SYLLABUS

Programme

M.Tech. Mechanical - AUTOMOTIVE ENGINEERING

with Effect from

2011-2012

In Collaboration with

ARAI, Pune

and

University of Alabama, USA

MECHANICAL ENGINEERING DEPARTMENT
COLLEGE OF ENGINEERING, PUNE
Wellesley Road, Shivaji Nagar,
Pune 411005
CURRICULUM STRUCTURE
Programme: M.Tech. (Mechanical – Automotive Technology)
(Duration TWO Years)

Semester – I

<table>
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<tr>
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Department Elective I
- Combustion Engineering: COEP
- Automotive Passion and Soft Skills: ARAI
- Engine Tribology: COEP
- Automotive Fuels and Emissions: ARAI

Semester – II

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Department Elective II
- Automotive Testing and certification: ARAI
- Global Product Development: ARAI
- Automotive Aerodynamics: COEP
- Automotive HVAC: COEP
### Open Elective Courses

To be selected for “Open Elective-I” and “Open Elective-II”

(Source list is dynamic)

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### Semester- III

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* For students who have NOT studied mandatory learning courses such as, Constitution of India, Environmental Studies during the undergraduate program.

### Elective III

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<tr>
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<td>Automotive Safety and Lighting</td>
<td>ARAI</td>
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<td>Finite Element Methods</td>
<td>COEP/UAB</td>
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<td>Automotive Enabling Technologies and Simulation</td>
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<td>Applied Physics</td>
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### Semester –IV

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</table>
Formulating problems in mathematical language for a variety of automotive related applications. Algebraic equations, differential equations, statistics. Some exposure to solving the problems but heavy immersion in defining the problems.

**Boundary Value Problems and Applications:**
Linear second order partial differential equation in two independent variables – Normal forms hyperbolic, parabolic and elliptic equations – Cauchy problem.
Wave equations – Solution of initial value problem – Significance of characteristic curves. Laplace transform solutions – Displacements in a long string – long string under its weight – a bar with prescribed force on one end – Free vibrations of a string.

**Calculus of Variations:** Concepts of functionals and their stationary values – Euler’s equation and solution for the problem and for more general cases – Natural boundary conditions – Variational problems with moving boundaries – Conditional variational problems – Isoparametric problems.
Direct Methods: Ritz, Kantorovich and Galerkin techniques.


**Numerical Methods:** Forward and inverse iteration schemes – Graham Schmidt deflation – Simultaneous iteration method – Subspace iteration – Lanczo’s algorithm – Estimation of core and time requirements.

**Computer Methods in Mechanical Engineering:** Applications of digital computers to solutions of problems in mechanical engineering, matrices, roots of equations, solution of simultaneous equations, curve fitting by least squares, differential and integration, differential and partial differential equations.

Statistical Techniques and Design of Experiments:
The scientific method. - The phases of an experiment. - Specifying the problem and the hypotheses - Experimental designs - Analyses of experiments - Statistical inference Hypothesis testing. - The Z-test, the T-test, the X2-test, and the F-test. Sample size.

**Design Optimization Techniques.** Methods of numerical optimization techniques applied to engineering design. Methods for optimization of both single and multiple variable functions, constrained, and unconstrained. Real-world problems as examples and student projects.

**Multi-Disciplinary Design Optimization.** Methods of numerical optimization techniques applied to engineering design. Statistical design optimization methodologies utilizing design of experiments and meta-modeling techniques. Multi-criteria formulations and multidisciplinary design optimization (MDG) frameworks. Real-world problems as examples and student projects.

**References**
5. Fundamental Concepts in the Design of Experiments, 5th Ed., by Hicks and Turner
AUTOMOTIVE NOISE VIBRATION AND HARSNESS

<table>
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<td>Mid-Sem – 30, Assignments/Quiz- 20</td>
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NVH in the Automotive Industry

Sound and Vibration Theory

Test Facilities and Instrumentation
Laboratory simulation: rolling roads (dynamometers), road simulators, semi-anechoic rooms, wind tunnels, etc. Transducers, signal conditioning and recording systems. Binaural head recordings., Sound Intensity technique, Acoustic Holography, Statistical Energy Analysis

Signal Processing

NVH Control Strategies & Comfort

Text Books:

Reference Books:

INTERNAL COMBUSTION ENGINES

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Engine Basic Theory: Analysis of Engine Cycles, Analysis of fuel-air cycle and actual cycles.

Fuel Supply in SI and CI Engines: Mixture distribution and inlet manifold, Multipoint fuel injection system. Injection system components, Jerk, Distributor, Rotary & Common Rail pumps, Maximum and minimum speed governors, Mechanical and Pneumatic governors, Injectors and spray characteristics, conventional and electronic ignition systems for SI engine.

