UNIVERSITY OF PUNE
B. E. (Automobile Engineering) (2008 Course)
With effect from July 2012

Code	Subject	Teaching Scheme		Examination Scheme				
		L	P/D	P	TW	Or	Pr	Total
	Semester I							
416488	Automotive Refrigeration and Air Conditioning	4	2	100	25	50		175
416489	Machine and Vehicle Dynamics	4	2	100	25	50		175
416490	Automotive System Design	4	2	100	25	50		175
416491	Elective I	4	2	100	25			125
416492	Elective II	4		100				100
416493	Project Work (Automotive and automobile related) Phase -I		2					
	Total of Semester I	**20**	**10**	**500**	**100**	**150**		**750**
	Semester II							
416494	Project Work (Automotive and automobile related) Phase -II		6		100	50		150
416495	Alternative Fuels and Emission Control	4	2	100	25	50		175
416496	Vehicle Performance and Testing	4	2	100	25		50	175
416497	Elective III	4	2	100	50			150
416498	Elective IV	4		100				100
	Total of Semester II	**16**	**12**	**400**	**200**	**100**	**50**	**750**

Elective – I

416491A	Automotive Aerodynamics and Styling
416491B	Tribology*
416491C	CAD-CAM and Automation*
416491D	Automotive NVH

Elective – II

416492A	Automotive Materials
416492B	Vehicle Safety
416492C	Off Road Vehicles
416492D	Auxiliary Engine Systems

Elective – III

416497A	Computational Fluid Dynamics*
416497B	Finite Element Analysis*
416497C	Hydraulics and Pneumatics
416497D	Product Development and Costing

Elective - IV

416498A	Transport Management and Motor Industry
416498B	Energy Engineering and Management
416498C	Hybrid, Electric and Fuel-cell Vehicles
416498D	Open Electives****

*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		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 hrs/week	Term work	25 Marks
		Practical	50 Marks

Section- I

Unit-1: Refrigeration Fundamentals **08**

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 **10**

Environmental concerns/Legislation for automotive A/C systems, types & properties of refrigerants, refrigerant oils, refrigerant piping. Future refrigerants, Air conditioning components: Compressors, Condensers, flow control devices, evaporators – Design guidelines, types, sizing & their installation. Accumulators, receiver driers & desiccants. Refrigerant charge capacity determination.

Unit-3: Air distribution system **08**

Comfort conditions, Air management & heater systems, air distribution modes (Fresh/Recirculation, Face, Foot, Defrost, and Demist), A/C ducts & air filters. Blower fans, Temperature control systems (manual/semiautomatic, automatic). Vehicle operation modes & Cool-down performance.

Section- II

Unit-4: Psychrometry **08**

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 **10**

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 **08**

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, Hating 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:

1. Roy J Dossat: "Principles of Refrigeration"; Pearson Education Inc.
2. Steven Daly: "Automotive air conditioning & Climate control systems"
3. Tom Birch: "Automotive heating & air conditioning"; Prentice Hall
4. William H Crouse & Donald L Anglin: "Automotive air conditioning"
5. Paul Weissler: "Automotive air conditioning"; Reston Publishing Co. Inc.
6. Arora and Damkondwar: "Refrigeration and Air Conditioning"; Dhanpatrai and Company.
7. Arora C.P.: "Refrigeration and Air Conditioning"; Tata McGraw Hills Pub.

University of Pune
B E (Automobile Engineering) Part I (2008 Course)
416489 Machine and Vehicle Dynamics

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 hrs/week	Term work	25 Marks
		Practical	50 Marks

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:

