to Tribology, general tribological considerations in design of gears, cams, reciprocating components, Engine tribology basics – importance, tribological aspects of engine components such as bearing, piston assembly, valve train, transmission drive line-transmission, traction drive, universal and constant velocity joints, wheel bearings, drive chains, lubrication regimes in the engine

FRICTION AND WEAR
Nature of metal surface, surface properties, surface parameters and measurements, types, sliding friction, rolling friction, theories of friction, modified adhesive theory, engine friction, losses and engine design parameters.
Introduction to wear, types of wear, theories of wear, mechanism of wear, wear testing and methods of wear measurements, factors affecting wear.

BEARINGS, LUBRICATION AND AUTOMOTIVE LUBRICANTS
Theory of hydrodynamics, lubrication, generalized Reynold’s equation & physical significance of terms, pressure distribution and load carrying capacity equations for hydrodynamic journal bearing- infinitely long and short bearing approximations, thrust bearings, Raleigh bearing sintered bearings.

Automotive Lubricants- introduction, properties, standard test methods for automotive lubricants, testing, classification, engine oil performance designations, tests, transmission fluids, gear lubricants, axle lubricants, solid lubricants, automotive engine oils, EP lubricants, Lubricant monitoring, SOAP, ferrography and other rapid testing methods of lubricant contamination

HYDROSTATIC AND ELASTOHYDRODYNAMIC LUBRICATION
Hydrostatic bearings, basic concepts, bearing pad coefficients, restriction, capillary, orifice, flow control valve, bearing characteristic number and performance coefficients, flat, conical & spherical pad thrust bearing, air & gas lubricated bearing, squeeze film lubrication
Elastohydrodynamic Lubrication, introduction, rolling of two cylinders, Ertel Gurbin criterion, lubrication of ball & roller bearings, cams and gears, selection and life estimation, fatigue and diagnosis. Road tyre contacts. Hydroplaning
INTRODUCTION TO PREVENTIVE MAINTENANCE
Definition of preventive maintenance, difference between regular maintenance and preventive maintenance, preventive maintenance schedule for passenger vehicles and commercial vehicles, Noise, wear and corrosive maintenance.

SIGNATURE ANALYSIS OF BEARINGS AND GEARS, real time condition monitoring using vibration analysis

PERIODIC MAINTENENCE
Maintenance of batteries, Lead acid battery, Factor affecting battery life, testing and battery troubles Maintenance of auxiliaries Lubrication system, greasing of vehicle, lubrication charts, Cooling system Maintenance, Maintenance of Electrical system, testing of starters, alternators, ignition coils, wiring harness, horns, wipers, maintenance of drive line system

Reference Books

7. Automotive Chassis – P. M. Heldt, Chilton Co. NK
AUTOMOTIVE SAFETY AND REGULATIONS
(502303 B)

Teaching Scheme: Examination
Lecture: 3 hrs/week Paper: 100 Marks
Credits: 03 Paper Duration: 3hrs

1) Safety and Crash Testing

Introduction - Active and passive safety, characteristics of vehicle structures,
Optimization of vehicle structures for crash worthiness - Types of crash / roll over
- Tests, Regulatory requirements for crash testing
- Instrumentation, high speed photography, Image Analysis

2) Pedestrian Safety and Ergonomics

Importance of Ergonomics in Automotive safety- Locations of controls-
Anthropometry- Human impact tolerance- Determination of Injury thresholds,
Severity Index, Study of comparative tolerance. Study of crash dummies

3) Vehicle Safety systems

Survival space requirements, Restraint systems used in automobiles

- Types of safety belts- Head restraints, Air bags

- Use of energy absorbing systems - Impact protection from steering controls

- Design of seats for safety- types of seats-Importance of Bumpers -
  Damageability criteria in bumper designs

- Types of safety glass and their requirements, rearward field of vision in
  automobiles

- Types of rear view mirrors and their assessment - Warning devices -
  Hinges and latches, etc

- External Projections, Door locks & retension systems
  Rear/front/side under run protection devices.
4) **Automotive Lighting and Light Signalling Devices**

Automotive lamps, types, design, construction, material, performance

- Light signalling devices such as stop lamp, rear position lap, direction indicator, reverse lamp, reflex reflector, position lamp, number plate lamp, etc.
- New technology in automobile lighting-Gas Discharge lamp, LED, Adoptive Front Lighting System (AFLS), Daylight Running Lamps (DRL).

5) **Safety regulations:** As Issued from time to time by Government Of India as per AIS 037 (Automotive Indian Standard)

**Reference books**

4. Prasad, Priya and Belwafa Jamel, “Vehicles Crashworthiness and Occupant Protection”, American Iron and Steel Institute, USA.
11. McCluney W.R. "Introduction to Radiometry and Photometry”
12. Walsch JWT, "Photometry", Dover Publication
13. Central motor vehicle rules and standards.
15. Updated CDs of AIS 037, giving procedure for type approval and estimating Conformity of production for safety of critical components, published by ARAI Pune,
Automobile Air Conditioning
(502303 C)

Teaching Scheme:                                 Examination
Lecture: 3 hrs/week                         Paper: 100 Marks
Credits: 03                                    Credits: 03
Paper Duration: 3hrs                         Paper Duration: 3hrs

1. **Introduction**: Air Refrigeration System and its applications, Refrigerants for automotive applications, Automobile air conditioning, Air conditioning for passengers, isolated vehicles, transport vehicles, Applied Psychrometry, Psychrometric processes using chart

2. **Air Conditioning Systems**: Classification and layouts, Central / unitary air conditioning systems Components like compressors, evaporators, condensers, expansion devices, fan blowers, heating systems etc.

3. **Load Estimation**: Load Analysis, Outside & inside design consideration, Factors forming the load on air conditioning systems, Cooling & heating load calculations, Load calculations for automobiles, Equivalent Temperature Difference Method, Cooling Load Temperature Difference, and Radiance Method, Effect of air conditioning load on engine performance, solar heat gain, study of various sources of the internal and external heat gains, heat losses, etc.

4. **Air Distribution**: Air Distribution Systems Fundamentals of air flow in ducts, pressure drop calculations, design ducts by velocity reduction method, equal friction method and static regain method, duct materials and properties, insulating materials, types of grills, diffusers, ventilation, noise level etc. Layout of duct systems for automobiles and their impact on load calculations, Air Routine & Temperature Control, evaporator care air glow through the dash recirculating unit, Automatic temperature control, Controlling flow, Control of air handling systems

5. **Sound Control**: Definitions of various terms like level, pitch, attenuation, frequency, sources of noise in air conditioning plants, design procedure for noise prevention, noise and vibration study and elimination techniques (description only).

6. **Ventilation and Infiltration**: Requirement of ventilation air, various sources of infiltration air, ventilation and infiltration as a part of cooling load. Fans and Blowers: Types, performance characteristics, series and parallel arrangement, selection procedure.

7. **Air Conditioning Equipments and Controls**: Chillers, Condensing units, Cooling coils, bypass factors, Air Conditioning Controls, humidifiers, dehumidifiers, various types of filters, air washers, thermostat, humidistat, control dampers, Pressure cutouts and relays cycling and sequence controls, modern control of purity, odour and bacteria, Air filtration- Study of different types of filters. Air conditioner maintenance & service - servicing heater system. Removing & replacing components, Trouble shooting of air conditioning system Compressor service, methods of dehydration, charging & testing.
8. **Automotive Air conditioning systems**: Classification, central and unitary systems, design of typical air conditioning systems for automobile, warm air system, hot water systems.

**Reference Books:**

1. ASHRAE Handbooks
2. Norman C. Harris, Modern air conditioning
4. Trane air conditioning manual,
Lab Practice – I
502304

Teaching scheme
Practical 06 hr/week

Examination Scheme
Credits: 03
Term Work: 50 Marks

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**Term Work**

Term work shall consist of any ten experiments given below.