Combustion in SI and CI Engines:
Premixed combustion, diffused combustion, laminar and turbulent combustion of fuels in engines. Droplet combustion, Cylinder pressure data and heat release analysis.

Ignition and combustion in SI engine, Flame travel, Review of detonation, effect of various factors, Combustion chambers for SI engines.

Combustion in CI engine, Ignition delay and diesel knock, Excess air supply and air motion. Combustion chamber for CI engines - Construction and Performance aspects, M-combustion chamber.

**Air induction:**
Air filter, Manifolds, EGR, Supercharging-power required and effect on engine performance, different type of turbochargers.

**Engine Friction and Lubrication:** Friction estimates and Lubrication requirements, theory of lubrication, types of lubrication, splash lubrication system, petrol lubrication system, forced feed lubrication system.

**Cooling System:**
Air cooling and water cooling – thermosympno cooling, forced cooling systems. Fins and radiator - design aspects.

**Design of Engine Components:**
Overall engine system parameter, configuration finalization, Design and Drawings of Piston, cylinder block & head, Connecting rod – Crankshaft, camshaft, valve train,

**New Engine Technology:**
Lean Burn engine, Different approaches to lean bum, LHR engine, Surface ignition concept, catalytic ignition, homogenous charge compression ignition (HCCI) in diesel engines, variable valve timing, Latest Trend.

**TEXTBOOK**

**REFERENCES:**

<table>
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<th>AUTOMOTIVE ENGINEERING SYSTEMS</th>
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<td>Tutorial: 2 hrs/Week</td>
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**Chassis & Body**
Classification of vehicle, layout with reference to power plant, steering location and drive, chassis, construction and details (frames, sub-frames, defects in frame, frameless vehicles, vehicle dimensions), details of chassis & body materials. Integrated body construction, BIW type and corresponding design parameters, Vehicle interior system (dash board & seating system), Cosole design, Pillar trims (Type A, B, C), head roofs.

**Transmission & Driveline**
Clutches, principle, types, Fluid coupling and torque convertors, problems on performance of automobile such as resistance to motion, tractive efforts, engine speed, power and acceleration requirements. Determination of gear box ratios for different vehicle applications, different types of gear boxes, Automatic transmission, Effect of driving thrust and torque-reaction, Hotchkiss drives, Torque tube drive, radius rods, Propeller shaft, Universal joints, Final drive- different types, two speed rear axle, Rear axle construction: full floating, three quarter floating and semi-floating arrangements, Differential: conventional type & Non-slip type, differential locks.

**Front Axle & Steering**

**Braking & Suspension**

Types of suspension, factors influencing ride comfort, types of suspension springs (leaf & coil springs), independent suspension (front and rear). Rubber, pneumatic, hydro-elastic suspension, Shock absorbers, types of wheels, construction of wheel assembly, types of tyres and constructional details, Static and rolling properties of pneumatic tyres, tubeless tyres and aspect ratio of tubed tyres.

**Electrical System**
Battery, Charging circuit, Alternator ,generator, current – voltage regulator – starting systems, bendix drive mechanism solenoid switch, lighting systems, Horn, wiper, fuel gauge – oil pressure gauge, engine temperature indicator, wiring harness, Trouble shooting.

**Text Books:**

**References:**
1. William Crouse, "Automobile Engineering “

**COMBUSTION ENGINEERING**
(Department Elective-I)

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**Thermodynamics of Combustion**
Premixed and diffusion combustion process in IC engines and gas turbines. First and Second Law of Thermodynamics applied to combustion: combustion Stoichiometry, chemical equilibrium, spray formation and droplet combustion.

**Chemical Kinetics of Combustion**

**Flames**
Laminar premixed – flame speed correlations, quenching, flammability, and ignition, flame stabilization, laminar diffusion flames, turbulent premixed flames-Damkohler number.

**Burning of Fuels:** spray formation & droplet behavior, gas turbine spray combustion, direct injection engine combustion, detonation of liquid – gaseous mixture, combustion of solid fuels,

**References**

**AUTOMOTIVE PASSION & SOFT SKILLS**
(Department Elective-I)

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**Introduction**
Introduction to Soft Skills, Personality Development and Human Values, Self Awareness & Esteem, Perception and Attitudes, Self Assessment & SWOT Analysis, Career Plan & Personal Goal setting, Building Personal Brand, Johari Window and Leadership.

**Communication and Skill Building**

**Ethics and Etiquettes:**
Professional Ethics & Etiquettes, Business Ethics, Corporate Ethics, Engineering Ethics, Office Etiquettes, Email Etiquettes, Telephone Etiquettes, Lunch/Dinner Etiquettes Social and Public Etiquettes.

