

**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**

Code	Subject	Teaching Scheme		Examination Scheme				Credits
		Lect	Pract	Paper	TW	OR	Total	
<b>Semester - I</b>								
502201	Mathematical Modeling and Analysis	03	-	100	-		100	03
502103	Technology and Financial Management	03	-	100	-		100	03
502301	Automotive Engine Design	03	-	100	-		100	03
502302	Elective - I	03	-	100	-		100	03
502303	Elective - II	03	-	100	-		100	03
502304	Lab Practice - I	-	06	-	50		50	03
502305	Seminar - I	-	04	-	50		50	02
	<b>Total</b>	<b>15</b>	<b>10</b>	<b>500</b>	<b>100</b>	<b>-</b>	<b>600</b>	<b>20</b>

**SEMESTER II**

Code	Subject	Teaching Scheme		Examination Scheme				Credits
		Lect	Pract	Paper	TW	OR	Total	
<b>Semester - II</b>								
502306	Automotive Fuels & Emissions	03	-	100	-		100	03
502307	Autotronics	03	-	100	-		100	03
502308	Fundamentals of Vehicle Dynamics	03	-	100	-		100	03
502309	Elective - III	03	-	100	-		100	03
502310	Elective - IV	03	-	100	-		100	03
502311	Lab Practice - II	-	06	-	50		50	03
502312	Seminar - II	-	04	-	50		50	02
	<b>Total</b>	<b>15</b>	<b>10</b>	<b>500</b>	<b>100</b>	<b>-</b>	<b>600</b>	<b>20</b>

**University of Pune**  
**Course Structure**  
**M.E. Mechanical (Automotive Engineering)**  
**(Wef 2009-2010)**

**SEMISTER- III**

Code	Subject	Teaching Scheme		Examination Scheme					Credits
		Lect.	Pract.	Paper	TW	Or	Pr	Total	
602301	Seminar - III	-	04	-	50	-	-	50	02
602302	Project work Stage - I	-	18	-	50	-	-	50	06
	<b>Total</b>	-	<b>22</b>	-	<b>100</b>	-	-	<b>100</b>	<b>08</b>

**SEMISTER- IV**

Code	Subject	Teaching Scheme		Examination Scheme					Credits
		Lect.	Pract.	Paper	TW	Or	Pr	Total	
602303	Project work Stage - II	-	18		150*	50	-	200	12
	<b>Total</b>	-	<b>18</b>		<b>150</b>	<b>50</b>	-	<b>200</b>	<b>12</b>

CODE	<b>Elective - I</b>	CODE	<b>Elective - II</b>
502302 A	Advanced Heat Transfer	502303 A	Tribology and Preventive Maintenance
502302 B	Finite Element Method	502303 B	Automotive Safety and Regulations
502302 C	Advanced Hydraulics and Pneumatic Systems	502303 C	Automobile Air Conditioning

CODE	<b>Elective - III</b>	CODE	<b>Elective - IV</b>
502309 A	Noise Vibrations and Harshness	502310 A	Computational Fluid Dynamics
502309 B	Automotive Materials	502310 B	Automotive Chassis Design
502309 C	Vehicle Aerodynamics	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)

Teaching Scheme:  
Lecture: 3 hrs/week

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

---

## **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**

Numerical method for solution of continuous time state. Ordinary differential equations: Explicit and implicit techniques. Adaptive step size control, Adaptive RK method. Numerical methods for partial differential equations.

## **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**

The inverse Z-transform, Z-transform analysis of linear discrete time systems, nature of response of linear discrete-time systems, Computation system, Deconvolution.

## **9. Wavelet Transform**

Multi resolution Analysis and construction of wavelets. Representation of functions by wavelets. The characterization of MRA wavelets.

## **10 Simulation:**

Introduction to simulation: Digital and Analogue simulation, Analytic and Monte Carlo simulation, Stochastic and Deterministic simulation. Random and pseudo random number generation. Designing a simulation experiment. Simulating basic stochastic models. Simulator technology. Applications.

### **Text Books**

1. Modelling Mathematical Methods & Scientific Computations, 1995, Nicola Bellomo & Luigi Preziosi, CRC Press.
2. Systems Modelling & Analysis, I.J. Nagarath & M. Gopal, Tata Me Graw Hill, New Delhi.
3. Jan Willen Polderman, Jan C. Willems -Introduction to Mathematical Systems Theory – A behavioural approach, 1998, Springer.
4. J.L. Shearer, A.T. Murphy, H.H. Richardson: Introduction to System Dynamics, 1971, Addison & Wesley.
5. T.H. Glisson: Introduction to System Analysis, 1987, Me Graw Hill.
6. W.J. Palm: Modelling Analysis and Control of Dynamic Systems, 2nd Ed., 1999, John Wiley.
7. Ernest O Doebelin, System Modelling and Response, theoretical and experimental approaches, 1980, Wiley.

### **Reference Books**

1. Gray M. Sandquist: Introduction to System Science.  
David K. Cheng: Analysis of Linear Systems.
2. James B. Reswick Charles K Taff: Introduction to Dynamic Systems.
3. Robert L. Woods, Kent L. Lawrence: Modeling & Simulation of dynamic system.
4. Robert A. Gabel & Richard A. Roberts: Signals and Linear Systems.
5. A First Course on Wavelets, 1996, Eugenio Hernandez, Guido Weiss: CRC Press.
6. Digital Sigal Processing, Alan V Oppenheim & Ronald W. Schafer, Prentice Hall of India, Pvt. Ltd.
7. Fast Algorithms for Digital Signal Processing, 1985, Richard E Blahut, Addis on-Wesley Publishing Co.
8. Fast Transforms Algorithms, Analysis and Applications, 1982, Dougllao F Elliott, K Ram Mohan Rao, Academic Press Inc., Chapters i, 2 & 3.

# 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
- 3) Collin Drury, Management & Cost Accounting, English Language Book Series, Chapman & Hall, London [ISBN 0412 341204]
- 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
- 10) Fred Luthans, McGraw Hill Publications, Organizational Behaviour
- 11) Robbins S P, Prentice Hall Publications, Organizational Behaviour.

# 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

1. I. C. Engine & Air Pollution – E. F. Obert, Harper & Row Publishers, New York
2. Engine Design – Giles J. G., Liffle Book Ltd.
3. Engine Design – Crouse, Tata McGraw Publication, Delhi
4. I.C. Engine - Maleev V. L., McGraw Hill Book, Co.
5. I. C. Engine – L. C. Litchy, International Student Edition
6. Design of Automotive Engine – A. Kolchin and V. Demidov
7. I. C. Engine – Heywood
8. SAE Handbooks

# Advanced Heat Transfer

(502302 A)

Teaching Scheme:  
Lecture: 3 hrs/week

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

---

**1. Overview of the subject of heat transfer with orientation to automotive applications.** The various boundary conditions. Analytical solutions for temperature distribution. Concept of thermal resistance, contact resistance. Problems related to anisotropic materials. Numerical methods for fin analysis.

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

**3. Principle of Fluid flow and heat transfer.** Concept of velocity and thermal boundary layers: Laminar and Turbulent flow. Navier-stokes equations and convection equation. Boundary layer approximations and special conditions. Boundary layer similarity. The normalized convection transfer equations. Dimensionless parameters & physical significance. Reynolds analogy, Chilton-Colburn analogy.

#### **4. Convection**

Empirical method. Flat plate in parallel flow. The Blasius solution (highlights only), local and average Nusselt number calculations, mixed boundary layer considerations. Forced Convection (Internal Flow) Laminar flow in a pipe, friction factor, thermal considerations, mean temperature, constant heat flux and constant wall temperature. Thermal analysis and convection correlations for laminar flow in circular tubes. Evaluation of Nusselt number, Marcos and Bergles correlation. Convection correlations: turbulent flow in circular tubes, for non circular tubes. Heat transfer enhancement, Passive, active and compound techniques. Free convection governing equations, similarity considerations. Laminar free convection on a vertical surface, effects of turbulence. Empirical correlations for external free convection flows for various geometries and orientations. Free convection within parallel plate channels. Empirical correlations for enclosures. Mixed convection.

#### **5. Boiling and Condensation**

Boiling modes, the boiling curve, modes of pool boiling, correlations. Forced convection boiling. Two phase flow. Condensation: Physical mechanisms, laminar film condensation on a vertical plate. Turbulent film condensation, film condensation on radial systems, film condensation in horizontal tubes, on banks of tubes. Dropwise condensation correlations.

## **6. Thermal Radiation**

Fundamental concepts, Radiation Intensity: Relation to emission, irradiation and radiosity. Black body radiation and associated laws. Spherical and hemispherical properties. Environmental radiation. Radiation exchange between surfaces, the view factor, black and gray surfaces, Network method, Reradiating surfaces. Multimode heat transfer. Gaseous emission and absorption.

## **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.** Classification of heat exchangers. Logarithmic Mean Temperature Difference, Correction factor and effectiveness of heat exchangers. Effectiveness as a function of Number of Transfer Units and heat capacity ratio. Overall heat transfer coefficient, Fouling factor. Radiators for automobiles and its construction.

## **Reference books**

1. Incropera and Dewitt. Fundamentals of heat and mass transfer. John Wiley and sons.
2. Yunus Cengel: Heat transfer - an practical application. Tata Mc Graw Hill. M.N. Ozisik - Heat transfer a basic approach - Mc Graw Hill Int.
3. A Bejan - Convective heat transfer.- John Wiley and sons.
4. J.P. Holman- Heat transfer, Mc Graw Hill, Int.
5. S.P. Sukhatme, Heat transfer, University Press
6. Principles of Heat Transfer, 6<sup>th</sup> ed., Frank Kreith, CENGAGE Learning
7. Heat and Mass Transfer - C.P. Arora., Dhanpatrai and Co.
8. Heat and Mass Transfer - Prof. Sachdeva
9. Heat and Mass Transfer - R.Yadav.
10. Heat and Mass Transfer- R.K.Rajput - S.Chand & Company Ltd.

# 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

1. Segerling L.J. – 'Applied finite elements analysis' John Wiley and Sons.
2. Bathe- 'Finite Element Methods' Prentice Hall of India (P) Ltd, New delhi.
3. O.C. Zienkiewicz 'Finite Element Method' Tata Mc Graw Hill, New Delhi.
4. J.N. Reddy- 'An Introduction to FEM', Mc Graw Hill International Edition
5. C.S. Krishnamoorthy-'Finite Element Analysis – Theory and Programming', Tata Mc Graw Hill Publishing Co. Ltd, New Delhi.
6. Nitin Gokhale, Deshpande-'Practical Finite Element Analysis, Finite to Infinite Pune.

# Advanced Hydraulic and Pneumatic Systems

## 502302 C

Teaching Scheme:  
Scheme  
Lectures: 3 Hrs/Week  
Marks

Examination

Theory: 100

Credits:

03

Duration: 3

Hrs

---

### **Introduction to Hydraulics / Pneumatics**

Hydraulic and Pneumatic system: Components, Applications in automobiles. Hydraulic Fluids: Properties, Types, Factors affecting oil performance, Fire resistant hydraulic fluids. Hydraulic Power Unit: Hydraulic Pump, Oil reservoir, Oil filter. Fluid Power Lines: Layout requirement, Selection of pipe / tubing, Couplings. Packing and seals: Applications, Materials, Types, Packing standards, Factors affecting selection of packing and Seals.

### **Source of Hydraulic / Pneumatic Power**

Pump: Pumping theory, Pump classification, Gear pumps, Vane pumps, Piston pumps, Pump performance, Pump noise, Pump selection, and Pump performance rating. Intensifier. Hydraulic Accumulator: Types, Applications. Compressor: Types of compressors, Compressor specification. Compressed air generation and distribution system.

### **Hydraulic / Pneumatic Actuators**

Hydraulic cylinders, Mechanics of hydraulic cylinder loadings, limited rotation hydraulic actuator, Gear motors, Vane motors, Piston motors. Hydraulic motor theoretical torque, Power and Flow rate. Hydrostatic transmission, Hydraulic motor performance. Air cylinders and their design. Power operated holding devices. Air motors.

### **Valves and Components in Hydraulic / Pneumatic systems**

Pressure, Direction and Flow Control valves. Servo valves, Cartridge valves, Hydraulic fuses, Switches, Control elements, PLC, Filter, Lubricator, Muffler, Dryer, Shuttle valve, Vacuum clamp. Etc.

### **Hydraulic / Pneumatic Systems**

Fluid power symbols: IS, DIN, JIC, and ISO. Synchronizing the movement of fluid power rams, Dual pressure hydraulic systems, Safety controls for hydraulic systems, Sequencing of hydraulic cylinder motion. High pressure hydraulic systems. Pneumatic safety systems. Remote control pneumatic systems. Etc.

**Fluid Logic Control Systems:** Moving Part Logic (MPL) control system, MPL Control of fluid power circuits, Principles of Fluidic Logic Control, Basic Fluidic Devices, Fluid Sensors, Fluidic Control of Fluid Power Systems, Introduction to Boolean algebra, Examples.

### **Hydraulic / Pneumatic System Design and Analysis**

Testing of hydraulic and pneumatic components as per standards. Testing equipments, procedure. Hydraulic system design, Analysis of hydraulic system with frictional losses, Accumulators system design. Analysis of electro hydraulic servo system, Hydraulic power unit design. Pneumatic system design considerations, Air pressure losses in pipelines, Economic cost of energy losses in pneumatic systems, Basic pneumatic circuits, and Pneumatic circuit 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
3. D.A.Pease - 'Basic Fluid Power', Prentice hall
4. J,J.Pipenger - 'Industrial Hydraulics', McGraw Hill
5. H.L.Stewart - 'Hydraulics and Pneumatics', Industrial Press
6. B. Lall- 'Oil Hydraulics', International Literature Association
7. Yeaple - 'Fluid Power Design Handbook'
8. Vickers Manual on Industrial Hydraulics
9. Festo's Manual on Pneumatic Principle, applications
- 10.ISO - 1219, Fluid Systems and components, Graphic Symbols
- 11.Majumadar, "Oil Hydraulics- Principle & Maintenance", Tata McGraw Hill
- 12.Majumadar – 'Pneumatic Systems'
- 13.Turner Ian C. – 'Engineering Applications of Hydraulics and Pneumatics'  
Arnold
- 14.S. Ilango and V. Soundarajan – 'Introduction to Hydraulics and Pneumatics', PHI

# Tribology and Preventive Maintenance

(502303A)

Teaching Scheme:  
Lecture: 3 hrs/week

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

---

## **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 regims in the engine

## **FRICITION 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 MAINTANENCE**

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 MAINTANENECE**

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**

1. Fuller D. D., "Theory and Practice of Lubrication for Engineers ". John Wiley and Sons.
2. Halling J., "Principles of Tribology ", McMillan Press Ltd.
- 3 Cameron A. "Basic Lubrication Theory ", Wiley Eastern Ltd.
- 4 Neale M. J. "Tribology Hand Book ", Butterworths.
- 5 O. P. Orlov, "Fundamentals of Machine Design ", Vol.IV, MIR.
- 6 Hamrok B.J. "Fundamentals of Fluid film lubrication", McGraw Hill, New York,NY
- 7 Automotive Chassis – P. M. Heldt, Chilton Co. NK
- 8 Young, Griffiths , "Automobile Electrical & Electronic Equipments' Butterworths, London
- 9 G.B.S. Narang, "Automobile Engineering"
- 10 Nakra B.C., "Theory & Practice of mechanical Vibrations", McGraw Hill
- 11 Nakra B.C. & Chowdhari K.K., "Instrumentation, measurements and analysis", McGraw Hill.

# AUTOMOTIVE SAFETY AND REGULATIONS

(502303 B)

Teaching Scheme:  
Lecture: 3 hrs/week

Examination  
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 lamp, direction indicator, reverse lamp, reflex reflector, position lamp, number plate lamp, etc.
- New technology in automobile lighting-Gas Discharge lamp, LED, Adaptive 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**

1. Watts, A. J., et al "Low speed Automobile Accidents" Lawyers and Judges 1996
2. Jullian Happian-Smith 'An Introduction to Modern Vehicle Design' SAE, 2002
3. Johnson, W., and Mamalis, A.G., "Crashworthiness of Vehicles, MEP, London.
4. Prasad, Priya and Belwafa Jamel, "Vehicles Crashworthiness and Occupant Protection", American Iron and Steel Institute, USA.
5. Edward A., "Lamps and Lighting" Hodder & Stoughton, London 1993.
6. Keitz H. A. E. "Light calculations and Measurements", Macmillan 1971.
7. Olson L. P., "Forensic aspects of driver perception and response, Lawyers and Judges 1996.
8. Pantazis M., "Visual instrumentation: Optical design & engineering Principles, McGraw - Hill 1999.
9. Handbook of Applied Photometry – OSA, AIP Press (1997)
10. Born M and Wolf E "Principles of Optics", 1999, Cambridge University Press
11. McCluney W.R. "Introduction to Radiometry and Photometry"
12. Walsch JWT, "Photometry", Dover Publication
13. Central motor vehicle rules and standards.
14. Recent Development in Automotive Safety Technology. SAE International Publication. Editor: Daniel J Helt.
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:  
Lecture: 3 hrs/week

Examination  
Paper: 100 Marks  
Credits: 03  
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 parity, 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
3. Handbook of Air Conditioning System Design, Carrier Incorporation, McGraw Hill Book Co., USA.
4. Trane air conditioning manual,
5. Jones W. P., Air conditioning Engineering, Edward Arnold Publishers Ltd, London, 1984.
6. Hainer R. W., Control System for Heating, Ventilation and Air Conditioning, Van Nostrand Reinhold Co., New York, 1984.
7. Refrigeration and Air conditioning- C P Arora, Tata McGraw Hill Publication, New Delhi.
8. McQuiston, Faye; Parker, Jerald; Spitler, Jeffrey 2000, Heating, Ventilating and Air Conditioning-Analysis and Design, 5th ed. John Wiley & Sons.

# Lab Practice – I

502304

Teaching scheme  
Practical 06 hr/week

Examination Scheme  
Credits: 03  
Term Work: 50 Marks

---

## **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

## SEMINAR I

502305

Teaching scheme

Practical: 4 Hrs. /week

Examination scheme

Credits: 2

Term work: 50 marks

---

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.

# Automotive Fuels and Emissions

(502306)

Teaching Scheme:  
Lecture: 3 hrs/week

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

---

## **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  $K_p$  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**

1. Ganesan, V., 'Internal Combustion Engines', Tata McGraw Hill., 1994.
2. Heywood John, 'Internal Combustion Engines'.
3. Crouse, W.M. and. Anglin, A.L, 'Automotive Emission Control', McGraw Hill 1995.
4. Springer, G.S. and Patterson, D.J., 'Engine Emissions, pollutant formation', Plenum Press, 1986.
5. Patterson, D.J and Henin, N.A., 'Emissions from Combustion engines and their Control', Anna Arbor Science, 1985.
6. "Alcohols as Motor Fuels", SAE, 1980
7. Maxwell, et al, "Alternative Fuel : Emission, Economic and Performance" SAE, 1995
8. Watson, E.B., "Alternative fuels for the combustion engine", ASME, 1990
9. Bechtold, R., "Alternative fuels guidebook", 1998.
10. Joseph, N., "Hydrogen fuel for structure transportation", SAE, 1996.
11. I Mech E, "Alternatively fuelled vehicles", 2000.
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

# Autotronics

(502307)

Teaching Scheme:  
Lecture: 3 hrs/week

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

---

**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.

**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; feed back 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**

1. Automotive Electronics Handbook, Ronald K. Jurgen, 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

# Fundamentals of Vehicle Dynamics

(502308)

Teaching Scheme:  
Lecture: 3 hrs/week

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

---

## **Vehicle Ride**

Human response to vibration: ISO standards, Response of idealized suspension systems to stop and sinusoidal disturbances in bounce and to wheel out of balance. Combined pitch and bounce motion: application to multi wheel station vehicles. Random ground input excitation: Use of sinusoidal transmissibility function to predict mean square motion of spring mass.

## **Wheeled Vehicle Handling**

Handling control loop, vehicle transfer function. Kinematic behavior of vehicles with rigid wheels and with compliant tyres: neutral steer point, static margin, over and under-steer. Derivation of generalized equations of motion for a vehicle: stability derivative notation. Solution with two degree of freedom in the steady state: stability factor, characteristic and critical speeds.

## **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**

Requirements. Spring mass frequency. Wheel hop, wheel wobble, wheel shimmy, Choice of suspension spring rate. Calculations of effective spring rate. Vehicle suspension in fore and aft directions. Hydraulic dampers and choice of damper characteristics. Independent compensated rubber & air suspensions systems. Roll axis and vehicle under the action of side forces.

## **Reference Books**

1. Vehicle Dynamics, 1989, IR Ellis, Business Book.
2. Theory of Ground vehicles, 2001, JY Wong, Wiley.
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

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

---

## **Introduction to Automotive NVH**

Natural vibration of Single Degree of Freedom System (SDOF) and Multi Degree of Freedom System (MDOF), Undamped, damped and forced vibrations and Vibration of beams, plates & shells. Basics of sound propagation, Quantification of sound, Noise sources, generation and radiation, Pass-by noise limits, Automotive NVH sources, Interior noise of vehicles, Sound quality, Ride comfort, Noise and vibration control in vehicles.

## **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
2. Mechanical Vibrations: S S Rao Addison-Wesley Publishing Co.
3. Fundamentals of Vibration : Leonard Meirovitch , McGraw Hill International Edison.
4. Principles of Vibration Control : Asok Kumar Mallik, Affiliated East- West Press.
5. Mechanical Vibrations A H Church ,John Wiley & Sons Inc
6. Mechanical Vibrations J P Den Hartog, McGraw Hill.
7. Mechanical Vibration Analysis: Srinivasan, McGraw Hill.
8. Mechanical Vibrations: G K Groover.
9. Vibration and Noise for Engineers: Kewal Pujara , Dhanpat Rai And co.

# Automotive Materials

(502309 B)

Teaching Scheme:  
Lecture: 3 hrs/week

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

---

- 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
- 2. Heat treatment** – Definitions, Full annealing, stress relief, recrystallisation and spheroidizing, normalising, hardening and Tempering of steel. Isothermal transformation diagrams, cooling curves, Hardenability, Jominy end quench test, Austempering, martempering, case hardening, carburising, nitriding, cyaniding, carbonitriding, Flame and Induction hardening, precipitation hardening of non-ferrous alloys, importance of heat treatment in design of components.
- 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
- 7. Other Materials** - Electrical insulating materials. Gaskets, automotive glasses, Sound insulating materials, Protective coating materials - Paints, primers, varnishes, enamels, anodizing, blackodizing, electro plating, CVD and PVD, Sealant and adhesives, smart materials, Refractory materials
- 8. Pysico-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

**11. Quality Control** – Testing & validation of materials & components, National & International specifications, Testing & Characterization, Safety and environment impacts, ISO 9001, TQM, OSHA standards.

### **Reference books**

1. Kenneth G. Budinski and Michael K. Budinski "Engineering Materials" Prentice-Hall of India Private Limited, 4th Indian Reprint 2002.
2. Raghavan. V. Materials Science and Engineering, Prentice Hall of India Pvt. Ltd., 1999.
3. Sydney H. Avner "Introduction to Physical Metallurgy" McGraw-Hill Book Company, 1994.
4. C. Daniel Yesudian, D. G. Harris Samuel "Material Science and Metallurgy", SPI Publication, 2006
5. Donald R. Askeland, P. P. Phule "Essentials of Materials Science and Engineering, Cengage Learning, 2008

# Vehicle Aerodynamics

(502309 C)

Teaching Scheme:  
Lecture: 3 hrs/week

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

---

## **Fundamental of aerodynamics**

Scope, historical development trends, fundamental of fluid mechanics, flow phenomenon related to vehicles, external and internal flow problems, performance of cars, light vans, resistance to vehicle motion, drag cars as bluff body - flow field around car - drag force - type of drag force - analysis of aerodynamic drag coefficient of car - strategies for aerodynamic development of car - optimization of car bodies for low drag.

## **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 fanning - hatch back - fast back & square back dust flow pattern at rear - effect of gap configuration - effect of fastener.

## **Wind tunnels and test techniques**

Principles of wind technology - limitation of simulation - stress with scale models - Existing automobile wind tunnel - full scale wind tunnels - climatic tunnels - measuring equipments and transducers - measurement techniques - velocity measurements - flow visualization techniques - road test method - numerical method - wind noise measurements .

## **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.

## **Rererence Books**

- 1) W.H.Hucho - "aerodynamic of road vehicle"
- 2) Schlichting H "boundary layer theory"
- 3) Pope A " low speed wind tunnel testing" joho wiley and sons

# Computational Fluid Dynamics

(502310 A)

Teaching Scheme:  
Lecture: 3 hrs/week

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

---

## **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:**

Introduction to Finite Difference, Finite Elements and Finite Volume Methods. Detailed treatment of Finite Difference method, explicit and implicit methods, Errors and stability analysis.

## **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**

1. John D. Anderson Jr, "Computational Fluid Dynamics-The Basics with Applications", Mcgraw Hill. Inc.
2. Fletcher C.A.J. "Computational Techniques for Fluid Dynamics", Volumes I and II, Springer, Second Edition [2000]
3. C. Hirsch, "Numerical Computation of Internal and External Flows", Volumes I And II, John Wiley & Sons [2001]

# 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:**

Introduction, Function of brakes, Elementary theory of Shoe Brakes, Brake Shoe Adjustments, Disc Brakes, Self Energizing disc brake, Brake linings, Hydraulic Brakes, Dual Brakes, Servo Power assisted brake system , Vacuum brake, Bendix Hydrovac, Direct acting vacuum servos, Power assisted brakes, Brake lining devices, The load conscious valve, Apportioning valve.

## **Wheels and Tyres:**

Introduction , wheel tyre assemblies, wheels, rims, Wheel fixing, Tyres, Constructional details, Tread Design, Noise, Aspect Ratio, Tread Design consideration, Run Flat Tyres , 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:**

1. T.K.Garrette, Steeds, Newton, "The Motor Vehicle", Butterworth Heinemann.
2. Crouse / Anglin, "Automotive Mechanics", TMH Edition.
3. Jack Erjarn, "Automotive Technology", Delmar Thomson Learning
4. Schwaller, "Motor Automotive Technology" , Delmar Thomson Learning
5. N.K.Giri, "Automotive Mechanics", Khanna Publications

## 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

## SEMINAR II

502312

Teaching scheme

Practical: 4 Hrs. /week

Examination scheme

Credits: 2

Term work: 50 marks

---

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

Teaching scheme

Practical: 4 Hrs. /week

Examination scheme

Credits: 2

Term work: 50 marks

---

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.

# PROJECT WORK STAGE I

## 602302

Teaching scheme

Examination scheme

Practical: 18 Hrs. /week

Credits: 6

Term work: 50 marks

---

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.

**PROJECT STAGE II**  
602303

Teaching scheme

Practical: 18 Hrs. /week

Examination scheme

Credits: 12

Term work: 150 marks

Oral: 50 Marks

---

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.