1. William I Thomson, "Vibration, Theory and Applications", Prentice Hall
2. Kewal Pujara and R.S. Pujara, "Vibration and Noise for Engineers", Dhanpat Rai and Sons, Delhi
3. Gillespie Thomas D, "Fundamentals of Vehicle Dynamics", SAE USA 1992.
4. Wong J Y, "Theory of Ground Vehicles", John Wiley & Sons, New York, 1978
5. Ellis.J.R - "Vehicle Dynamics"- Business Books Ltd., London- 1991
6. Giles.J.G. "Steering Suspension and Tyres",- Illiffe Books Ltd., London- 1998
7. Ham B, Pacejka, "Tyre and Vehicle Dynamics", SAE Publication - 2002.
8. Maurice Olley, "Chassis Design – Principles and Analysis", Bentley publishers
9. Cole, D E, "Elementary Vehicle Dynamics", Ann Arbor, Michigan, USA, 1972.
10. Giri N.K., "Automobile Mechanics", Khanna Publishers, 2002.
11. Grover, G. K. and Nigam, S. P., "Mechanical Vibrations", Nemchand and Brothers, Roorkee
12. Singh, V.P., "Mechanical Vibrations", Dhanpat Rai and Sons, New Delhi
13. William W. Seto, "Theory and Problems of Mechanical Vibrations", McGraw Hill International Book Co., Singapore (Schaum's outline series)
14. Church, A. W., "Mechanical Vibration", John Wiley and Sons, USA
15. Giri, N. K., "Automobile Mechanics (Through Problems)", Khanna Publishers, Delhi
16. Srinivasan, P., "Mechanical Vibration Analysis", TMH
17. Rao, S. S., "Mechanical Vibrations", Pearson Education Inc.,
18. Kelly, G. S., "Mechanical Vibrations", Schaum's Outline Series, Tata McGraw Hill Publishing Co. Ltd., New Delhi
19. Rao, J. S. and Gupta, K., "Theory and Practice of Mechanical Vibrations", New Age International Publications, New Delhi
20. Meirovitch, L., "Elements of Vibrations Analysis", Tata McGraw Hill, New Delhi
21. Tse F. S., Morse I. E. and Hinkle T., "Vibrations", CBS Publishers and Distributors, Delhi
22. Hertog, D., "Mechanical Vibrations", McGraw Hill
23. Heldt. P.M., "Automotive Chassis"- Chilton Co., New York- 1992

University of Pune
B E (Automobile Engineering) Part I (2008 Course)
416490 Automotive System Design

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 hrs/week	Term work	25 Marks
		Practical	50 Marks

Section - I

Unit-1: Statistical Consideration in Design and Optimization: **10**
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: **08**
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: **08**
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: **08**
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: **08**
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: **10**
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:

1. Joseph E. Shigley & Larry D. Mitchell, 'Mechanical Engineering Design', Fourth Edition, McGraw-Hill International Book Company.
2. Patil S.P., 'Mechanical System Design', 2nd edition, Jaico Publishers
3. M. F. Spotts & T.E. Shoup, 'Design of machine Elements', Seventh Edition, Pearson Education.
4. Bhandari V. B., 'Design of Machine Elements', Tata McGraw-Hill Publishing Company Ltd., New Delhi.
5. Julian Happian – Smith, 'An Introduction to Modern Vehicle Design', Butterworth Heinemann
6. Pandya N.C. & Shah C.S., 'Elements of Machine Design', Twelth Edition, 1994, Charotar Publishing House.
7. R.C. Johnson, 'Optimum Design of Mechanical Elements', John Wiley & Sons.
8. J.S. Arora, 'Introduction to Optimum Design', McGraw-Hill Book Company Ltd.

University of Pune
B E (Automobile Engineering) Part I (2008 Course)
416491 Elective – I A -Automotive Aerodynamics and Styling

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

SECTION - I

Unit-1: Fundamental of fluid mechanics **08**

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 **08**

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 **10**

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 **10**

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 **08**

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 **08**

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:

1. K. Newton and W. Seeds, T.K. Garrett, Motor Vehicle" 13th Edition, Elsevier publications
2. William H. Crouse.,"Automotive Mechanics,, - Tata McGraw Hill Publishing House
3. James E. A., John and Haberm W. A., Introduction to Fluid Mechanics, Prentice Hall of India
4. Frank M.White, Fluid Mechanics, McGraw Hill Publication.
5. Cengel & Cimbla Fluid Mechanics, TATA McGraw-Hill
6 Anderson- Fundamentals of CFD McGraw-Hill, International Edition, Mechanical Engineering Series
7. W.H.Hucho – "aerodynamic of road vehicle"
8. Schlichting H "boundary layer theory"
9. Pope A "low speed wind tunnel testing" joho wiley and sons1. Rathakrishnan,E., "Gas Dynamics", Prentice Hall of India, 2003.
10. Shapiro, A.H., "Dynamics and Thermodynamics of Compressible Fluid Flow", Ronold Press, 1982.
11. Zucrow, M.J. and Anderson, J.D., "Elements of gas dynamics", McGraw-Hill Book Co., New York, 1989.
12. Mc Cornick. W. "Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, New York, 1979.
13. Anderson Jr., D., – "Modern compressible flows", McGraw-Hill Book Co., New York 1999.