**Soft Skills at Workplace:**
Business/Work Success:

Reference Books:

ENGINE TRIBOLOGY
(Department Elective-I)

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Introduction: Introduction of Tribology, General tribological considerations in the design of bearings, gears, cams, reciprocating components,

Engine Tribology Basics: Tribological aspects of engine components such as bearings, piston assembly, valve train and drive train components.

Surface Properties: Surface properties of metals, composites, Surface texture measurement and assessment, statistical methods of surface texture assessment.

Friction: Theories of friction, Sliding friction – Rolling friction characteristics of common metals and non-metals – friction under different environments. Engine friction – Losses and engine design parameters.

Wear: Wear theories, types of wear and their mechanism, factors affecting wear, selection of materials for different wear situations, measurement of wear, tribometers and tribometry. Engine wear mechanisms, wear resistant materials and coatings and failure mode analysis.

Lubrication: Hydrodynamics, basic concepts, generalized Reynolds equation, slider bearings, fixed & pivoted shoe bearings, hydrodynamic journals bearings, short and finite bearings, thrust bearings, sintered bearing, non-circular bearings and multi side surface bearings. Hydrostatic bearing -basic concepts, bearing pads, flat, conical and spherical pad thrust bearing, multi-recess journal and thrust bearings, air and gas lubricated bearings.

Lubricants: Type of lubricants, properties and testing, service, classification of lubricants, lubrication of tribological components, lubrication system, lubricant monitoring, SOAP, ferrography and other rapid testing methods for lubricants contamination.

Rheodynamics (Static ) Lubrication: Non-Newtonian fluids, characteristics, general recommendations of lubricants, SAE & other cloud numbers, thixotropic materials and Bingham solids, grease lubrication, tribology of components in extreme environments like vacuum, pressure, temperature,

Reference Books
2. Friction & Wear of Material, Ernest Rabinowicz

AUTOMOTIVE FUELS AND EMISSIONS
(Department Elective-I)

<table>
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**Introduction:** Estimate of petroleum reserve, need for alternate fuel, availability and comparative properties of alternate fuels, CNG, LPG, Alcohol, Vegetable oil and Bio-gas

**CNG and LPG:** Availability, properties, modifications required in SI and CI engines, performance and emission characteristics, storage, handling and dispensing, safety aspects. Alcohol - Manufacture of alcohol, properties, blending of Methanol and Ethanol, engine design modifications required and effects of design parameters, performance and emission characteristics, durability.

Types of vegetable oils for engine application, esterification, biogas, properties, engine performance and emission characteristics.

**Hydrogen and Fuel cells:** Production methods, properties, performance and emission characteristics, storage and handling, safety aspects, Working principle, classification, description of fuel cell systems, fuel cell components, properties of fuel cell, general performance characteristics, emission characteristics, merits and demerits, vehicle design and layout aspects.

**Emissions from SI & CI Engines and its Control:** Emission formation in S.I. engines – Hydrocarbons – Carbon monoxide – Nitric Oxide, Lead particulates – Polynuclear aromatic hydro carbon emission – Effects of design and operating variables on emission formation in spark ignition engines – Controlling of pollutant formation in engines – Thermal reactors – Catalytic converters – Charcoal Canister Control for evaporative emission – Positive crank case ventilation system for UBHC emission reduction.


**Emission Measurement and Test procedure:** Measurement of CO, CO2, by NDIR. Hydrocarbon by FID – Chemiluminescent detector for NOx measurement, Smoke meters – Dilution tunnel technique for particulate measurement. Procedures on Engine and Chassis


**References:**
SEMINAR

Seminar should be based on detailed study of any topic related to Automobile Engineering, preferably in the area in which the candidate would like to do the project work. The topic of the seminar shall be approved by the Guide and the Head of the Department on the basis of abstract submitted within the first month of the starting of the semester.

AUTOMOTIVE LAB-I (NVH Lab.)

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The term work shall consist of minimum eight exercises. Minimum two exercises from each subject based on preferably experimental measurements

1. Study of sound and vibration instrumentation, measurement and analysis.
2. Modal Analysis of Automotive components
5. Measurements of Tail Pipe Noise as per IS 10399
6. Vehicle Pass by Noise Measurement as per IS 3028
7. Evaluation of Normal Incidence Sound Absorption Coefficient
8. Evaluation of Sound absorption coefficient-Random incidence ISO354

Books & References:

1. Tail pipe noise measurement as per IS 10399
2. Vehicle Pass by Noise Measurement as per IS 3028

Semester-II

VEHICLE DYNAMICS

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Basic of Vibration

Tyres
Tire forces and moments, rolling resistance of tires, relationship between tractive effort and longitudinal slip of tyres, cornering properties of tyres, ride properties of tyre.

**Performance Characteristics of Vehicle**

**Handling Characteristics of Vehicles**
Steering geometry. Steady state handling characteristics. Steady state response to steering input. Transient response characteristics. Directional stability of vehicle.

