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*marked subjects are common with B. E. (Mechanical) 2008 course

****Open Elective Subjects – BoS Automobile/Mechanical will declare the list of subjects which can be taken under open electives. Open Elective may be a subject in the list of electives offered by the same institute, in the same semester of any branch.
University of Pune
B E (Automobile Engineering) Part I (2008 Course)
416488 Automotive Refrigeration and Air Conditioning

Teaching Scheme
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<th>Lectures</th>
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<tbody>
<tr>
<td>Practical</td>
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Examination Scheme
| Theory         | 100 Marks |
| Term work      | 25 Marks  |
| Practical      | 50 Marks  |

Section- I

Unit-1: Refrigeration Fundamentals
Introduction to refrigeration & vapour compression system, cycle diagram (Carnot cycle, Reverse Carnot cycle, Simple vapor compression cycle, bell Coleman cycle), effects of various operating parameters on performance of A/C System.

Unit-2: Refrigerants & Air conditioning Components

Unit-3: Air distribution system

Section- II

Unit-4: Psychrometry
Moist air as a working substance, Psychrometric properties of air, Use of Psychrometric tables and charts, Processes, Combinations and Calculations, ADP, Coil Condition line, Sensible heat factor, Bypass factor.

Unit-5: Load analysis & control devices
Load Analysis: Outside & inside design consideration, Factors forming the load on refrigeration & air conditioning systems, Cooling & heating load calculations, Load calculations for automobiles, Effect of air conditioning load on engine performance, Air conditioning electrical & electronic control, pressure switching devices, sensors & actuators.

Unit-6: Diagnostics, Trouble Shooting, Service & Repair
Initial vehicle inspection, temperature measurements, pressure gauge reading & cycle testing, leak detection & detectors, Sight glass.
Refrigerant safety/handling, refrigerant recovery; recycle & charging, system oil, system flushing, odor removal, retrofitting. Removing & replacing components, Compressor service.
Term Work:

The term work shall consist of record of minimum eight experiments from the following: (Experiment No 10 is compulsory)

1. Test on vapour compression test rig.
2. Test on air conditioning test rig.
3. Study of various methods of transport refrigeration systems.
4. Study and demonstration on car & bus air conditioning system.
5. Study of defrosting methods.
6. Study and demonstration of controls in refrigeration.
7. Study of different components with the help of cut sections/models/charts- Compressor, Condenser, Evaporators, Expansion device, Blower fans, Heating systems etc.
8. Study of installation/operations/maintenance practices for refrigeration systems.
9. Study of leak testing and leak detection methods.
10. Visit to maintenance shop of automotive air conditioning and writing report on it.

References:

2. Steven Daly: “Automotive air conditioning & Climate control systems”
3. Tom Birch: “Automotive heating & air conditioning”; Prentice Hall
University of Pune  
B E (Automobile Engineering) Part I (2008 Course)  
416489 Machine and Vehicle Dynamics

<table>
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Section- I

Unit-1: Balancing  08
Balancing of rotating masses in one and several planes, balancing of reciprocating masses in single and multi cylinder engines: in-line, radial and V-type, primary and secondary balancing analysis, concept of direct and reverse cranks method, static and dynamic balancing machines.

Unit-2: Single Degree of Freedom Systems - Free and Damped Vibrations  10
Fundamentals of Vibration: Elements of a vibratory system, S.H.M., degrees of freedom, modeling of a system, concept of linear and non-linear systems, equivalent spring, linear and torsional systems.
Undamped free vibrations: Natural frequency by equilibrium and energy methods for longitudinal and torsional vibrations.
Damped free vibrations: Different types of damping, equivalent viscous damping, free vibrations with viscous damping - over damped, critically damped and under damped systems, initial conditions, logarithmic decrement, dry friction or coulomb damping - frequency and rate of decay of oscillations.

Unit-3: Single Degree of Freedom Systems - Forced Vibrations  08
Forced vibrations of longitudinal and torsional systems, Frequency Response Functions - Simple harmonic excitation, excitation due to reciprocating and rotating unbalance, base excitation, magnification factor, resonance phenomenon and phase difference, Quality Factor, Vibration Isolation, Force and Motion transmissibility.

Section - II

Unit-4: Vehicle Dynamics:  10
Scope, Fundamentals, and Challenges, - Modelling philosophy and coordinate systems, Axle Loads, Acceleration - free body diagram of accelerating vehicle, maximum transferable tractive force, gradability, deceleration - maximum decelerating rates, stopping distance, maximum braking force, adhesion utilization - Straight line motion - aerodynamic forces and moments, viscosity effects - separation and its control - aerodynamic lift and its control - ground effect - profile for minimum drag.

Unit-5: Ride Mode  08
Ride performance criteria, Mathematical modeling of vehicle ride - Effects of damping the vibration, vibration absorbers, pitch and bounce motion, oscillation centers - active and semi active suspension - orthogonality of mode shapes, modal analysis, vehicle performance testing, Practical suspension system design for ride.

Unit-6: Handling Mode  08
Handling performance criteria, The mathematical modelling of vehicle handling - Tyres - mechanics, testing and modeling, vehicle control - low speed cornering and static steering -Ackerman steering geometry, steady-state cornering - steering factors, vehicle control parameters (under steer, neutral steer and over steer), steady state handling – lateral acceleration gain, characteristic speed, yaw
velocity gain and critical speed - effect of braking on vehicle handling - constant radius testing - fish hook measurement testing. Practical suspension system design for handling and the trade-off with ride.

**Term Work:**
The Term Work shall consist of any eight experiments of following.
1. Experimental verification of dynamic balancing of rotating masses.
2. To determine the natural frequency of damped vibration of single degree freedom system and to find it’s damping coefficient.
3. To verify natural frequency of torsional vibration of two rotor system and position of node.
4. To determine critical speed of single rotor system.
5. To determine resonance frequency of transverse vibration of beam.
6. To determine the frequency response curve under different damping conditions for single degree freedom system of vibration
7. Multi body simulation of steering and suspension components using any of the following mentioned FEA and MBD software’s. (Compulsory)
8. To study shock absorber & to plot transmissibility curve.
9. Measurement of vibration parameters like frequency, amplitude, acceleration of any vibrating system by using vibration measuring instruments.
10. Analysis of machine vibration signature using any analysis software.

**Softwares:**
Ansys, Abaqus, MSC-Nastran, MSC Adams, Motion Solve, AMESim, CarSim, and Matlab

**Reference Books:**
8. Maurice Olley, “Chassis Design – Principles and Analysis”, Bentley publishers
14. Church, A. W., “Mechanical Vibration”, John Wiley and Sons, USA
Unit-1: Statistical Consideration in Design and Optimization:  
Ergonomics and Aesthetic Design, Statistics in design, design for natural tolerances, statistical analysis, and mechanical reliability. Introduction to design optimization of mechanical elements, adequate & optimum design, methods of optimization, Johnson’s method of optimum design-Simple problems in optimum design like axially loaded members, shaft subjected to tensional and bending moments and other machine elements.