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 **08**

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 **08**

Friction: Introduction, laws of friction, kinds of friction, causes of friction, friction measurement, theories of friction, effect of surface preparation.

Wear: Types of wear, various factors affecting wear, measurement of wear, wear between solids and liquids, theories of wear.

Unit-3: Hydrodynamic Lubrication **10**

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 **08**

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 **08**

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 **10**

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 electro-less 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

1. Cameron A., "Basic Lubrication Theory", Wiley Eastern Ltd.
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
4. Halling J., "Principles of Tribology", McMillan Press Ltd.
5. B. Bhushan, B.K. Gupta, "Handbook of tribology: materials, coatings and surface treatments", McGraw-Hill
6. Davis J "Surface Engineering for corrosion and Wear Resistance", Woodhead Publishing, 2001
7. V.B. Bhandari., "Design of Machine Elements" Tata McGraw Hill Pvt Ltd.
8. Tadausz Burakowski, "Surface Engineering of Metals: Principles, Equipments, Technologies", Taylor and Francis

*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*

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

Section- I

Unit-1: Computer Graphics **08**

Transformation-Introduction, Formulation, Translation, Rotation, Scaling, Reflection Homogenous Representation, Concatenated Transformation, Mapping of Geometric Models, Inverse Transformations,

Projections: Orthographic, Isometric, and Perspective.

Introduction to open GL and commands required for the transformation.

Unit-2: Modelling **10**

Curves:-Introduction, Analytic Curves, Line, Circle, Parabolas, Hyperbolas, Ellipses, Conics, Synthetic Curves, Hermite Cubic Spline, Bezier Curve, B-Spline Curve, Numericals on above topic.

Surfaces:-Introduction, Surface Representation, Analytic Surfaces, Synthetic Surfaces,

Hermite bicubic Surface, Bezier surfaces, B-spline Surfaces, Coons Surface. No analytical treatment.

Solids: Introduction, Geometry and Topology, Solid Representation, Boundary Representation, Euler's equation, Constructive Solid Geometry, Boolean operation for CSG, Hybrid modeling, Feature Based Modeling, Parametric modeling, constraint based modeling, Mass, area, volume calculation.

Unit-3: Finite Element Analysis **08**

Introduction, Stress and Equilibrium, Boundary Condition, Strain - Displacement Relations, Stress-Strain Relation, Temperature Effects, Potential Energy and Equilibrium: - Rayleigh-Ritz Method, Galerkin's Method.

One Dimensional Problem: Finite Element Modelling, Coordinate and Shape function, Potential Energy Approach, Galerkin Approach, Assembly of Global Stiffness Matrix and Load Vector, Properties of Stiffness Matrix, Finite Element Equations, Quadratic Shape Function, Temperature Effects .

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

1. Ibrahim Zeid and R. Sivasubramanian - CAD/CAM - Theory and Practice Tata McGraw Hill Publishing Co. 2009
2. Ibraim Zeid, "Mastering CAD/CAM" – Tata McGraw Hill Publishing Co. 2000
3. Chandrupatla T.R. And Belegunda A.D. -Introduction to Finite Elements in Engineering" - Prentice Hall India.
4. Segerling L.J. - Applied Finite Elements Analysis" John Wiley and Sons.
5. Rao P.N., Introduction to CAD/CAM Tata McGraw Hill Publishing Co.
6. Groover M.P.-Automation, production systems and computer integrated manufacturing' - Prentice Hall of India
7. Yoram Koren - Robotics McGraw Hill Publishing Co.
8. James G. Keramas, Robot Technology Fundamentals, Delmar Publishers.
9. S.R.Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill.
10. Lakshiminarayana H. V. Finite Element Analysis (Procedures in Engineering), University Press, 2004.
11. Chandrupatla T. R., Finite Element Analysis for Engineering and Technology, University Press, 2009.
12. Seshu P. Text book of Finite Element Analysis, PHI Learning Private Ltd. New Delhi, 2010.