**Dynamics of Suspension System**

**Textbook:**

**References:**

**AUTOMOTIVE ELECTRONICS**

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**Fundamentals of Automotive Electronics**
Components for electronic engine management system, open and closed loop control strategies, PID control, Look up tables, introduction to modern control strategies like Fuzzy logic and adaptive control. Parameters to be controlled in SI and CI engines.

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

**Digital Engine Control System**
Open loop and close loop control system, engine cooling and warm up control, idle speed control, acceleration and full load enrichment, deceleration fuel cutoff. Fuel control maps, open loop control of fuel injection and closed loop lambda control exhaust emission control, on-board diagnostics, diagnostics, future automotive electronic systems, Electronic dash board instruments – Onboard diagnosis system.

**SI Engine Management**
Feedback carburetor system, throttle body injection and multi point fuel injection system, injection system controls, advantage of electronic ignition systems, three way catalytic converter, conversion efficiency versus lambda. Layout and working of SI engine management systems like Bosch Monojetronic, L-Jetronic and LH-Jetronic. Group and
sequential injection techniques. Working of the fuel system components. Advantages of electronic ignition systems. Types of solid state ignition systems and their principle of operation, Contactless electronic ignition system, Electronic spark timing control.

**CI Engine Management**

**Reference Books:**
5. Understanding Automotive Electronics – Bechfold SAE 1998
6. Automobile Electronics by Eric Chowaniez SAE.
10. Eaglewood, Cliffs, NJ

**IC ENGINE MODELING**

<table>
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<td>Tutorial: 2 hrs/Week</td>
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**Fundamentals:** Governing equations, Equilibrium charts of combustion chemistry, Chemical reaction rates, Approaches of modeling, Model building and integration methods. Gas exchange through valves, engine and porting geometry, exhaust gas recirculation, valve lift curves.

**Thermodynamic Combustion Models of Engines:** Single zone models, premixed and diffusive combustion models, combustion heat release using Wiebe function, wall heat transfer correlations, ignition delay, internal energy estimations, two-zone model, applications of heat release analysis.

**Modeling of Charging System:** Constant-pressure and pulse turbocharging, compressor and turbine maps, charge air cooler.

**Fuel Spray Behavior:** Fuel injection, overall spray structure, fuel atomization, spray penetration, droplet size distribution, spray evaporation models, thick spray models, droplet turbulence-interactions, droplet impingement on walls.

**Mathematical Models of SI Engines:** Simulation of Otto cycle at full throttle, part throttle and supercharged conditions, progressive combustion, Autoignition Modeling, single zone models, multi-zone models and mass burning rate estimation, SI engine with stratified charge. Friction in pumping, in piston assembly, bearings and valve train etc. Friction estimation for warm and the warm-up engines.

**Text Books**
Reference Books:
15. Bosch Handbook

AUTOMOTIVE TESTING AND CERTIFICATION
(Department Elective-II)

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INTRODUCTION:
Classification of vehicles (including M, N and O layout), regulations overview (ECE, EEC, FMVSS, AIS, CMVR, ADR), specifications of vehicles & engines.

4 WHEELER PASSENGER VEHICLES-M1 CATEGORY (Vehicle Related Tests):
Photographs, CMVR physical verification, Vehicle weighment, Coast down test, Brake test, ABS, Turning circle diameter test, Steering effort test, Speedometer calibration, Pass by noise test, External projection test, Wheel guards, Hood latch test, Tell tale symbols, Gradeability test, Documentation VEL, Accelerator control system, Horn installation, Rear view mirror installation, Installation requirements for lighting & signaling devices, Windscreen Wiping system.

Wheel Nuts, Wheel Cap & Hub Cap, Vertical orientation for dipped beam - head lamp, Interior Fittings, Driver's field of vision (M1 category), Steering Impact test (GVW < 1500 kg), Body block test, Head form test, Fixture charges, Crash test, Bumper Testing, Documentation SHL, Engine power & smoke (diesel engine).


4 WHEELER PASSENGER VEHICLES-M1 CATEGORY (Component Related Tests):
Wheel nuts, wheel discs & hub caps, Door locks & door retention, Performance requirements for Lighting & Signaling devices, Head lamp assembly (Glass lens), Head lamp assembly (Plastic lens), Head lamp + Fr. Position lamp / Fr. Direction Indicator lamp / Fr. Fog lamp, Rear combination lamp (each additional function), Independent Fr. Position lamp / Fr. Direction Indicator lamp / Fr. Fog lamp, Rear combination lamp (single function), Fuel tank: Metallic, Plastic (excluding fire resistance test), Bumper (F&R), Warning Triangles, Safety belt assemblies, Safety belt anchorages, Seat anchorages and head restraints.