Unit-2: Design of Clutches:  
Design requirements of friction clutches, selection criterion, torque transmission capacity, lining materials, Design of single plate clutch, multi-plate clutch and centrifugal clutch

Unit-3: Design of Gearbox:  
Selection of gear ratios & final drive ratio, Design of gears, shafts, splines and housing, selection of bearings.

Section – II

Unit-4: Design of Propeller Shafts and Axles:  
Design of Propeller shafts for bending, torsion & rigidity, Design of universal joints and slip joints, final drive, Design of front & rear axles,

Unit-5: Brake Systems:  
Design of Hydraulic Braking System, Internal Expanding Shoe Brake and Disc Brake Design of master cylinder, drum cylinder and piping design

Unit-6: Design of Suspension and Steering System:  
General design considerations of suspension system, Design of leaf springs for automobile suspension system, Design considerations of Belleville springs, Elastomeric springs, Air (Pneumatic) springs. Design considerations of Steering System and Vehicle Frame.

Term Work: (Minimum two)  
1. Design for working details and assembly drawing of automotive clutch system. (Two full imperial sheets along with design calculations report) shall comprise of:
   • Functional design of clutch
   • Design of clutch shaft, hub and flange
   • Design of damper springs
   • Design of sectors, rivets etc.
   • Design of pressure plate assembly
   • Design for linkage mechanism
   • Details and assembly drawing
2. Design for working details & assembly drawing of automotive gear box along with reverse gear (Two full imperial sheets along with design calculations report) shall comprise of:
   • Calculation of gear ratios
   • Determination of number of teeth on gear pair
   • Determination of gear reductions
   • Design of gear pairs
   • Design of shafts
   • Selection of bearings
   • Details and assembly drawing
3. Design of automotive brake system.

Reference Books:

SECTION - I

Unit-1: Fundamental of fluid mechanics
Energy, Momentum, continuity and state equations, velocity of sound, Adiabatic steady state flow equations, Flow through converging, diverging passages, Performance under various back pressures. Types of flow- steady, unsteady, uniform, non-uniform, laminar, turbulent, One, Two and Three dimensional, compressible, incompressible, rotational, irrotational. Stream lines, path lines, streak lines, velocity components, convective and local acceleration, velocity potential, stream function, Lift and Drag, Classification of Drag.

Unit-2: Aerofoil in high speed flows
Flow around circular cylinder and Aerofoil, Development of lift on Aerofoil, Lower and upper critical Mach numbers, Lift and drag divergence, shock induced separation, Characteristics of swept wings, Effects of thickness, camber and aspect ratio of wings, Transonic area rule, Tip effects.

Unit-3: Fundamental of aerodynamics
Scope, historical development trends, 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.

SECTION - II

Unit-4: Shape optimization of cars
The origin of forces and moments, effects, Front end modification, front and rear windshield angles, vehicle dynamics under side wind, force moment coefficients, dirt accumulation on vehicle, wind noise, air flow around individual components, boat failing, hatch back, fast back & square back dust flow pattern at rear, effect of gap configuration, effect of fastener.
Introduction to CFD Methodology – Application to vehicle aerodynamics.

Unit-5: Wind tunnel testing 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.

Unit-6: Vehicle Styling
Vehicle body types - body styles, front grill shapes, headlight shapes, side vent, rear side shapes, overall profiles, visual features, aesthetic preference, specific brand image, Vehicle color - color codes, Introduction to computer-aided concept design system.
Term Work:

Any eight experiment from the following
1. Experimental study of flow past cylinder in a wind tunnel
2. Measurement of lift and drag force on circular disc, cylinder and sphere in wind tunnel
3. Measurement of lift and drag force on aero foil shape
4. Measurement of lift and drag force on scaled models of various vehicles
5. Visit to automotive testing organization
6. Preparation of vehicle body outline for best aerodynamics with desired inside volume of the vehicle
7. Measurement of wind noise around the vehicle body
8. Study of aesthetic features of car bodies
9. Study of flow conditions over the vehicle with the help of CFD
10. Study of effect of different shapes, styles and exterior objects on drag force

Reference Books:
5. Cengel & Cimbla Fluid Mechanics, TATA McGraw-Hill
7. W.H.Huco – “aerodynamic of road vehicle”
8. Schlichting H “boundary layer theory”
University of Pune  
B E (Automobile Engineering) Part I (2008 Course)  
416491 Elective - I B- Tribology*

Teaching Scheme | Examination Scheme
--- | ---
Lectures 4 hrs/week | Theory 100 Marks
Practical 2 hrs/week | Term work 25 Marks

**Section- I**

**Unit-1: Introduction to Tribology**
Introduction to Tribology, Tribology in design, Tribology in industry, economic aspects of Tribology, lubrication, basic modes of lubrication, lubricants, properties of lubricants - physical and chemical, types of additives, extreme pressure lubricants, recycling of used oils and oil conservation, disposal of scrap oil, oil emulsion.

Types of sliding contact bearings, comparison of sliding and rolling contact bearings

**Unit-2: Friction and Wear**
Wear: Types of wear, various factors affecting wear, measurement of wear, wear between solids and liquids, theories of wear.

**Unit-3: Hydrodynamic Lubrication**
Hydrodynamic lubrication: Theory of hydrodynamic lubrication, mechanism of pressure development in oil film, two-dimensional Reynold’s equation, infinitely long journal bearing, infinitely short journal bearing, finite bearing
Hydrodynamic thrust bearing: Introduction, flat plate thrust bearing, pressure equation, load, center of pressure, friction in tilting pad thrust bearing.

**Section -II**

**Unit-4: Hydrostatic Lubrication**
Hydrostatic lubrication: Basic concept, advantages and limitations, viscous flow through rectangular slot, load carrying capacity and flow requirement of hydrostatic step bearing, energy losses, optimum design of step bearing. Compensators and their actions.
Squeeze film lubrication: Introduction, circular and rectangular plates approaching a plane.

**Unit-5: Elasto-hydrodynamic Lubrication and Gas Lubrication**
Elasto-hydrodynamic Lubrication: Principle and application, pressure - viscosity term in Reynold’s equation, Hertz theory. Ertel-Grubin Equation
Gas lubrication: Introduction, merits and demerits, applications.
Lubrication in metal working: Rolling, forging, drawing and extrusion. Bearing materials, bearing constructions, oil seals, shields and gaskets.

**Unit-6: Surface Engineering**
Introduction to surface engineering, concept and scope of surface engineering, manufacturing of surface layers, solid surface-geometrical, mechanical and physico chemical concepts, superficial-layer, development of concept, structure of superficial layer, general characteristics of superficial layer, obtained by machining, strengthening and weakening of superficial layer.
Surface Engineering for Wear and Corrosion resistance: Diffusion, coating, electro and electroless plating, hot deep coating, metal spraying, cladded coating, crystallizing coating, selection of coating for wear and corrosion resistance, potential properties and parameters of coating.
Term Work:

A] Any one case study out of the following
   1. Friction in sliding/rolling contact bearing.
   2. Wear of cutting tool.
   3. Corrosion and Surface coating.
   4. Sliding/rolling contact bearing performance.