*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		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 hrs/week	Term work	25 Marks

Section – I

Unit-1: Introduction to NVH **08**

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 **08**

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 **10**

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 **08**

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 **10**

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 **08**

Methods for control of engine noise, Transmission Noise, Intake and Exhaust Noise, Aerodynamic Noise, Tyre Noise, Brake noise. Noise control strategy, noise control at source – along the path – isolation, damping, balancing, resonators, absorption, barriers and enclosures.

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.
3. Numerical problems on noise and vibration analysis.
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

1. Bell, L. H. and Bell, D. H., "Industrial Noise Control – Fundamentals and Applications", Marcel Dekker Inc, NewYork, 1994.
2. Ambekar, A. G., "Mechnical Vibrations and Noise Engineering", Prentice Hall of India, New Delhi, 2006.

3. Beranek, L. L. and Ver, I, L., “Noise and Vibration Control Engineering – Principles and Application”, John Wiley & Sons, Inc, 1992.
4. Wilson, C. E., “Noise Control – Measurement , Analysis, and Control of Sound and Vibration”, Harper & Row Publishers, New York, 1989.
5. Thomson, W. T., “ Theory of Vibrations with Applications”, CBS Publishers Delhi
6. Norton, M.P., “Fundamentals of Noise and Vibration Analysis for Engineers”, Cambridge University Press, Cambridge, 2003.
7. Irwin, J. D. and Graf, E. R., “Industrial Noise and Vibration Control”, Prentice Hall, Englewood Cliffs, New Jersey.
8. Kewal Pujara “Vibrations and Noise for Engineers, Dhanpat Rai & Sons, 1992.
9. Moser, M., “Engineering Acoustics – An Introduction to Noise Control”, Springer, Indian Edition, 2009
10. Matthew Harrison, “Vehicle Refinement – Controlling Noise and Vibration in Road Vehicle”, Butterworth-Heinemann, Indian Edition,2011.
11. Smith, J. H., “An Introduction to Modern Vehicle Design”, Butterworth Heinemarm, 2002.

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**

Elasticity-forms - Stress and strain relationship in engineering materials - Deformation mechanism - Strengthening material - Strain hardening, alloying, polyphase mixture, martensitic precipitation, dispersion, fibre and texture strengthening - iron carbon diagram. Strength and stiffness – failure modes – analysis of laminated composites – stress-strain variation in a laminate.

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**

Definition –Need – General Characteristics, Applications. Fibers, flake and particulate composites – Glass, Carbon, Ceramic and Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Lamina Constitutive

Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Typical Commercial material properties, Rule of Mixtures. Generally

Orthotropic Lamina –Transformation Matrix, Transformed Stiffness.

Manufacturing: Bag Moulding – Compression Moulding – Pultrusion – Filament Winding

Unit-5: Manufacturing & testing methods **10**

Manufacturing methods: Production of various fibers – matrix materials and surface treatments – fabrication of composites – fabrication of thermosetting resin matrix Composites – fabrication of thermoplastic resin matrix composites – short fiber Composites – fabrication of metal matrix and ceramic matrix composites.

Testing aspects of composites: Experimental characterisation of composites – uniaxial tension, compression and shear tests – determination of interlaminar fracture toughness damage identification through non-destructive evaluation techniques – ultrasonic, acoustic emission and X-radiography.

Unit-6: Special laminates **08**

Symmetric laminates, uni-directional, cross-ply and angle-ply laminates, quasi-isotropic laminates. Recent trends in composite materials – carbon composites, Bucky Papee. Application of composite materials in aerospace, automotive, defence and industry. Mechanical behaviour of UD composites: Longitudinal strength and stiffness – transverse strength and stiffness – failure modes – analysis of laminated composites – stress-strain Variation in a laminate.