BOOKS & REFERENCES:
1. Bosch Automotive Handbook
3. ECE,
4. EEC,
5. FMVSS,
6. AIS,
7. CMVR,
8. ADR

GLOBAL PRODUCT DEVELOPMENT
(Department Elective-II)

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**Introduction:** A project-based course in which each student team comprising students from different universities/courses will be responsible for development of a product for the global market. Teams will use collaboration technology tools extensively. Several case studies on global product development will be presented and follow-up lectures will focus on the issues highlighted.

**Product Design:** Definition of Design – Industrial Product vs Consumer Products – Asthetic vs Functional design – Various techniques reducing product development cycle time – Product planning – Product life cycle – Cost of development.


**Product Features:** – Identifying customer needs – Concept generation – Techniques for identifying product features – Quality function deployment (QFD) – Concern for manufacturability, Serviceability, Maintainability, disposal problem – Ergonomical factors.


**Design Synthesis:** Integration of ideas, concepts, and fundamentals of science and engineering into preliminary design; synthesis of technical, human, and economic factors. Mathematical modeling and design optimization.

**Fatigue in Mechanical Design:** A broad treatment of stress, strain, and strength with reference to engineering design and analysis. Major emphasis is placed on the analytical and experimental determination of stresses in
relationship to the fatigue strength properties of machine and structural components. Also considered are deflection, post-yield behavior, residual stresses, temperature and corrosion effects.

References

AUTOMOTIVE AERODYNAMICS
(Department Elective-II)

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Introduction

Aerodynamic Drag of Cabs

Shape Optimization Of Cabs

Vehicle Handling

Wind Tunnels For Automotive Aerodynamics

Textbook:

References:
AUTOMOTIVE HEATING VENTILATION AND AIR CONDITIONING
(Department Elective-II)

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Fundamentals of Air-Conditioning, Cooling and Heating System
Basic terminology, design factors and concepts related to air conditioning system
- Construction and Working principles of Thermostatic Expansion valve and Orifice tube based system - Heating system types - detailed study of HVAC components like compressor, evaporator, condenser, TXV, orifice tube, Receiver-drier, heater core etc. Location of air conditioning components in a vehicle.

Refrigerants & Air Management Systems
Refrigerants:
Temperature and pressure relation, Properties of R-12 and R134a - refrigerant oil  
Simple problems - Containers - Handling refrigerants - Tapping into the refrigerant container - Ozone Layer Depletion.

Air management system:
Air routing for manual, semi and automatic system- cases and ducts- Air distribution, control head and doors- Defrost system, Refrigerant charging, system installation.

Automatic Climate Control System
ATC system block diagram- different types of Sensors and Actuators, - Control Logic Electrical wiring diagram of manual and automatic system - multiplexing between BCM and PCM- control of compressor clutch, blower motor etc.- diagnostics tools and features.

Modeling of Air-Conditioning Components
Modeling of Fixed and variable Displacement type compressor, evaporator modeling - heat transfer correlations for the fluids inside the evaporator, analysis of evaporator frosting- condenser modeling - improvement of refrigerant flow control method.

Air Conditioning Diagnosis And Services
AC system diagnosis based on temperature and pressure measurements, sight glass, sound etc. - refrigerant leak detection- Trouble shooting and Servicing of compressor, evaporator, condenser, heater core etc. – HVAC equipment, recovery and charging.
Air routing system service.

Textbooks:

References:
5) SAE paper No: 931121,900084, 850040,931137,870029 etc.
6) Vehicle Service Manuals.
7) ASHRAE Handbook, All four volumes.
AUTOMOTIVE LAB - II

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<td>Lectures: 4 hrs/week</td>
<td>Term Work / Tutorials 100</td>
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The term work shall consist of minimum eight exercises. Minimum two exercises from each subject based on preferably experimental measurements.

**Engine:**
1. Performance test on Gasoline engine
2. Performance & emission test on Genset diesel engine
3. Performance & emission test on CNG engine

**Emission:**
5. Performance & emission test on Heavy duty diesel engine (transient Dyno)
7. Study of Emission test for SI Engine 3 wheelers on Chassis Dynamometer.

**Fuel:**
9. Analysis of Carbonyl Compound from exhaust emission using HPLC.

**Reference Books:**
5. Introduction to engine testing and development SAE R-344, Atkins, Richard D, SAE Publisher, 2009

INTELLECTUAL PROPERTY RIGHTS

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<td>Lectures : 1 hr/week</td>
<td>End-Sem Exam- 50</td>
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**Unit 1**

**Unit 2**

**Unit 3**

**Unit 4**
New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.
Unit 5

Registered and unregistered trademarks, design, concept, idea patenting.