B] Assignment based on the Tribological design of the system like I C Engine, Machine Tool, Rolling Mill.

   OR

   Industrial visit: students should visit the industry to study the lubrication systems or to study the techniques of surface coating.

   OR

   Seminar on recent trends in Tribology or related areas: Seminar on recent trends in Tribology or related areas shall be given by the student. A seminar report shall be submitted as a part of term work.

Reference Books

2. B. C. Majumdar, “Introduction to Tribology and Bearings“, S.Chand and Company Ltd. New Delhi
3. Fuller D. D., “Theory and Practice of Lubrication for Engineers“, John Wiley and Sons

*Common with B.E. (Mechanical) 2008 Course
University of Pune
B E (Automobile Engineering) Part I (2008 Course)
416491 Elective – I C- CAD –CAM and Automation*

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**Section- I**

**Unit-1: Computer Graphics**  
08
Introduction to open GL and commands required for the transformation.

**Unit-2: Modelling**  
10

**Unit-3: Finite Element Analysis**  
08
Trusses: Introduction, 2D Trusses, Assembly of Global Stiffness Matrix.
Introduction, Constant Strain Triangle Problem, Modeling and Boundary Conditions.

**Section -II**

**Unit-4: Computer Aided Manufacturing**  
08
CAD Hierarchy, Integrating CAD, NC and CAM, NC programming using G and M codes adoptable to FANUC controller for lathe and milling, Generative programming on CNC, DNC, Adaptive control system, CIM,CAPP.

**Unit-5: Introduction to Automation**  
10
Types of Automation, Transfer line mechanism, Geneva mechanism, Group Technology, Automated guided Vehicles, Automatic Storage and Retrieval System, Flexible Manufacturing System

**Unit-6: Robot Technology**  
08
Classification and Structure of Robotic Systems Point-to-Point Robotic Systems, Continuous Path Robotic System. Configurations of Robotic system, Joints, Drives, Controller, Types of end effectors mechanical, magnetic, pneumatic etc., Industrial Applications of Robots, Robot Programming, Programming Languages.
Term Work
The term work shall consist of record of six assignments of problems based on the following topics:
1. OpenGL program on transformation
2. Stress and deflection analysis of two dimensional truss using finite element package.
3. Stress and deflection analysis of any Mechanical component consisting of 2-D or 3-D elements using finite element package.
4. Tool path generation using CAM software and Manufacturing on CNC.
5. Demonstration on any one industrial robot or Industrial visit to automation plant.
6. Assignment on Robot gripper design/ Robot programming.

Reference Books

6. Groover M.P. -Automation, production systems and computer integrated manufacturing’ - Prentice Hall of India

*Common with B. E. (Mechanical) 2008 Course
University of Pune
B E (Automobile Engineering) Part I (2008 Course)
416491 Elective – I D- Automotive NVH

Teaching Scheme
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Examination Scheme
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<tbody>
<tr>
<td>Term work</td>
<td>25 Marks</td>
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Section – I

Unit-1: Introduction to NVH
Noise, Vibration and Harshness (NVH) and its role in automotive design and development. Physiological effects of noise and vibration, sources of vibration and noise in automobiles.

Unit-2: Basics of Vibration Analysis
Basic concepts, mathematical models, formulating the equations of motion - linear and torsional system characteristics and response – damped and undamped single & two degree of freedom systems under harmonic force, coordinate coupling, generalized coordinates and modal analysis.

Unit-3: Vibration Control Techniques
Vibration isolation, tuned absorbers, untuned viscous dampers, damping treatments, Applications: isolation of the engine from vehicle structure and control of torsional oscillation amplitudes in engine crankshaft.

Section – II

Unit-4: Noise Fundamentals
Fundamentals of acoustics – general sound propagation – structure borne sound & air borne sound, Plane wave propagation - wave equation, specific acoustic impedance, acoustic intensity, Spherical wave propagation – acoustic near and far fields, Reference quantities, The decibel scale, relationship among sound power, sound intensity and sound pressure level, summation of pure tones, Decibel addition, subtraction and averaging, Effects of reflecting surfaces on sound propagation, octave band analysis, Anatomy of Human Ear, Mechanism of hearing, loudness, weighting networks, equivalent sound level.

Unit-5: NVH Measurements
Vibration and Noise Standards – Pass/Drive by noise, noise from stationary vehicles, interior noise in vehicles, NVH measurement tools and techniques, Modal parameter (natural frequency, mode shape and damping) estimation techniques, signal and system analysis.

Unit-6: Automotive Noise Sources and Control Techniques

Term Work

1. Determination of Natural Frequencies & Modal analysis of automobile components, Equipments to be used: FFT Analyzer, with Impact Hammer or Exciter, Necessary Transducers etc.
2. Noise measurement & Analysis, Equipment to be used: Noise measurement & analysis Instruments.
4. Assignment on solving noise & vibration problems using MATLAB.
5. Assignment on solving noise & vibration problems using FEA/BEA Software’s like ANSYS, ABAQUS, MSC-Nastran, Sysnoise.

Reference Books
University of Pune  
B E (Automobile Engineering) Part I (2008 Course)  
416492 Elective – II A - Automotive Materials

Teaching Scheme                                             Examination Scheme
Lectures  4 hrs/week                                           Theory  100 Marks

Section – I

Unit-1: Elastic and plastic behaviour of materials  08

Unit-2: Heat treatment and surface treatment  08
Heat treatment of steel - Annealing - Types, normalizing, Types, hardening and tempering with specific relevance to automotive components, surface hardening techniques, Induction, flame and chemical hardening, coating of wear and corrosion resistance, Electroplating. Phosphating, Anodizing, hot dipping, thermal spraying, hard facing and thin film coatings.

Unit-3: Selection of materials  10
Criteria of selecting materials for automotive components viz 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, body panel - Radiator, Brake lining etc. Application of non-metallic materials such as composite, ceramic and polymers in automobile.

Section – II

Unit-4: Introduction, lamina constitutive equations & manufacturing  08
Manufacturing: Bag Moulding – Compression Moulding – Pultrusion – Filament Winding

Unit-5: Manufacturing & testing methods  10

Unit-6: Special laminates  08
Reference Books:

Section - I

Unit-1: Introduction 08
Characteristics of vehicle structure, Role of safety systems in Automobiles, Importance of ergonomics in automotive safety.

Unit-2: Vehicle Structure Analysis (Crashworthiness & Crash Testing) 10
Optimization of vehicle structures for crashworthiness, Types of Impacts, Crash/ Roll over, Impact with rebound, movable barrier tests.
Requirements for crash testing, Instrumentation, Photographic image analysis of impact tests
Crumples zone, General requirements on body structure.

Unit-3: Vehicle Ergonomics & Human Response to Impact 08
Necessity of ergonomics in automobile safety, Location of controls, Anthropometry – Human impact tolerances, Determination of injury thresholds, servicity index, Study acceptable tolerances. Different types of dummies & their instrumentation.