Reference Books:

1 Khanna.O.P., "Material Science and Metallurgy ", Dhanapat Rai & Sons, 1992.
2 B. D. Agarwal, L. J. Broutman, Analysis and Performance of Fibre Composites, John Wiley.
3 Kapoor, "Material Science and Processes ", New India Publishing House, 1987
4 Dieter.G.E. Mechanical Metallurgy, McGraw Hill, New York, 1972.
5 Avner.S.H. Introduction to physical metallurgy, McGraw Hill, New York., 1982.
6 Raghavan.V. Physical Metallurgy, Principle and Practice, Prentice Hall, 1995.
7 R. F. Gibson, Principle of Composite Material Mechanics, McGraw Hill
8 M. M. Schwartz, Composite Materials Handbook, McGraw Hill. Inc.
9 R. M. Jones, Mechanics of Composite Materials, McGraw Hill. Inc

University of Pune
B E (Automobile Engineering) Part I (2008 Course)
416492 Elective – II B - Vehicle Safety

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

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
Crumple 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:

1. Watts, A.J. etal "Low speed Automobile Accidents" Lawyers & Judges 1996
2. Jullian Happian Smith 'An introduction to Modern vehicle Design' SAE 2002
3. Johnson, W. & Mamalis, A.G. "Crashworthiness of vehicles, MEP, Londan, 1995.
4. Edward A. 'Lamps & lighting" Hodder & Stoughton London 1993.
5. Cental Motor Vehicle Rules & Standards.
6. Updated CDs of AIS, giving procedure for type of approval & estimating conformity of Production for safety of critical components, published by ARAI Pune.

University of Pune
B E (Automobile Engineering) Part I (2008 Course)
416492 Elective - II C- Off Road Vehicles

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

Section – I

Unit-1: Classification and Requirements of Off Road Vehicles 08
Introduction, pretest, history and overview of an off-road machines, Construction layout, capacity and applications. Power Plants, Chassis and Transmission, Multi-axle vehicles.

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
Scrappers, elevating graders, motor graders, self powered scrappers and graders, Power shovel, revolving and stripper shovels – drag lines – ditchers – capacity of shovels.

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
Brake system and actuation – OCDB and dry disc caliper brakes. Body hoist and bucket operational hydraulics. Hydro-pneumatic suspension cylinders. Power steering system. Kinematics for loader and bulldozer operational linkages. Safety features, safe warning system for dumper. Design aspects on dumper body, loader bucket and water tank of sprinkler.

Unit-6:Vehicle Evaluation Mobility 10
Soil-Vehicle Mechanics, Characterstics 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

1. Goering, C. E., Stone, , D.W. Smith, P.K. Turnquist. St. Joseph, Mich., "Off-Road Vehicle Engineering Principles", ASAE. 2005
2. Robert Peurifoy, Clifford J. Schexnayder, Aviad Shapira, Robert Schmitt, "Construction Planning, Equipment, and Methods", Tata McGraw-Hill Education Pvt. Ltd.,2011
3. Satyanarayana. B., "Construction Planning and Equipment", standard publishers and distributors, New Delhi.
4. Sharma, S.C., "Construction Equipment and its Management".
5. Nakra C.P., "Farm Machines and Equipments", Dhanparai Publishing company Pvt. Ltd. 2003

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**

Definitions, Survey of Supercharging Methods, Petrol Engines, Diesel Engines, Exhaust Turbocharging. Fundamentals of Compressor matching, Compressor Power, air consumption, Types and Characteristics of Compressors. Relationship between air consumption and Power. Volumetric Efficiency of supercharged four stroke engines. Computations of gas exchange process.

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**

Introduction to engine cooling systems, Engine Coolants, heat exchangers (Radiator, Charge Air Cooler/Intercooler, Oil cooler): Nomenclature, In-vehicle installation, performance curves. Pressurized engine cooling systems: Filling, De-aeration & Drawdown. Radiator caps & filler necks, coolant hoses.

On-highway cooling system test code, Engine cooling systems Field test (Air-to-Boil), Heat exchanger thermal & Pressure cycle durability. Cooling Fans: Electric & Viscous Fan & Drives, Fan laws, Fan characteristics, and System resistance curve. Cooling flow measurement techniques.

Cooling System Inspection, trouble diagnosis & Service. Radiator field failures. Introduction to EGR (exhaust gas recirculation) Coolers & its significance in reduction of vehicle emissions.