Reference Books
- Resisting Intellectual Property by Halbert, Taylor & Francis Ltd, 2007
- Industrial Design by Mayall, McGraw Hill
- Product Design by Niebel, McGraw Hill
- Introduction to Design by Asimov, Prentice Hall
- Intellectual Property in New Technological Age by Robert P. Merges, Peter S. Menell, Mark A. Lemley

Mini Project
Min project includes topics such as design, fabrication, analysis, simulations, field study, market survey and case study etc.

Semester-III

ENVIRONMENTAL SCIENCES

Teaching Scheme

Lectures: 1 hr/week

Examination Scheme

End-Sem Exam- 50

Unit 1
Multidisciplinary nature of environmental studies: Definition, scope and importance, need for public awareness.

Unit 2
Natural Resources:
Renewable and non-renewable resources: Natural resources and associated problems.
Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources.

Unit 3
Biodiversity and its conservation: Introduction – Definition: genetic, species and ecosystem diversity, Biogeographically classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values,

Unit 4
Environmental Pollution: Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste Management.

Unit 5
Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns.

Text Books
- Marine Pollution by Clark R.S. Clanderson Press Oxford
- Environmental Chemistry by De A.K., Wiley Eastern Ltd.
- Global Biodiversity Assessment by Heywood, V.H & Waston, R.T. 1995.. Cambridge Univ. Press
CONSTITUTION OF INDIA

Teaching Scheme

Lectures : 1 hr/week

Unit 1
Preamble to the constitution of India. Fundamental rights under Part – III, details of Exercise of rights, Limitations & Important cases.

Unit 2
Relevance of Directive principles of State Policy under Part – IV, Fundamental duties & their significance.

Unit 3
Union Executive – President, Prime Minister, Parliament & the Supreme Court of India.

Unit 4
State executive – Governors, Chief Minister, State Legislator and High Courts

Unit 5

Unit 6
Electoral process, Amendment procedure, 42nd, 44th, 74th, 76th, 86th and 91st Constitutional amendments.

Examination Scheme

End-Sem Exam- 50

Text Books

- Engineering Ethics by Charles E.Haries, Michael S.Pritchard and Michael J.Robins Thompson Asia, 2003-08-05.

Reference Books

AUTOMOTIVE MATERIALS AND MANUFACTURING

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**Advanced Materials:** Composites – non metallic and metallic. Other specialty materials used in Automotive design and manufacturing. Role of Nano technology in Automotive systems.

**Mechanics of Polymers:** Constitutive equation for linear small strain viscoelastic response; constant rate and sinusoidal responses; time and frequency dependent material properties; energy dissipation; structural applications including axial loading, bending, torsion; three dimensional response, thermo-viscoelasticity, correspondence principle, Laplace transform and numerical solution methods.

**Composite Materials:** Mechanics, Manufacturing and Design. Composite materials, including naturally occurring substances such as wood and bone, and engineered materials from concrete to carbon-fiber reinforced epoxies. Development of micromechanical models for a variety of constitutive laws. Link between processing and as-manufactured properties through coupled fluid and structural analyses.

**Smart Materials and Structures:** Theoretical aspects of smart materials, sensors and actuator technologies. It will also cover design, modeling and manufacturing issues involved in integrating smart materials and components with control capabilities to engineering smart structures.

**Materials in Manufacturing and Design:** Material selection on the basis of cost, strength, formability and machinability. Advanced strength analysis of heat-treated and cold-formed parts including axial, bending, shear and cyclic deformation. Correlations of functional specifications and process capabilities. Problems in redesign for productability and reliability.


**Time Series Modeling:** Analysis, Forecasting. Time series modeling, analysis, forecasting, and control, identifying parametric time series, autovariance, spectra, Green's function, trend and seasonality. Examples from manufacturing, quality control, ergonomics, inventory, and management.


COMPUTATIONAL MODELING AND SIMULATION

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<td>Tutorial: 2 hrs/Week</td>
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**Introduction to CFD:** Computational approach to Fluid Dynamics and its comparison with experimental and analytical methods, Basics of PDE: Elliptic, Parabolic and Hyperbolic Equations.

**Governing Equations:** Review of Navier-Stokes Equation and simplified forms, Solution Methodology: FDM and FVM with special emphasis on FVM, Stability, Convergence and Accuracy.

**Finite Volume Method:** Domain discretizations, types of mesh and quality of mesh, SIMPLE, pressure velocity coupling, Checkerboard pressure field and staggered grid approach

**Geometry Modeling and Grid Generation:** Practical aspects of computational modeling of flow domains, Grid Generation, Types of mesh and selection criteria, Mesh quality, Key parameters and their importance

**Methodology of CFDHT:** Objectives and importance of CFDHT, CFDHT for Diffusion Equation, Convection Equation and Convection-Diffusion Equation


**Reference Books**

3. An Introduction to Computational Fluid Flow (Finite Volume Method), by H.K. Versteeg, W. Malalasekera, Prentice Hall

AUTOMOTIVE DESIGN
(Department Elective-III)

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**Fatigue strength and design of springs:** Variable and cyclic loads – Fatigue strength – S- N curve – Continued cyclic stress – Soderberg and Goodman equations – Design of Helical – Leaf - Disc springs under Constant and Varying loads.