Section – II

Unit-4: Vehicle Safety Systems 10
Active safety & passive safety, Pedestrian safety, importance of pedestrian safety, latest trends in traffic systems for improved road safety, seat anchorage, Head restraints, Air bags, importance of bumpers, Type of seats, steering & mirror adjustment, Hinges & latches, Introduction to the type of safety glass & their requirements, Types of different mirrors & their location.

Unit-5: Automotive Lighting & Signaling 08
Automotive lamps, types, construction, material, Testing of automotive lamps, Light signaling devices such as stop lamp, rear position lamp, direction indicator, reverse lamp, reflex indicator position lamp, number plate lamp
Recent trends in automotive lightening

Unit-6: Safety Regulations 08
AIS regulations as per CMVR

Reference Books:

6. Updated CDs of AIS, giving procedure for type of approval & estimating conformity of Production for safety of critical components, published by ARAI Pune.
Section – I

Unit-1: Classification and Requirements of Off Road Vehicles 08

Unit-2: Earth Moving Machines & Tractors 10
Different types of earth moving equipments and their applications. Bulldozers, cable and hydraulic dozers. Crawler track, running and steering gears, scrapers, drag and self powered types - Dump trucks and dumpers - Loaders, single bucket, multi bucket and rotary types - Power and capacity of earth moving machines.

Tractors: General description, specification and functions, light, medium and heavy wheeled tractors, crawler tracks mounted / wheeled-bull dozers, tilt dozers and angle dozers, front end loaders, factors affecting efficiency of output of tractors, simple problems, merits and demerits.

Unit-3: Scrappers, Graders, Shovels and Ditchers 08

Section – II

Unit-4: Farm Equipments, Military and Combat Vehicles 08
Power take off, special implements. Special features and constructional details of tankers, gun carriers and transport vehicles.

Unit-5: Vehicle Systems – Features 08

Unit-6: Vehicle Evaluation Mobility 10
Soil-Vehicle Mechanics, Characteristics of soils, Nominal Ground Pressure, Mean Maximum Pressure. The mobility Index (MI), Vehicle Cone Index (VCI) and rated Cone Index (RCI), Mobility Number, Dynamic behavior and Traction on wet soil, Traction performance & Factors affecting traction performance.

Reference Books
University of Pune  
B E (Automobile Engineering) Part I (2008 Course)  
416492 Elective - II D Auxiliary Engine Systems

Teaching Scheme            Examination Scheme
Lectures: 4 hrs/week        Theory     100 Marks

Section -I

Unit-1: Super Charging & Compressor mapping  08

Unit-2: Flow maps of Supercharging systems  10
Two and Four stroke Engines, Interaction between turbocharger and engine. Mechanical supercharging, Exhaust turbo charging and operational differences. Equivalent nozzle area of turbine. Pulse turbocharging and diagram for determination of operating condition of a single stage turbocharger system. Examples of computed results.

Unit-3: Thermodynamic Issues with Turbocharging  08
Cylinder release temperature and mean exhaust temperature, theoretical aspects of complete extraction of work by expanding from release pressure to ambient pressure. Complete conversion into kinetic energy at ambient pressure. Compressor power in terms of mean piston pressure, difference in fuel consumption between mechanical and exhaust superchargers. Effect of cooling the charge air. Exhaust turbocharger as a means to increase efficiency.

Section -II

Unit-4: Particular features of exhaust Turbocharging  08
Exhaust manifold arrangements for various firing sequences of Engines. Advantages and disadvantages of Constant pressure Vs Pulse Turbocharging. Modified forms of Pulse turbocharging. Transient response. Torque characteristics of engines with exhaust turbochargers. Measures to improve acceleration and torque characteristics of exhaust turbocharged engines. Altitude de-rating. Effect of supercharging on exhaust emissions of Diesel and Petrol Engines as well as on Thermal and Mechanical loading.

Unit-5: Modern design features of exhaust turbocharger features  08
Charge Boosting, Exhaust pre-release, Turbo-cooling, Miller, Two Stage, Comprex, Hyperbar, Rotor designs, Types of impellers, Materials for impellers and turbines, Bearing arrangements, Types and Lubrication of Bearings. Examples of supercharged engines of Road Vehicles (cases)

Unit-6: Engine Thermal management  10
Text Books:
3. BOSCH ;”Automotive Handbook”
5. Tom Birch: “Automotive Heating & Air Conditioning”; Prentice Hall publication
7. SAE Paper 821044: “De-aeration and Associate Systems consideration for the engine cooling system design”
Teaching Scheme
Practical 2 hrs/week

Objective
- To embed the skill in group of students (strictly four) to work independently on a topic/problem/experimentation selected by them and encourage them to think independently on their own to bring out the conclusion under the given circumstances of the curriculum period in the budget provided with the guidance of the faculty.
- To encourage creative thinking process to help them to get confidence by planning and carrying out the work plan of the project and to successfully complete the same, through observations, discussions and decision making process.
- The project may be in-house, sponsored by an Industry.

Project Load
Maximum two groups of four students per group, shall work under one faculty member of department. A group of one student is strictly not allowed.

Project Definition
Project work shall be based on any of the following:

1. Fabrication of product/testing setup of an experimentation unit/apparatus/small equipment, in a group.
2. Experimental verification of principles used in Mechanical Engineering/Automobile Engineering Applications.
3. Projects having valid database, data flow, algorithm, and output reports, preferably software based.

Project Term Work:
The term work under project submitted by students shall include

1. Work Diary: Work Diary maintained by group and countersigned by the guide weekly. The contents of work diary shall reflect the efforts taken by project group for
   a. Searching suitable project work
   b. Brief report preferably on journals/research or conference papers/books or literature surveyed to select and bring up the project.
   c. Brief report of feasibility studies carried to implement the conclusion.
   d. Rough Sketches/Design Calculations
   e. Synopsis
The group should submit the synopsis in following form.
   i. Title of Project
   ii. Names of Students
   iii. Name of Guide
   iv. Relevance
   v. Present Theory and Practices
   vi. Proposed work
   vii. Expenditure
   viii. References
2. The synopsis shall be signed by each student in the group, approved by the guide (along with external guide in case of sponsored projects) and endorsed by the Head of the Department.

3. Presentation: The group has to make a presentation in front of the faculty of department at the end of semester.
University of Pune  
B E (Automobile) Part II (2008 Course)  
416494 PROJECT WORK (Automotive Related) Phase – II

Teaching Scheme  
Practical: 6 Hrs. /Week

Examination Scheme  
Term work: 100 Marks
Oral: 50 Marks

Project Report  
Project report should be of 50 to 60 pages. The report must be hard bound. For standardization of the project reports the following format should be strictly followed.

1. Page size : Trimmed A4  
2. Top Margin : 1.00 Inch  
3. Bottom Margin : 1.32 Inch  
4. Left Margin : 1.5 Inch  
5. Right Margin : 1.0 Inch  
6. Para Text : Times New Roman 12 point font  
7. Line Spacing : 1.5 Lines  
8. Page Numbers : Right aligned at footer. Font 12 point Times New Roman  
10. Certificate

- All students should attach standard format of Certificate as prescribed by the department.  
- Certificate should be awarded to project group and not individual student of the group.  
- Certificate should have signatures of Guide, Head of Department and Principal.  
- Entire Report has to be documented as one chapter.