Text Books:

1. Zinner, K. : 'Supercharging of Internal Combustion Engines'. Springer-Verlag Berling Heidelberg New York.
2. N. Watson and M.S. Janota; "Turbocharging the Internal Combustion Engines". Macmillan Press, London 1982.
3. BOSCH ;"Automotive Handbook"
4. Lilly, L.C.R.:"Diesel Engine Reference Book". Butterworths, London, 1984. Benson, R.S. ,,Whitehouse N.D.: Internal Combustion Engines, Vol 1 and 2, Pergamon Press Ltd.Oxford UK.1980
5. Tom Birch: "Automotive Heating & Air Conditioning"; Prentice Hall publication
6. SAE HS-4040: "SAE Vehicle Cooling Systems Standards Manual"; SAE International
7. SAE Paper 821044: "De-aeration and Associate Systems consideration for the engine cooling system design"
8. Frank P Bleier: "Fan Handbook"; McGraw-hill publications
9. SAE Paper 971822: "Heat Exchanger for Cooled Exhaust gas recirculation"
10. SAE Paper 2001-01-1748: "Development of EGR coolers for truck & passenger car application"

University of Pune
B E (Automobile) Part I (2008 Course)
416493 PROJECT WORK (Automotive Related) Phase – I

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 the 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	**Examination Scheme**
Practical: 6 Hrs. /Week	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
9.	Headings	:	New Times Roman, 14 Points, Boldface
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		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 hrs/week	Term Work	25 Marks
		Oral	50 Marks

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, Polyneculear 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.
2. Measurements of Emission by portable exhaust gas analyzer.
3. Measurements of Emission by Infra Red Gas Analyzer (IRGA)
4. Measurements of smoke by Bosch smoke meter.
5. Measurements of smoke by Hartridge smoke meter.
6. Analysis of effect of Exhaust Gas Recirculation (EGR) on engine emission.
7. Demonstration / study of Evaporative Loss Control Device (ELCD).
8. Demonstration / study of catalytic converter.
9. Analysis of exhaust gas using Orsat Apparatus.
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
2. Ganesan, V., 'Internal Combustion Engines', Tata McGraw Hill., 1994.
3. Heywood John, 'Internal Combustion Engines'.
4. Crouse, W.M. and. Anglin, A.L, 'Automotive Emission Control', McGraw Hill, 1995.
5. Dr. S. S. Thipse, IC Engines Jaico publications 2008
6. Springer, G.S. and Patterson, D.J., 'Engine Emissions, pollutant formation', Plenum Press, 1986.
7. Patterson, D.J and Henin, N.A., 'Emissions from Combustion engines and their Control', Anna Arbor Science, 1985.
8. "Alcohols as Motor Fuels", SAE, 1980
9. Maxwell, et al, "Alternative Fuel : Emission, Economic and Performance" SAE, 1995
10. Watson, E.B., "Alternative fuels for the combustion engine", ASME, 1990
11. Bechtold, R., "Alternative fuels guidebook", 1998.
12. Joseph, N., "Hydrogen fuel for structure transportation", SAE, 1996.
13. Institute of Mechanical Engineering, "Alternatively fuelled vehicles", 2000.
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.
16. J.G Giles, "Vehicle operation & Testing" (Automotive Vehicle Technology Vol. 7)

University of Pune
B E (Automobile Engineering) Part II (2008 Course)
416496 Vehicle Performances and Testing

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 hrs/week	Term Work	25 Marks
		Practical	50 Marks

Section -I

Unit-1: Vehicle performance parameters **08**

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 **08**

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 **10**

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 **08**

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 restrain, air bags, GPS , roll-over protection system, Electronic stability program. Particulate traps Function & construction.