1. Assignment on basic engine design for passenger vehicles and commercial Vehicles.
2. Assignment on design of piston and cylinder for thermal, strength and wear consideration.
3. Assignment on development of CNG engine.
4. Experiments on engine to evaluate various performance characteristics.
5. Assignment on radiator sizing for automotive applications.
6. Experiment on passive heat transfer augmentations techniques.
7. Assignment on numerical methods in heat conduction and convection.
8. Experiments on solving simple FEA problems, geometry creation, meshing Analysis of the result.
9. Experiment on post processing and interfacing with CAD and 3D analysis.
10. Modelling and analysis of an engine part using solid modelling software / FEA software
11. Visit to an automotive industry to see the latest manufacturing and assembly of System.
12. Visit to an automotive R & D and testing centre like ARAI/VRDE/I CAT/ NATRIP Center at Pithampur
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Each student is required to deliver a seminar in first semester on state of the Art topic of his/her own choice. The topic of the seminar should be out of syllabus and relevant to the latest trends in Automotive Engineering.

The student is expected to submit the seminar report in standard format approved by University of Pune.
1) Conventional Fuels

Estimate of petroleum reserve and availability - Comparative properties of Fuels-Diesel and Gasoline, Quality rating of SI & CI engine fuels, fuel additives for SI & CI engines

2) Alternative Fuels

Need for alternative fuels, applications, types, Introduction to CNG, LPG, Ethanol, Vegetable Oils, Bio diesel, Biogas and Hydrogen. Study of availability, manufacture, properties, storage, handling and dispensing, safety aspects, engine/vehicle modifications required and effects of design parameters-performance and durability

3) Thermodynamics of fuel combustion

Introduction to Chemical Thermodynamics, Chemical reaction - Fuels and combustion, Enthalpy of formation and enthalpy of combustion, First law analysis of reacting systems, adiabatic flame temperature Chemical and Phase equilibrium - Criterion for chemical equilibrium, equilibrium constant for ideal gas mixtures, fugacity and activity, Simultaneous relations, Variation of Kp with Temperature.

4) Combustion in SI & CI Engines

Combustion in SI engine, Stages of combustion, phenomenon of detonation, effect of engine, variables on detonation, combustion chambers for SI engines. Combustion in CI engine, Stages of combustion, factors affecting delay period, the phenomenon of knock in CI engine, combustion chambers for CI engines

5) Emissions from Spark Ignition Engine Vehicles and their Control

Emission formation in S.I. engines - Hydrocarbons, Carbon monoxide, Oxides of Nitrogen, Polynuclear Aromatic Hydrocarbon. Effects of design and operating variables on emission formation in Spark Ignition engines Controlling of pollutant formation in engines Exhaust after treatment, Charcoal Canister Control for Evaporative Emission Control, emissions and drivability, Positive crank case ventilation system for UBHC emission reduction.

6) Emissions from Compression Ignition Engine Vehicles and their Control

Chemical delay, intermediate compound formation, Pollutant formation on incomplete combustion, Effect of design and operating variables on pollutant formation, Controlling of emissions, emissions and drivability, Exhaust gas re-circulation, exhaust after treatment.
7) Health effects of Emissions from Automobiles
Emission effects on health and environment. Emission inventory, ambient air quality monitoring

8) Emission Norms: As per Bharat Standard up to BS – IV and procedures for confirmation on production.

Reference Books

12. MORTH/CMVR- TAP 115,116 Issue III, Document on test method, testing equipment and related procedure for testing type approval COP of vehicle and emissions as per rule 115,116 and 126
1. **Fundamentals of Automotive Electronics**: Microprocessor and microcomputer applications in automobiles; components for engine management system; electronic management of chassis system; vehicle motion control; electronic panel meters.

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.

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.

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.

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.

6. **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.

7. **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.
8. Electromagnetic Interference Suppression: Electromagnetic compatibility
Electronic dash board instruments - Onboard diagnosis system. Security and
warning system.

Recommended books

2. Automotive Electricity and Electronics, Al Santini, Delmar
3. Automobile Electrical & Electronic Equipments, Young,
4. Understanding Automotive Electronics, Bechfold, SAE 1998
Vehicle Ride

Wheeled Vehicle Handling

Transient response:
Natural frequency and damping in yaw. Frequency response in yaw. Extension of two degree of freedom theory to include effects of traction and braking, aerodynamics, self-aligning torque, dual wheels and bogies, Handling of multi-axle vehicles. Development of equations of motion to include roll of sprung mass: Effect on steady state and frequency response.

Tracked Vehicle Handling
Analysis of sprocket torques and speeds, required to skid steer a tracked vehicle. Extension of theory to include three degrees of freedom. Modification of theory to allow for soil conditions and lateral weight transfer Application of theory of steering of articulated and half-track vehicles.

Suspension

Reference Books

3. Vehicles & Bridging, igSs/Tytler, Brassey’s.
4. Fundamental of vehicle dynamics: Thomas D Gillespie
Noise, Vibrations and Harshness  
(502309 A)

Teaching Scheme:  
Lecture: 3 hrs/week  
Credits: 03

Examination  
Paper: 100 Marks  
Paper Duration: 3hrs

**Introduction to Automotive NVH**  

**Transducers and Measurement Techniques**  
Transducers and exciters, Sound pressure, intensity and power measurement and Digital signal processing.

**NVH Legislations**  
Psycho-acoustics and effect of noise on human beings, Ambient air quality standards, Noise specifications for automotive vehicles – pass-by & stationary and Noise specifications for generator sets, fire crackers and household articles.

**Noise Source Identification Techniques**  
Frequency and order domain analysis, Sound intensity and sound power mapping and Introduction to array techniques - Acoustic holography & beam forming.

**Modal Analysis**  
Definition of Modal Properties, Modal analysis theory, FE & Experimental modal analysis, Excitation sources, Applications of Modal Analysis

**Passive Noise Treatments**  
A. Ducts & Mufflers -Types of mufflers, performance parameters – acoustics and backpressure, Reactive and absorptive silencers and Overall design considerations.

B. Acoustic Material Characterization -Sound transmission, absorption and damping, Behaviour of acoustic material wrt sound absorption and transmission, Standard methods for evaluating sound absorption coefficient and transmission loss, Types of sound absorbers, Prediction of transmission loss and flanking transmission, Damping materials and their applications

**Interior Noise of Automobiles**  
Interior noise sources, Structure borne noise, Airborne noise, Refinement techniques, Sound insulation
Reference Books

1. Theory of Vibrations with Applications: W T Thomson CBS Publishers Delhi
5. Mechanical Vibrations A H Church, John Wiley & Sons Inc
1. **Metallic Materials** - Effect of alloying additions, solid solutions, substitutional & interstitial alloying, eutectic, pearlitic, eutectoid reactions, classifications of steels and cast irons, High Strength Low Alloy Steels (HSLA), copper base alloys, aluminium base alloys, zinc base alloys, titanium alloys, typical properties of alloy grades, methods of identification of alloy grades


3. **Manufacturing processes** – steel melting practices, manufacturing of aluminium alloys, metal forming operations - rolling, extrusion, casting, forging, welding, soldering, brazing, powder metallurgy

4. **Non-metallic materials** – **Polymers** – types of polymer, commodity and engineering polymers – Properties and auto applications of PE, PP, PS, PVC, PMMA, PET, PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE Polymers – Urea and Phenol formaldehydes. **Elastomers** – natural and synthetic rubbers, tires, properties of rubbers and auto applications

5. **Composites** – Fiber reinforced plastics (FRP), engineering ceramics, metal-matrix /composites, nano-composites.

6. **Plastic and composite component manufacturing methods** – hand moulding, compression moulding, Reaction Injection moulding (RIM), blow moulding, filament winding, pultrusion, pulforming, SMC & DMC


8. **Physico-chemical properties of Automotive fluids and their importance** – Type of fluids - gasoline & diesel fuels, alternate fuels, engine oils, gear oils, greases, transmission fluids, brake fluids, antifreeze engine coolants, effects on vehicle performance

9. **Selection of materials** – selection criteria for auto components - cylinder block, Cylinder head, piston, piston ring, Gudgeon pin, connecting rod, crank shaft, crank case, cam, cam shaft, engine valve, gear wheel, clutch plate, axle, bearings, chassis, spring, shock absorber, propeller shaft, body panel, radiator, brake liners and brake pads, batteries, fuel tank, seats, application of non-metallic materials such as plastics, composites, ceramics, etc.
10. **Metallurgical Failure Analysis** - approach to analysis, types of failures, fracture mechanisms, types of defects in metals & cracks, types of fatigue, importance of endurance life, corrosion – causes, effects and preventions, wear & tear, hydrogen embrittlement, interpretation of tests & results, case studies


**Reference books**

**Vehicle Aerodynamics**

(502309 C)

Teaching Scheme:
Lecture: 3 hrs/week
Examination
Paper: 100 Marks
Credits: 03
Paper Duration: 3hrs

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**Fundamental of aerodynamics**

**Shape optimization of cars**
The origin of forces and moments - effects - Front end modification - front and rear windshield angles - vehicle dynamics under side wind - force moment coefficients - dirt accumulation on vehicle - wind noise - air flow around individual components - boat failing - hatch back - fast back & square back dust flow pattern at rear - effect of gap configuration - effect of fastener.

**Wind tunnels and test techniques**

**Application of CFD**
Introduction - method of solve Navier stoke equation - forces acting in fluid element - compressibility effect in flow field - inviscide flow - governing equations - irrotational
Flow field and consequences - potential flows - boundary layer methods - numerical modeling of fluid flow around vehicle body.

**Aerodynamic design**
Development and simulation methods - cars, buses, trucks.

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**Reference Books**

1) W.H.Huco – “aerodynamic of road vehicle”
2) Schlichting H “boundary layer theory”
3) Pope A “ low speed wind tunnel testing” john wiley and sons
1. **Introduction to CFD**
   Historical background, Impact of CFD

2. **The Governing Equations of Fluid Dynamics**
   Derivation, Discussion of physical meanings and Presentation of forms particularly suitable to CFD.

3. **Mathematical Behavior of Partial Differential Equations:**
   Impact on CFD

4. **Basic Aspects of Discretization:**

5. **Grids with Appropriate Transformations**
   Adaptive grids and unstructured meshes.

6. **A Few CFD Techniques**
   The Lax-Wendroff Technique, MacCormack’s Technique, Space marching, Relaxation technique, Numerical dissipation and dispersion, artificial viscosity, The ADI technique, Pressure correction Technique: Application to incompressible viscous flow, the SIMPLE algorithm.

7. **Numerical Solutions of Quasi-One-Dimensional Nozzle Flows**

8. **Numerical Solution of a 2D Supersonic Flow**
   Prandtl-Meyer Expansion Wave

9. **Incompressible Couette Flow**
   Solution by implicit method and the pressure correction method.

10. **Supersonic Flow over a Flat Plate**
    Numerical Solution by solving complete Navier Stokes equation.

**Reference Books**

Automotive Chassis Design
(502310 B)

Teaching Scheme:
Lecture: 3 hrs/week

Examination
Paper: 100 Marks
Credits: 03
Paper Duration: 3hrs

Design of Suspension System:
Springs, Types of Springs, Stress Deflection equation for helical springs, Wahl factor, Design of helical springs, Buckling of springs, Types of leaf springs, Steering effect of leaf spring Variable rate springs, rubber springs, air springs, Independent Suspension system, Camber, Castor, Roll Center, Double transverse link, McPherson Strut System, Single Transverse link, Single trailing/ leading link, Double Trailing link, Rear Suspension (Dead Axle) Active Suspension

Automotive Steering System:
Wheel Alignment, Checking and Adjustments, Fundamental Condition of True rolling, Ackerman Steering gear, Davis Steering Gear, Turning circle radius, Power Steering system, Centre point steering, Steering characteristics, Rear wheel steering, Steering Column, Reversible & irreversible steering, steering connections.

Automotive Brakes:

Wheels and Tyres:
Introduction, wheel tyre assemblies, wheels, rims, Wheel fixing, Tyres, Constructional details, Tread Design, Noise, Aspect Ratio, Tread Design consideration, Run Flat Tyes, Materials, Retrading And Manufacturing

Six Wheel Vehicles:
Introduction, The rigid Six Wheelers, Suspension, Transmission of six wheelers, a Scammell Design, Spring Stresses in rigid Six wheeler, Scammell articulated trailers, Scammell Route ness.

Reference books:
LAB PRACTICE –II
502311

Teaching scheme
Practical 06 hr/week

Examination Scheme
Credits: 03
Term Work: 50 Marks

TERM WORK

The Term work shall consist of any Ten experiment of following

1. Report of Full vehicle test at ARAI/VRDE or Tata Motors and failure analysis of various critical components.

2. Design project for system selection, load estimation, equipment selection, Control system, cost estimation, layout diagram for providing air Conditioning of a midsize passenger car.

3. Study of present day fuel system for conventional / non conventional fuels for CI and SI engines.

4. Experiment on measurement for emission from diesel /gasoline engine.

5. Study of MPFI and CRDI systems and their application.

6. Study of ABS system and draw a complete system diagram with costing for a passenger vehicle.

7. Experiment on chassis dynamometer to study deflection, spring rate and stress analysis on various components.

8. Study of latest suspension system e.g. active suspension system and their application.

9. Experiment on actual sound and vibrations measurements on a vehicle mounted on a chassis dynamometer.

10. Study of noise legislation issued by Govt.of India and actual measurement of pass by noise.

11. Study of Bharat I/II/III/IV/V norms, applications in Indian conditions especially in large cities.

12. Study of Automotive materials, specially polymers and composites. Visit to composite material laboratory at DRDO,R & D E Dighi Pune
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<th>Teaching scheme</th>
<th>Examination scheme</th>
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<tbody>
<tr>
<td>Practical: 4 Hrs. /week</td>
<td>Credits: 2</td>
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<td>Term work: 50 marks</td>
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Each student is required to deliver a seminar in second semester on the topic relevant to latest trends in Automotive Engineering, preferably on the topic of sub specialization based on the Elective subjects selected by him/her.

The student is expected to submit the seminar report in standard format approved by University of Pune.
### SEMINAR III
602301

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<th>Teaching scheme</th>
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<td>Practical: 4 Hrs. /week</td>
<td>Credits: 2</td>
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<tr>
<td></td>
<td>Term work: 50 marks</td>
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</table>

The term work will consist of a report prepared by every student on a seminar topic on advancement in technology, related to the selected dissertation topic or topics closely related to dissertation and oral presentation.

The student is expected to submit the seminar report in standard format approved by University of Pune.
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<th>Teaching scheme</th>
<th>Examination scheme</th>
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<tbody>
<tr>
<td>Practical: 18 Hrs. /week</td>
<td>Credits: 6</td>
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<tr>
<td></td>
<td>Term work: 50 marks</td>
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</table>

Project stage-I, is an integral part of dissertation work. The project should be based on the knowledge acquired by the student during course work and should contribute to needs of the society. The project aims to provide an opportunity of designing and building a complete system or sub systems in the area where the students likes to acquire specialized skills.

The student shall complete the part of the project that will consists of problem statement, literature review, project overview, scheme and method of implementation (block diagram, PERT, charts etc) layout and design setup.

The student shall submit the report of project work completed partly in standard format approved by University of Pune.
The project Stage I will be evaluated on the Basis of

1. Physical inspection of project in case of hardware project.
2. Analysis and validation of result.
3. Project report.
4. Oral examination.

NOTE: Term work will be assessed jointly by a pair of internal and external examiner along with the oral examination of the same.