11. Index of Report

   i) Title Sheet  
   ii) Certificate  
   iii) Acknowledgement  
   iv) Synopsis  
   v) List of Figures  
   vi) List of Photographs/ Plates  
   vii) List of Tables  
   viii) Table of Contents  
   1. Introduction  
   2. Literature Survey/ Theory  
   3. Design/ Experimentation/ Fabrication/ Production/ Actual work carried out for the same.  
   4. Observation Results  
   5. Discussion on Results and Conclusion
12. References: References should have the following format

For books:
“Title of Book”, Authors; Publisher; Edition;
For Papers:
“Title of Paper”, Authors; Conference Details; Year.

Important Notes
- Project group should continue maintaining a diary for project and should write about (a) Books referred (b) Company visited (c) Person contacted (d) Computer work done (e) Paper referred (f) Creative thinking.
- Students are expected to publish a paper on the project either in various paper contests or at least within department.
- The Diary along with Project Report shall be assessed at the time of oral examination.
- One copy of the report should be submitted to Institute/Department, One copy to

Term Work evaluation
1 The project term work shall be evaluated on the basis of reviews. In first semester two reviews are to be taken and evaluated for total 30 marks (15 marks each)
2 In semester two, two reviews are to be taken for total 30 marks (15 marks each)
3 The final presentation shall be taken in front of external examiner and to be evaluated for 40 marks
   - 10 marks for presentation for group,
   - 15 marks for quality of the project work.
   - 15 marks for quality of the project report.

Oral Examination

Oral examination shall be conducted with final presentation of the project. The distribution of marks shall be
- 15 marks for contribution of the student in the project work
- 15 marks shall be awarded for achieving the objectives of the project set forth.
- 20 marks for Question/Answer

The external examiner shall be preferably Industrial expert in the same field or senior teaching faculty from other University. In case, the external examiner is appointed by the college authorities, the bio data of the external examiner must be sent to ‘The Chairman Board Of Studies in Automobile Engineering’ so that the examiner shall be included in the Panel of Examiners for the Project oral.
University of Pune
B E (Automobile Engineering) Part II  (2008 Course)
416495 Alternative Fuels and Emission Control

Teaching Scheme

<table>
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Examination Scheme

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<tr>
<td>Term Work</td>
<td>25 Marks</td>
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<tr>
<td>Oral</td>
<td>50 Marks</td>
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Section - I

Unit–1: Conventional Fuels & Need for alternative fuels
10
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. 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. Need for alternative fuels, applications, types etc.

Unit–2: Alternative Fuels I – Gaseous Fuels and Biofuels
08
Introduction to CNG, LPG, Ethanol, Vegetable Oils, Bio-diesel, Biogas, Hydrogen and HCNG. Study of availability, manufacture, properties, storage, handling and dispensing, safety aspects, engine/vehicle modifications required and effects of design parameters performance and durability.

Unit–3: Alternative Fuels II - Synthetic Fuels
08
Introduction to Syngas, DME, P-Series, GTL, BTL, study of production, advantages, disadvantages, need, types, properties, storage and handling, dispensing and safety, discussion on air and water vehicles

Section - II

Unit–4: Emission Control (SI Engine)
08
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.

Unit–5: Emission Measurement & Control (CI Engine)
08
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 recirculation, exhaust after treatment – DOC, DPF, SCR and LNT. Measurement & test procedure (NDIR analyzers, FID, Chemiluminescence NOx analyzer, oxygen analyzer, smoke measurement, constant volume sampling, particulate emission measurement, Orsat apparatus.)

Unit–6: Health effects of Emissions from Automobiles
10
Emission effects on health and environment. Emission inventory, ambient air quality monitoring, Emission Norms: As per Bharat Standard up to BS – IV.
Term Work:

1. Study of Emission norms.
4. Measurements of smoke by Bosch smoke meter.
5. Measurements of smoke by Hartridge smoke meter.
7. Demonstration / study of Evaporative Loss Control Device (ELCD).
8. Demonstration / study of catalytic converter.
10. Demonstration / study of LPG Kit.
11. Measurement of petrol engine emission with the help of HC/CO analyzer.
12. Study of Flame Ionization Detector.

Reference Books
1. Dr. S. S. Thipse, Alternative Fuels, Jaico publications, 2010
5. Dr. S. S. Thipse, IC Engines Jaico publications 2008
14. 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.
15. B.P Pundir, Engine Emission, Narosa publication.
University of Pune
B E (Automobile Engineering) Part II (2008 Course)
416496 Vehicle Performances and Testing

Teaching Scheme

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Examination Scheme

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Section -I

Unit-1: Vehicle performance parameters
Vehicle Performance parameters: Fuel economy, acceleration, deceleration, grad ability, top speed, handling, comfort, life durability, EGR systems, Vehicular systems: Suspension steering, Brakes & carriage unit testing, test procedure, Catalytic converters function &construction, Lambda close loop control system for gasoline vehicles.

Unit-2: Drive train and testing
Vehicular transmission performance: Characteristics and comparison of automotive clutches, Epicyclic transmission, Torque converter, testing of clutch, final drive and differential. Test procedure for gear box noise and shifting force.

Unit-3: Vehicle testing
Vehicle Testing - Road test, Free acceleration test, Coast down test, Passer by noise test, Wheel alignment and balancing test, Test tracks û proving ground testing, high speed track, pavement track, corrugated track, mud track, steering pad, gradient track, deep wading through shallow water, Laboratory testing û testing on chassis dynamometer transition testing- Euro III onwards, accelerated testing, Virtual testing, Evaporative emission testing, Oil consumption testing.

Section- II

Unit-4: Safety Systems and auxiliaries
Safety: Motor vehicle safety standards, active safety, passive safety, bio-mechanics Structural safety, energy absorption, ergonomic consideration in safety. Occupants safety systems like seat belts, head restraint, air bags, GPS, roll-over protection system, Electronic stability program. Particulate traps Function & construction.

Unit-5: Collisions and crash testing
Crash testing: Human testing, Dummies, crashworthiness, pole crash testing, rear crash testing, vehicle to vehicle impact, side impact testing, crash test sensors, sensor mounting, crash test data acquisition, Braking distance test.