Unit-5: Collisions and crash testing **08**

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 **10**

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., ôEngine performance Diagnosis & Tune Up Shop Manualö
6. J.G .Giles, ôVehicle Operation & Performanceö.
7. W. H. Crouse & D. L. Anglin, ôMotor Vehicle Inspectionö.
8. SAE Transaction Papers û 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 Josepf 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*

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 Hrs/Week	Term work	50 Marks

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, 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:

1) Suhas V Patankar, “Numerical Heat Transfer and Fluid Flow“, Taylor & Francis
2) J. D. Anderson, “Computational Fluid Dynamics - The Basics With Appications“, McGraw Hill
3) C T Shaw, “Using Computational Fluid Dynamics“
4) H K Versteeg, W Malalasekera ,“An introduction to Computational Fluid Dynamics“
5) P S Ghoshdastidar, “Computer simulation of flow and heat transfer“
6) Jiyuan Tu, Guan Heng Yeah, C Liu, “Computational Fluid dynamics“, Elsevier
7) T. J. Chung, “Computational Fluid dynamics“, Cambridge University Pres.
8) Charles Hirsch, “Numerical Computation of Internal and External Flows“, Vols I and II, Wiley
9) Sengupta Tapan K., Fundamentals of Computational Fluid Mechanics, University Press, 2005.

*Common with B. E. (Mechanical) 2008 Course

University of Pune
B E (Automobile) Part II (2008 Course)
416497 Elective – III B - Finite Element Analysis*

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 Hrs/Week	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.

B. Review of Matrix Algebra (Vectors, Matrices, Symmetric banded matrix, Determinants, Inverses, and Eigenvalues), Partitioning of matrix, Cholesky's decomposition of matrix, Consistent units. Solutions of simultaneous equations – banded skyline solutions

C. Review of Solid Mechanics – Stress equilibrium equations, Strain-Displacement equations, Stress-Strain-Temperature Relations, Plane stress, plane strain and axisymmetric problems, Strain energy, Total potential energy, Essential & natural boundary conditions

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.

B. Formulation of element equations (stiffness matrix and load vector). Numerical integration (full and reduced integration)

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, quadrilatateral 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: 10

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
2. Chandrupatla T. R. and Belegunda A. D., Introduction to Finite Elements in Engineering, Prentice Hall India.
3. Liu G. R. and Quek S. S.,The Finite Element Method – A Practical Course, Butterworth-Heinemann, 2003.
4. Lakshiminarayana H. V. Finite Element Analysis (Procedures in Engineering), University Press, 2004.

5. Chandrupatla T. R., Finite Element Analysis for Engineering and Technology, University Press, 2009.
6. Seshu P. Text book of Finite Element Analysis, PHI Learning Private Ltd. New Delhi, 2010.

Reference Books:

1 Bathe K. J., Finite Element Procedures, Prentice-Hall of India (P) Ltd., New Delhi.
2 Fagan M. J., Finite Element Analysis, Theory and Practice, Pearson Education Limited
3 Cook R. D., Finite Element Modeling for Stress Analysis, John Wiley & Sons Inc, 1995
4 Kwon Y. W., Bang H., Finite Element Method using MATLAB, CRC Press, 1997
5 S. Moaveni Finite element analysis, theory and application with Ansys –
6 Asghar Bhatti, Fundamental Finite Element Analysis and Applications, John Wiley & Sons Inc, 2005
7 David V. Hutton, Fundamental of Finite Element Analysis, Tata McGraw-Hill Education Pvt. Ltd.
8 Daryl Logan, First Course in the Finite Element Method, Cengage Learning India Pvt. Ltd.
9 Zienkiewicz O. C., Taylor R. I., The Finite Element Method, Butterworth-Heinemann
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

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 Hrs/Week	Term work	50 Marks

Section- I

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

Fluid power system: Components, advantages and applications. Transmission of power at static and dynamic states. Pascal's law and its applications such as hydraulic press/Jack (Numerical treatment). Fluids for hydraulic system: Types, properties, selection. Additives, effect of temperature and Pressure on hydraulic fluid. Seals, sealing materials, compatibility of seal with fluids. Types of pipes, hoses, material, quick acting couplings. Pressure drop in hoses/pipes. Fluid conditioning through filters, strainers, sources of contamination and contamination control, heat exchangers. Types of Filters.

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**

Principle of Pneumatics: (i) Laws of compression, types of compressors, selection of compressors. (ii) Comparison of Pneumatics with Hydraulic power transmissions. (iii) Types of filters, regulators, lubricators, mufflers, dryers. (iv) Pressure regulators – Fine & Coarse, Electro-pneumatic Pressure

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 **08**

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.
11. Testing of liner actuator.

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.

Refrences from Dr. Lele?