**Design of Clutches and Gear Boxes:** single plate, multiple plates, centrifugal clutch, lining material, lever design, sliding mesh, constant mesh, synchromesh gear box, gear ratio and gear shifting lever, sliding mechanism

**Design of Drivetrain:** Design of propeller shaft and U-joints, Design of propeller shaft, criteria, failure theories, U-joint design, Design of Final drive and differential, Design of bevel, worm and hypoid type of final drive, differential.

**Design of axel and Steering:** Axle and shaft design, design of fully floating, half floating axle and dead axle, Steering gear and steering mechanism design, geometry for correct steering, linkages

**Design of brakes and Suspension:** internal expanding shoe brake, braking condition, friction lining material, mechanical and hydraulic braking system, leaf spring, coil spring, materials, suspension system and linkages, independent suspension

**Automotive Body Structures:** Emphasis is on body concept for design using first order modeling of thin walled structural elements. Practical application of solid/structural mechanics is considered to design automotive bodies for global bending, torsion, vibration, crashworthiness, topology, material selection, packaging, and manufacturing constraints.

**Text Books :**


**Reference Books:**

1. DTB Donkins, Elements of Motor Vehicles Design, TMH
2. P. Lukin, Automobile Chasis Design and calculations, Mir Publishers

### AUTOMOTIVE SAFETY AND LIGHTING
(Department Elective-III)

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Introduction to safety and Vehicle structural crashworthiness & Crash testing

**Automotive Safety:** Active and passive safety, Driver assistance systems in automobiles, Definitions and terminology, Balance of stiffness and toughness characteristics and energy absorption characteristics of vehicle structures, Design of crash crumple zones, Modeling and simulation studies, Optimization of vehicle structures for crash worthiness, Types of impacts, and Impact with rebound, movable barrier tests, Analysis and simulation of vehicle in barrier impacts, Roll over crash tests, Behavior of specific body structures in crash testing, Photographic analysis of impact tests, Regulatory requirements for crash testing.

**Ergonomics and Human response to Impact:** Importance of Ergonomics in Automotive safety, Locations of controls, Anthropometry, Human impact tolerance, Determination of Injury thresholds, Severity Index, Study of comparative tolerance, Application of Trauma for analysis of crash injuries. Injury criteria’s and relation with crash and modeling and simulation studies in dummy.
Vehicle safety systems: Survival space requirements, Restraints systems used in automobiles, Types of safety belts, Head restraints, Air bags used in automobiles, Use of energy absorbing systems in automobiles, Impact protection from steering controls, Design of seats for safety, types of seats used in automobiles. Importance of Bumpers in automobiles, Damageability criteria in bumper designs. Introduction to the types of safety glass and their requirements and rearward field of vision in automobiles, Types of rear view mirrors and their assessment. Warning devices, indicators, hinges, latches, wipers, horns, etc.


Light Measurements, Testing equipment, calibration and photometric practice: Basics of standards and detectors, spectral measurements and Colorimetry, illuminant meters and luminance meters, colorimeters. Fundamentals of equipment used for light measurement in Automotive field; Gonio-Photometer, Reflecto-meter, Colorimeter, Integrating sphere, types, application, coordinates system, Types of sensors and working principle, construction, characteristics etc. used in different equipment. National and international Regulations, test requirements and testing procedure.

New Technology in Automotive lighting: Technology progress in automotive lighting, Gas Discharges lamps, LED, adoptive front lighting system, Daylight running lamps.

References:

FINITE ELEMENT METHOD
(Department Elective-III)

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Introduction: Steps in finite element method, descretisation, types of elements used, Shape of functions, Linear Elements, Local and Global coordinates, Noddle degrees of freedom, Finite element formulation, variational, weighted residual and virtual work methods, Field problems, irrotational flow, conduction heat transfer, electromagnetic and electrostatic fields, Quasi harmonic equation, Axisymmetric field problems, computer implementation, higher order elements, isoparametric version, Application to non-linear problems, solution to Navier Stokes equations, phase change, radiation, temperature dependant materials, stress analysis in simple cases, axisymmetric solids, stress concentration factors,

References Books:

AUTOMOTIVE ENABLING TECHNOLOGIES AND SIMULATION
(Department Elective-III)

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**Introduction to Finite-Element Method:** Concepts and applications of the finite element method. Development and applications of basic elements used in engineering mechanics. Use of finite-element analysis software. Application of finite-element concept to several areas of mechanics.

**Introduction to Computational Fluid Dynamics:** Review of governing equations of fluid dynamics, mathematical behavior of partial differential equations, basic aspects of discretization, basic CFD techniques, basic grid generations, coordinate transformations, advanced numerical schemes, future CFD methodology.


**Introduction to Turbulent Flows:** Characteristics of turbulence, length and time scales, energy cascade, vorticity stretching, Reynolds averaging technique, Closure problem, Boussinesq hypothesis, Eddy viscosity concepts, introduction to zero-, one- and two-equation models, Reynolds stress model.

**Computational Structural Mechanics I.** Modeling and simulation of three-dimensional solid bodies using computational methods. Fundamental principles in structural mechanics and basic concepts of numerical methods. Practice of static, vibration, and high-speed impact simulation using finite element codes.

**Numerical Mesh Generation.** Mesh generation strategies, error analysis, and their role in field simulation systems and engineering applications. Structured and unstructured meshing algorithms including algebraic, elliptic, parabolic, hyperbolic, advancing front and Delaunay triangulation methods, computer aided geometry techniques and surface generation schemes.

**Computer Aided Geometry Design.** Bezier curves, polynomial interpolation, splines, NURBS, tensor product Bezier surfaces, composite surfaces, Differential Geometry, Parametric curves and surfaces, decimation and refinement algorithms.

**Computer Visualization Techniques in Engineering.** Introduction to the importance of scientific visualization in engineering, algorithms in data visualization, computer graphics, and visualization software.

**Advanced Visualization and Virtual Reality.** Advanced scientific visualization in engineering, algorithms in data visualization, computer graphics, and visualization software.

**Fluid Structure Interactions.** Modeling and simulation of fluid-structure interaction (FSI) phenomena using computational methods. The Arbitrary Lagrangian Eulerian (ALE) formulation, a variety of interpolation methods, mesh movement and time mapping algorithms, Solution of FSI problems using the interface codes.

**Enabling Technology Tools for Scientists.** Computational methods and tools for simulations and modeling of mechanical and biomedical applications. Numerical geometry, numerical mesh generation, and scientific visualization tools will be introduced and applied.
**Parallel Computational Simulations.** Parallel algorithms for high fidelity simulations will be covered using domain decomposition strategies. Performance evaluation and metrics will be developed. MPI, OpenMP, PVM, and other parallel message passing languages will be described. Shared and distributed memory machines will be considered.

**APPLIED PHYSICS**
(Department Elective-III)

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**Multidisciplinary perspective that includes:** Applied physics, engineering, art, psychology, marketing, and economics. Using a decision-making framework, emphasis placed on quantitative methods. Building mathematical models and accounting for interdisciplinary interactions.


**Laser:** Laser characteristics, Einstein's coefficients- its significance, population inversion, three levels, four level laser – Schawlow and Townes condition- Nd. YAG, He-Ne-CO₂ laser welding, drilling, cutting- optical disk systems, recording data readout from optical disks, Holography, Recording and Reconstruction- Problems.

**Fiber Optics:** Light propagation through fibers, Acceptance angle, and numerical aperture- types of fibers, step index, graded index, single mode, multimode dispersion, intermodal, intramodal application of fiber optics in communication, source LED, Laser diode, Detector, PIN photo diode endoscope, problems.

**Ultrasound and Microwaves:** Properties, generation, Magnetostriction method, Piezo-electric method - detection of ultrasonic- applications-NDT Characteristic features of micro waves, TE and TM modes, Klystron- Gunn diode-applications of microwaves.

**Nano Technology:** Nanoscale, Nanomaterials, properties of Nanomaterials, Moore's Law Semiconductor, nanoparticles, Nanocomposites, Quantum well, Wire, Dots, Nanolithography, Applications of Nanotechnology, Aerospace components, sensors, Medicine.

**Reference Books:**

DISSERTATION STAGE – I

The Project work will start in semester III and should preferably be a live problem in industry or a micro issue having a bearing on performance of the automobile industry and should involve scientific research, design, generation / collection and analysis of data, determining solution and must preferably bring out the individual contribution. The dissertation should be presented in standard format. The oral examination shall be conducted with the help of approved external examiner

Semester-IV

DISSERTATION STAGE-II

The project work will start in semester III and will continue in the semester-IV. The problem should preferably be a live problem in industry or a micro issue having a bearing on performance of the automobile industry and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution. The dissertation should be presented in standard format. The oral examination shall be conducted with the help of approved external examiner
Mechanical engineering careers center on creating technologies to meet human needs. Every product or service has been touched by a mechanical engineer. Mechanical engineering is one of the broadest engineering disciplines. Mechanical engineers design, develop, build, and test. They deal with anything that moves, from components to machines to the human body. What Is Mechanical Engineering?