Unit-6: Noise vibration and EMI
Noise & vibration: Mechanism of noise generation, engine noise & vibration, causes and remedies, road shocks wind noise & measurement, vehicle measurement testing. Automobile testing instrumentation: Sensors types and selection, Instrumentation for functional tests, Battery testing, endurance test, model test and full scale.
**Term Work:**

1. Estimation of power requirement or vehicle propulsion
2. Coast down test to find vehicle inertia
3. On road fuel consumption measurement
4. Brake efficiency measurement
5. Pass-by noise test.
6. Vibration measurement in passenger compartment
7. Laboratory testing of vehicle on chassis dynamometer for performance
8. Laboratory testing of vehicle on chassis dynamometer for emission
9. Battery testing
10. Report based on visit to vehicle testing & research organization
11. On road emission testing of petrol & diesel vehicles for PUC/RTO

**References:**

1. Wolt, Heinrich Hucho, Aerodynamics of road vehicles
2. Bosch, Automotive Handbook
3. George Pieters Barbara Pieters, Automotive Vehicle Safety
4. Michel Plint Engine Testing Theory and Practice
5. Gousha H. M., Engine performance Diagnosis & Tune Up Shop Manual
8. SAE Transaction Papers 831814/820346/820367/820371/820375
9. SAE handbook vol 2 & 3
10. Automobile Engineering by Ramlingam (Anna University)
11. Automobile engineering by Kripal Singh
12. Automotive Mechanics by Joseph Heitner
13. ARAI vehicle emission test manual
14. Automobile Engineering by Rangawala
University of Pune
B E (Automobile) Part II (2008 Course)
416497 Elective – III A - COMPUTATIONAL FLUID DYNAMICS*

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Section -I

Unit-1: Introduction 10
Conservation Equations, Derivation of Mass Momentum and Energy equations in differential and integral forms, General scalar transport equation, Application to simple control volumes, Mathematical classification of PDEs, elliptical, parabolic, hyperbolic

Unit-2: Numerical Methods: 08
Overview, Discretization Methods overview FDM, FVM, Solution of discretization equation: Direct Methods, Iterative Methods. Accuracy, consistency, stability and convergence.

Unit-3: Finite Difference Method: 08
Taylor Series expansion, finite approximation of first order derivatives using FDS, BDS, CDS, Transient conduction, 2D diffusion equation discretization, Boundary conditions : Drichlet, Neumann and mixed. Implicit, Explicit and Crank-Nicholsan scheme.

Section- II

Unit-4: Solution of linear system of equations: 10
Direct and iterative methods, Jacobi, Gauss-Siedel, Tri Diagonal Matrix Algorithm, Alternating Direction Implicit methods.

Unit-5: Finite Volume Method: 08
2D Convection diffusion equation, Lax-Wendroff and Maccormak methods, Central and Upwind differencing. Pressure Correction- SIMPLE algorithm

Unit-6: Essentials of CFD analysis: 08
Practical guidelines for CFD simulation processes, Grid Generation types, problem setup, types of boundary conditions, solution process, post-processing.

Term Work

Assignments: Any eight
1) Problems on Gauss-Siedel/Jacobi/TDMA.
2) Numerical simulation of quasi one dimensional nozzle flow.
3) Analysis of flow over a flat plate with boundary layer.
4) Analysis of internal flow: Fully developed pipe flow.
5) Analysis of external flow: Aerofoil.
6) Validation of natural convection in a square cavity.
7) CFD analysis of heat transfer in pin fin.
8) Analysis of any turbo machine application.
9) Study of different mesh generation schemes.
Reference Books:

2) J. D. Anderson, “Computational Fluid Dynamics - The Basics With Applications“, McGraw Hill
3) C T Shaw, “Using Computational Fluid Dynamics“
4) H K Versteeg, W Malalasekera ,“An introduction to Computational Fluid Dynamics“
6) Jiyuan Tu, Guan Heng Yeah, C Liu, “Computational Fluid dynamics“, Elsevier

*Common with B. E. (Mechanical) 2008 Course*
Teaching Scheme | Examination Scheme
---|---
Lectures | Theory | 100 Marks
Practical | Term work | 50 Marks

Section - I

Unit-1: Introduction 08
A. Theoretical background - Ritz method, Finite difference method and Finite element method, Brief History of FEM, General FEM procedure, Applications of FEM in various fields, Advantages & disadvantages of FEM.

Unit-2: 1D and 2D Elements Subjected to In-plane Loads 08
A. Finite element modelling - Node, Element, different types of element – spring, bar, truss, beam, frame, plane stress/strain (CST element) and axi-symmetric elements, Coordinate systems – global, local and natural coordinate systems, Order of element, internal and external node/s, Degrees of freedom, primary and secondary variables, shape functions – linear and quadratic, properties of shape functions.
B. Calculation of elemental stiffness matrix and load vector (mechanical & thermal load) using Potential energy (PMPE).
C. Transformation matrix – 2D truss and plane frame, Assembly of global stiffness matrix & load vector, Properties of stiffness matrix, half bandwidth, Numbering system to reduce bandwidth, Boundary conditions – elimination method and penalty approach, Multipoint constraints, Symmetric boundary conditions, Stress calculations.

Unit-3: Isoparametric Elements and Formulations: 10
A. Coordinate mapping - Natural coordinates, Area coordinates (for triangular elements), Global coordinate systems for 1D and 2D linear and higher order elements (Lagrangean and serendipity elements). Terms Isoparametric, super parametric and subparametric. Convergence requirements – patch test, Uniqueness of mapping - Jacobian matrix.
C. FE Discretisation- higher order elements vs. refined mesh (p vs h refinements), submodel, substructure.

Section -II

Unit-4: 1D Steady State Heat Transfer Problems 08
A. Introduction, steady state heat transfer – 1D and 2D heat conduction and convection.
B. Governing differential equation, boundary conditions, formulation of element.

Unit-5: Dynamic Considerations (Undamped Free Vibration): 08
A. General dynamic equation of motion, Formulation for point mass and distributed masses – Consistent and lumped element mass matrices for bar element, truss element, beam element, CST element, axisymmetric triangular element, quadrilateral element and frame element.
B. Generalized eigenvalue problem, Evaluation of eigenvalues and eigenvectors, Applications to bars, stepped bars, and beams.

Unit-6: Computer Implementation of the Finite Element Method:

A. Pre processing: model definition – nodal coordinates element connectivity, material and element type & property definitions, type of analysis (static/modal), loading and boundary conditions. Meshing techniques - free & mapped meshing. Quality checks – aspect ratio, warp angle, skew, jacobian, distortion, stretch, included angle, taper

B. Processing: Element level calculations, Equation assembly, Equation solver (sparse solvers, factorization, numerical/computational issues)

C. Post Processing: strain and stress recovery (integration and nodal points), interpretation of results (results validation and data interpretation) and design modification

Note: Examination paper will be set based on units 1 to 5.

Term Work

The term work shall consist of record of any three from 1 to 4* and any three from 5 to 8** assignments of the problems based on following topic:

1. Computer program for 1-D temperature analysis
2. Computer program for stress analysis 2-D truss subjected to plane forces
3. Computer program for modal analysis 1-D beam (simply supported or cantilever beams)
4. Computer program for frames subjected to transverse forces and moments
5. Static stress concentration factor calculation for a plate with center hole subjected to axial loading in tension using FEA software.
6. 2D Forced convection problem using FEA software.
7. Modal analysis of any machine components using FEA software.
8. Stress and deflection analysis of any machine component consisting of 3-D elements using FEA software.