University of Pune
B E (Automobile) Part II (2008 Course)
416497 Elective – III D - Product Development and Costing

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 Hrs/Week	Term work	50 Marks

Section- I

Unit -1: Product planning **08**

Development processes and organization: A generic development process, Concept Development: The Front-End process, adapting the Generic Product Development Process, Technology Push Products, Platform Products, Process-Intensive Products, Customized Products, The AFM Development Process, Product Development Organization, Organization Are Formed by Establishing Links among Individuals, Organizational Links May Be Aligned with Functions, projects, or Both, Choosing an Organizational Structure, The AFM Organization

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

Unit-2: Customer needs & Product specification **08**

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 **10**

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 **08**

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 **10**

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 **08**

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
- Product Design By Kevin Otto and Kristin Wood, Pearson Education, 2008

University of Pune
B E (Automobile) Part II (2008 Course)
416498 Elective – IV A - Transport Management and Motor Industry

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

Section- I

Unit-1: Motor Vehicle Act **10**

Short titles & definitions, Laws governing to use of motor vehicle & vehicle transport, Licensing of drivers & conductors, Registration of vehicle, State & interstate permits, Traffic rules, Signals & controls, Accidents, Causes & analysis, Liabilities & preventive measures, Rules & regulations, Responsibility of driver, Public & public authorities, Offences, penalties & procedures, Different types of forms, Government administration structure, Personnel, Authorities & duties, Rules regarding construction of motor vehicles.

Unit-2: Taxation **08**

Objectives, Structure & methods of laving taxation, Onetime tax, Tax exemption & tax renewal

Unit-3: Insurance **08**

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 **10**

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 **08**

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 **08**

Traffic navigation, Global positioning system

References Book:

1. Motor Vehicle Act - Govt. of India Publications.
2. S.K. Shrivastava, "Economics of Transport"
3. "Transport Development in India", S. Chand & Co. Pvt. Ltd., New Delhi.
4. Santosh Sharma, "Productivity in Road Transport", 2nd Edition, Association of State Road Transport Undertakings, New Delhi.
5. P.G.Patankar, "Road Passenger Transport in India", CIRT, Pune.

University of Pune
B E (Automobile) Part II (2008 Course)
416498 Elective – II B - Energy Engineering and Management

Teaching Scheme	**Examination Scheme**
Lectures 4 hrs. /week	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:

1. W.O.Paul. Callaghan, Energy Management – Mc Graw Hill book company, New Delhi, 1993
2. Jose Goldemberry, Thomas B Johanson, K.n Amulya. Reddy & Robert H. Williams, Energy for a sustainable world – Wiley Eastern Ltd., 1990
3. P.S RAIKHY. And PARAMINDER SINGH, Energy Consumption in India – Deep and Deep Publications, 1990
4. W.R MURPHY. Energy Management – Butter Worths, London, 1982
5. D A. RAY. Industrial Energy conservation – Permagon Press, 1980

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

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	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**

Fuel cell characteristics- fuel cell types – alkaline fuel cell- proton exchange Membrane; direct methanol fuel cell- phosphoric acid fuel cell- molten carbonate fuel cell- solid oxide fuel cell- hydrogen storage systems- reformers- fuel cell EV- super and ultra capacitors- PEM fuel cell vehicles

Unit -6: Nonelectric Hybrid Systems **08**

Short Term Storage Systems Flywheel Accumulators. Continuously Variable Transmissions Hydraulic Accumulators Hydraulic Pumps/Motors- Pneumatic Hybrid Engine Systems Operation Modes.

Text Books:

1. The Electric Car: Development & Future of Battery- Hybrid & Fuel Cell Cars- Mike Westbrook- M H Westbrook- British library Cataloguing in Publication Data.
2. Electric and Hybrid Vehicles- Robin Hardy- Iqbal Husain- CRC Press.
3. Propulsion Systems for Hybrid Vehicles- John M. Miller- Institute of Electrical Engineers- London.
4. Alternative Fuels, Dr. S.S.Thipse, Jaico publications

Reference Books:

1. Energy Technology Analysis Prospects for Hydrogen and Fuel Cells- International Energy Agency- France.
2. Handbook of Electric Motors- Hamid A Toliyat- Gerald B Kliman- Marcel Decker Inc.