* 1. Students can write the program in any of the programming language (i.e., Fortran, C, C++, Matlab, Python, VB)
   2. Minimum number of elements considered should be 10
   3. Comparison of the results of the program with analytical or existing FEA software (Abaqus, Ansys, Msc-Nastran, Optistruct/Radioss, Comsol-Multiphysics) should be done

** 1. Students should do convergence study for all assignment problems.
   2. Use different element types from element library
   3. If possible use sub-model/symmetry option.

Text Books:

1. Bhavikatti S. S. Finite element analysis, , New Age International Publishers

Reference Books:
5. S. Moaveni Finite element analysis, theory and application with Ansys –
10. Carlos A. Introduction to Finite Element Methods, Felippa
11. G. Lakshmi Narasaiah, Finite Element Application, BS Publications
12. Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N., Practical Finite Element Analysis, Finite to Infinite, Pune

*Common with B. E. (Mechanical) 2008 Course*
University of Pune  
B E (Automobile) Part II (2008 Course)  
416497 Elective – III C - Hydraulics and Pneumatics

<table>
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**Section- I**

**Unit-1: Introduction to Fluid Power**  
08  

**Unit-2 Pumps**  
08  
Types, classification, principle of working and constructional details of Vane pumps, gear pumps, radial and axial plunger pumps, screw pumps, power and efficiency calculations, characteristics curves, selection of pumps for hydraulic Power transmission.  
**Power units and accessories:** Types of power units, reservoir assembly, constructional details, pressure switches, Temperature switches.  
**Accumulators:** Types, selection/ design procedure, applications of accumulators. Types of Intensifiers, Pressure switches/sensor, Temperature switches/sensor, Level sensor

**Unit-3: Fluid Power Control**  
10  
Symbols for hydraulic and pneumatic circuits. Control of fluid power through different valves such as pressure control valves, directional control valves, and flow control valves (Principle, classification, constructional details, symbols, advantages, disadvantages and applications). Flow rate, working pressure, differential pressure, Check valve, Servo valves, Applications of Proportional valves and Cartridge valves. Cut off Valves. Working of Hydraulic Power Steering Mechanism

**Section- II**

**Unit-4: Hydraulics:**  
08  
**Actuators:**  (i) Linear and Rotary.  (ii) Hydraulic motors- Types- Vane, gear, Piston types, radial piston. (iii) Methods of control of acceleration, deceleration. (iv) Types of cylinders and mountings. (v) Calculation of piston velocity, thrust under static and dynamic applications, considering friction, inertia loads. (vi) Design considerations for cylinders. Cushioning of cylinders. (Numerical treatment)  
**Industrial circuits** – Simple reciprocating, Regenerative, Speed control (Meter in, Meter out and bleed off), Sequencing, Synchronization, transverse and feed, circuit for riveting machine, automatic reciprocating, fail safe circuit, counter balance circuit, actuator locking, circuit for hydraulic press, unloading circuit (Numerical treatment), motor breaking circuit.

**Unit-5: Pneumatics**  
08  
Regulators (I/P & E/P) with its applications (v) Direction control valves, two way, three way, four way valves. Solenoid operated valves, push button, lever control valves. (vi) Speed regulating - Methods used in Pneumatics. (vii) Pneumatic actuators-rotary, reciprocating – Power Clamps & its applications in BIW.(viii) Air motors- radial piston, vane, axial piston (ix) Basic pneumatic circuit, selection of components(x) Application of pneumatics in low cost Automation and in industrial automation

Introduction to vacuum generators, vacuum regulators, vacuum filters & types of vacuum cups, vacuum measurement, Vacuum pumps, types, introduction to vacuum sensors and valves. Industrial application of vacuum in material handling & leak testing.

Unit-6: System Design

Design of hydraulic/pneumatic circuit for practical application, Selection of different components such as reservoir, various valves, actuators, filters, pumps based on design. (Students are advised to refer manufacturers’ catalogues.).

Term work:

List of experiments:

Minimum of 8 experiments from the following; out of which serial no. 1 to 4 are compulsory, three from serial no. 5 to 9 and one from serial no 10 and 11. Record of experiments and assignments shall be submitted in the form of journal.

1. Trial on Gear/Vane/Piston pump and plotting of performance characteristics.
2. Following experiments to be done on hydraulic trainer:
   1. Regenerative circuit
   2. Speed control circuit
   3. Sequencing circuit
   4. Transverse and feed circuit
3. Following experiments to be done on pneumatic trainer:
   a. Automatic reciprocating circuit
   b. Speed control circuit
   c. Pneumatic circuit involving shuttle valve/ quick exhaust valve
   d. Electro pneumatic valves and circuit
4. Design report of a hydraulic or pneumatic system using manufacturer’s catalogue.
5. Study of accumulators and intensifiers.
6. Industrial visit to BIW (Weld-shop) or Assembly Shop of a Car / Truck Manufacturer, to study automation by means of hydraulic and pneumatics.
7. Study of compressed air generation, air preparation and distribution systems.
8. Study of simple hydraulic systems used in practice such as copy turning attachment, hydraulic clamps, jack, dumper, forklift etc.
9. Study and Demonstration of hydraulic system such as hydraulic press, Injection Moulding machines.
10. Testing of pressure relief valve.

Suggested Exercise (May be attached with Journal)

Compilation of file (with logical sequence) of catalogues of pneumatic and hydraulic system manufacturers with reference to above major components. Best file to be kept in library for future reference.

References from Dr. Lele?
University of Pune  
B E (Automobile) Part II (2008 Course)  
416497 Elective – III D - Product Development and Costing

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Section- I

Unit-1: Product planning


-Product planning: The Product Planning Process, Four Types of Product Development Projects,

Unit-2: Customer needs & Product specification

Identifying customer needs-Gather Raw Data from Customer, Choosing customers, Data Documenting Interaction with Customers, Interpreting Raw data and organizing the Needs into a Hierarchy, Establish the Relative Importance of the Needs and reflects on the results and the Process

Product specification - Establishing Target Specifications and Setting the Final Specifications.

Unit-3: Concept generation

The Activity of Concept Generation, Structured Approaches reduce the likelihood of costly problems, a five step Method like Clarify the Problem, Search Externally-Consult experts, Search patents, Search published Literature, Benchmark related products, Search Internally- Both individual and group sessions can be useful, Hints for generating solution concepts Explore Systematically- Concept classification tree, Concept combination table, Managing the exploration process, Reflect on the results and the Process

- Concept selection- Concept Selection Is an Integral Part of the Product Development, All Terms Use Some Method for Choosing a Concept, A Structured Method Offers Several Benefits, Overview of Methodology

-Concept screening and Concept scoring stepwise and reflects on the result and the process. Caveats

Section- II

Unit-4: Concept testing

Defining the Purpose, Choose a Survey Population and the Survey Format Communicate the Concept, verbal description, sketch, photos and renderings, storyboard, video, simulation, interactive multimedia, physical appearance models, working prototypes, matching the survey format with the means of communicating the concept, issues in communicating the concept, Measure Customer Response Interpret the Results .,Product architecture: Types of Modularity, Implication of the Architecture: product change, product Variety, component standardization, product performance, manufacturability, product development management, Establishing the Architecture stepwise, Variety and Supply Chain Considerations

-Platform planning: Differentiation plan, Commonality plan, managing the trade off between differentiation and commonality, Related System Level Design Issues: Defining secondary systems, establishing the Architecture of the Chunk, Creating detached interface specifications
Unit -5: Industrial design

What is Industrial Design? Assessing the Need for Industrial Design: Expenditures for Industrial Design, How important is Industrial Design to a Product? , Ergonomic Needs, Aesthetic Needs, and The Impact of Industrial Design: is Industrial Design worth the Investment? How does Industrial Design establish a corporate identity?, The Industrial Design Process: Conceptualization, preliminary Refinement, Further refinement and final concept selection, control drawing, coordinate with engineering, manufacturing, and external vendors, the impact of computer based tools on the ID process, Managing the Industrial Design Process: Technology –driven products, User driven Products, Timing of Industrial Design involvement, Assessing the Quality of Industrial Design: Quality of the user interfaces, Emotional appeal, Ability to maintain and repair the product, appropriate use of resources, Product differentiation - Design for Manufacturing Defined: DFM requires a cross-functional team,. DFM is performed throughout the development process

Unit-6: Product development economics

Estimate the manufacturing costs, Reduce the Costs of Components and Cost of Assembly and costs of Supporting ,Consider the Impact of DFM Decisions on the Other Factors, The impact of DFM on development time, The impact of DFM on development cost, The impact of DFM on product quality, The impact of DFM on external factors and Results.
-Elements of Economics Analysis: Qualitative Analysis, Quantitative Analysis, When should economics analysis be performed? Economics analysis process

Term Work: (any five)
1) Carrying out Qualitative Analysis
   Example 1: Decrease in the price of substitute product
   Example 2: Increased composition in a complementary product market
   Example 3: The OPTION value of creating a good platform product.
2) Case study on product development and analysis.
3) Industrial visit to any small scale industries to acquaint with practical procedure of product development and its costing.
4) Aesthetic design consideration of consumer product.
5) Form design of dashboard unit of car.
6) Value analysis and cost reduction of engineering products.
7) Collection of documents required for getting patent.

References books:

- Product design and development by Karl T Ulrich, Steven D Eppinger Mc- Graw Hill International Edition
- Product Design by Prashant Kumar, Creativity, concepts and usability, PHL, Learning private limited, New dehli-2012
University of Pune
B E (Automobile) Part II (2008 Course)
416498 Elective – IV A - Transport Management and Motor Industry

Teaching Scheme | Examination Scheme
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Lectures 4 hrs/week | Theory 100 Marks

Section- I

Unit-1: Motor Vehicle Act

Unit-2: Taxation
Objectives, Structure & methods of levying taxation, Onetime tax, Tax exemption & tax renewal

Unit-3: Insurance
Insurance types & significance, Comprehensive, Third party insurance, Furnishing of particulars of vehicles involved in accident, MACT (Motor Accident Claims Tribunal), Solatium Fund, Hit & Run case, Duty of driver in case of accident, Surveyor & Loss Assessor, Surveyor’s report

Section- II

Unit-4: Passenger Transport Operation
Structure of passenger transport organizations, Typical depot layouts, Requirements and Problems on fleet management, Fleet maintenance, Planning - Scheduling operation & control, Personal & training-training for drivers & conductors, Public relations, Propaganda, publicity and passenger amenities, Parcel traffic., Theory of fares-Basic principles of fare charging, Differential rates for different types of services, Depreciation & debt charges, Operation cost and Revenues, Economics & records

Unit-5: Goods Transport Operation
Structure of goods transport organizations, Scheduling of goods transport, Management Information System (MIS) in passenger / goods transport operation, Storage & transportation of petroleum products

Unit-6: Advance Techniques in Traffic Management
Traffic navigation, Global positioning system

References Book:
1. Motor Vehicle Act - Govt. of India Publications.
2. S.K. Shrivastava, "Economics of Transport"
5. P.G.Patankar, "Road Passenger Transport in India", CIRT, Pune.
Teaching Scheme
Lectures 4 hrs. /week

Examination Scheme
Theory 100 Marks

Section - I

Unit-1: Energy and environment 08
Global primary energy resources, energy consumption pattern, global warming and green house effect, Indian energy policy and prising, energy conservation act 2001, energy needs for growing economy, fuel & energy substitution, concept of energy use on biodiversity, prototype carbon fund, sustainable development.

Unit-2: Application of renewable energy technologies 06
Solar, wind, hydro and bio energy.

Unit-3: Energy conservation 08
Energy conservation measures and impact on environment, energy surveying & auditing, energy conservation in thermal systems, buildings, engineering & process industries, substitution of energy intensive devices by non conventional energy systems, response to climate change, energy balance, waste minimization & resource conservation.

Section - II

Unit-4: Efficient Design of Energy Intensive Devices 10
Chillers, cooling tower, Energy consumptions in boilers and furnaces, waste heat recovery systems, calculation of losses in heat pump, refrigerators, storage systems, heat exchanger, steam turbine working and losses.

Unit-5: Energy management 06
Principles of energy management, energy resource management, Instrumentation and measurement, performance test of energy intensive utilities, HVAC, electric motor, furnaces, lighting system, fans and blowers, cogeneration techniques & its application.

Unit-6: Energy economics 08
Investment needs in energy sector, methods of economic analysis, techniques used in financial analysis of energy sector, finance & legislation, energy project forecasting & management, case study, sensitivity and risk analysis of energy financing.

Reference Book:

University of Pune
B E (Automobile) Part II (2008 Course)
416498 Elective – IV C - Hybrid, Electric and Fuel-cell Vehicles

Teaching Scheme
Lectures 4 hrs/week

Examination Scheme
Theory 100 Marks

Section -I

Unit -1: Electric Vehicles and Motors 08
Electric vehicle, introduction, components, advantages, disadvantages, applications, vehicles. DC motors series wound- shunt wound- compound wound and separately excited motors AC motors Induction-synchronous- brushless DC motor- switched reluctance motors.

Unit – 2: Hybrid Vehicles and Propulsion Methods 06
Introduction to hybrid vehicles Performance characteristics of road vehicles; calculation of road load-predicting fuel economy- grid connected hybrids.

Unit -3: Hybrid Architecture and Power Plant Specifications 08
Series configuration locomotive drives- series parallel switching- load tracking architecture. Pre transmission parallel and combined configurations Mild hybrid- power assist- dual mode- power split-power split with shift- Continuously Variable transmission (CVT)- wheel motors. Grade and cruise targets- launching and boosting- braking and energy recuperation- drive cycle implications

Section - II

Unit -4: Sizing the Drive System and Energy Storage Technology 06
Matching electric drive and ICE; sizing the propulsion motor; sizing power electronics. Battery basics; lead acid battery; different types of batteries; battery parameters.

Unit-5: Fuel Cells 08

Unit -6: Nonelectric Hybrid Systems 08

Text Books:
2. Electric and Hybrid Vehicles- Robin Hardy- Iqbal Husain- CRC Press.
4. Alternative Fuels, Dr. S.S.Thipse, Jaico publications

Reference Books: