SYLLABUS

Programme

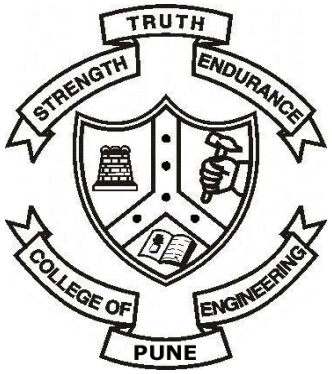
M.Tech. Mechanical - AUTOMOTIVE ENGINEERING

with Effect from

2011-2012

In Collaboration with

ARAI, Pune
and
University of Alabama, USA



MECHANICAL ENGINEERING DEPARTMENT
COLLEGE OF ENGINEERING, PUNE
Welleseley Road, Shivaji Nagar,
Pune 411005

Mechanical Engineering Department
College of Engineering, Pune

CURRICULUM STRUCTURE
Programme: M.Tech. (Mechanical –Automotive Technology)
(Duration TWO Years)

Semester –I

Sr. No	Subject Title	Course Category	Contact hours per week L	T	P	Credits
1	Open Elective – I (To be offered by other departments of the Institute)	OEC	3	0	0	3
2	Automotive Noise Vibrations and Harshness	PCC	3	-	-	3
3	I. C. Engines	PCC	3	-	-	3
4	Automotive Engineering Systems	OEC	3	1	-	4
5	Department Elective-I	EC	3	-	-	3
6	Seminar	LC	0	0	4	2
7	Automotive Laboratory-I (NVH)	LC	0	0	4	2
	Total		24			20

Department Elective I	
Combustion Engineering	COEP
Automotive Passion and Soft Skills	ARAI
Engine Tribology	COEP
Automotive Fuels and Emissions	ARAI

Semester –II

Sr. No.	Subject Title	Course Category	Contact hours per week L	T	P	Credits
1	Open Elective - II	OEC / SEC / HSSC	3	0	0	3
2	Vehicle Dynamics	PCC	3	0	0	3
3	Automotive Electronics	PCC	3	0	0	3
4	I. C. Engine Modeling	PCC	3	0	0	3
5	Department Elective II	PCC	3	0	0	3
6	Automotive Lab-II (Engine / Emissions / Fuel)		0	0	4	2
7	Intellectual Property Rights	MLC	1	0	0	1
8	Mini Project / Seminar	LC	0	0	4	2
	Total		**24**			**20**

Department Elective II	**Offered by**
Automotive Testing and certification	ARAI
Global Product Development	ARAI
Automotive Aerodynamics	COEP
Automotive HVAC	COEP

Open Elective Courses *To be selected for "Open Elective-I" and "Open Elective-II"* **(This list is dynamic)**	**Offered by**
Engineering Mathematics for Problems Solving	COEP
Mechanics of Composite Materials	COEP
Engine Tribology	COEP
Finite Element Method	COEP
Automotive Electronics	COEP
Industrial Automation	COEP
Industrial Drives	COEP
ERP	COEP
FEM	COEP
Complex Analysis	COEP
Quantum Information Theory	COEP

Semester- III

Sr. No	**Subject Title**	**Course Category**	**Contact hours per week**			**Credits**
			L	**T**	**P**	
1	Environmental Studies *	MLC	2	0	0	2
2	Constitution of India *	MLC	2	0	0	2
3	Automotive Materials and Manufacturing	PCC	3	0	0	3
4	Computational Modeling and Simulation	PCC	3	2	0	4
5	Department Elective-III	PCC	3	0	0	3
6	Dissertation Stage-I	Project Work	0	0	12	6
	Total		**27**			**20**

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

Elective III	
Automotive Design	COEP
Automotive Safety and Lighting	ARAI
Finite Element Methods	COEP/UAB
Automotive Enabling Technologies and Simulation	UAB
Applied Physics	UAB

Semester –IV

Sr. No	**Subject Title**	**Course Category**	**Contact hours per week**			**Credits**
			L	**T**	**P**	
1	Dissertation Stage-II					20
	Total					**20**

OEC: Open Elective Courses
PCC: Program Core Courses
EC: Department Elective Courses
LC: Laboratory Courses
SEC: Science Elective Courses

ENGINEERING MATHEMATICS FOR PROBLEM SOLVING

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
	End Sem Exam – 50 marks

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

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

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

Eigen Value Problems: Standard Eigen value problems – properties of Eigen values and Eigen vectors – Generalized Eigen value problems – strum sequence – Jacobi, Givens and House holder transformations.

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

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

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

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

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

References

1. Jennings. A., Matrix Computation for Engineers and Scientists., John Wiley and Sons, 1992.
2. Prem.K.Kythe, Pratap Puri, Michael R.Schaferkotter, Introduction to Partial Differential Equations and Boundary Value problems with Mathematics, CRC Press, 2002
3. Kreyszig, Erwin, I.S., Advanced Engineering Mathematics, Wiley, 1999.
4. Ramamurthy. V., Computer Aided Design in Mechanical Engineering., Tata McGraw Hill Publishing Co., 1987.
5. Fundamental Concepts in the Design of Experiments, 5th Ed., by Hicks and Turner
6. Devore, Jay L., Probability and Statistics for Engineering and the Sciences, 5th edition, Brooks-Cole (1999).

AUTOMOTIVE NOISE VIBRATION AND HARSHNESS

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
	End Sem Exam – 50 marks

NVH in the Automotive Industry
Sources of noise and vibration. Design features. Common problems. Marque values. Noise quality. Pass-by noise requirements. Target vehicles and objective targets. Development stages in a new vehicle programme and the altering role of NVH engineers.

Sound and Vibration Theory
Sound measurement. Human sensitivity and weighting factors. Combining sound sources. Acoustical resonances. Properties of acoustic materials. Transient and steady state response of one degree of freedom system applied to vehicle systems. Transmissibility. Modes of vibration.

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

Signal Processing
Sampling, aliasing and resolution. Statistical analysis. Frequency analysis. Campbell's plots, cascade diagrams, coherence and correlation functions.

NVH Control Strategies & Comfort
Source ranking. Noise path analysis. Modal analysis. Design of Experiments, Optimisation of dynamic characteristics. Vibration absorbers and Helmholtz resonators. Active control techniques.

Text Books:

1. Norton M P, Fundamental of Noise and Vibration, Cambridge University Press,1989
2. Munjal M.L., Acoustic Ducts and Mufflers, John Wiley, 1987

Reference Books:

1. Baxa, Noise Control of Internal Combustion Engine, John Wiley, 1984.
2. Ewins D. J., Model Testing : Theory and Practice, John Wiley,1995.
3. Boris and Kornev, Dynamic Vibration Absorbers, John Wiley, 1993.
4. McConnell K, "Vibration Testing Theory and Practice", John Wiley, 1995.

INTERNAL COMBUSTION ENGINES

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
	End Sem Exam – 50 marks

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

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

Combustion in SI and CI Engines:

Premixed combustion, diffused combustion, laminar and turbulent combustion of fuels in engines. Droplet combustion, Cylinder pressure data and heat release analysis.

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

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

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

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

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

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

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

TEXTBOOK

1. J.B.Heywood, 'Internal Combustion Engine Fundamentals', McGraw Hill Book Co, 1988.
2. V. Ganesan, 'Internal Combustion Engines', Tata McGraw Hill Book Co, Eighth Reprint, 2005.

REFERENCES:

1. Edward F.Obert, 'Internal combustion engines and air pollution' Harber and Row Publishers, 1973.
2. M.Khovakh, 'Motor Vehicle Engines', Mir Publishers, Mascow,1976
3. W.H.Crouse and A.L.Anglin, 'Automotive Emission Control', McGraw Hill Book Co, 1995.
4. G.S.Springer and A.J.Patterson, 'Engine emissions and pollutant formation', plenum press, Newyork,1985.
5. ARAI & Western Section Proceedings, "I C Engine Design & Development", Jan 2009.

AUTOMOTIVE ENGINEERING SYSTEMS

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
Tutorial: 2 hrs/Week	End Sem Exam – 50 marks

Chassis & Body
Classification of vehicle, layout with reference to power plant, steering location and drive, chassis, construction and details (frames, sub-frames, defects in frame, frameless vehicles, vehicle dimensions), details of chassis & body materials, Integrated body construction, BIW type and corresponding design parameters, Vehicle interior system (dash board & seating system), Cosole design, Pillar trims (Type A, B, C), head roofs.

Transmission & Driveline

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

Front Axle & Steering

Front axle types, rigid axle and split axle, constructional details, materials, front wheel geometry viz., camber, castor, kingpin inclination, toe-in and toe-out, Wheel alignment and balancing, Condition for true rolling motion of road wheels during steering. Steering geometry. Ackermann and Davis steering. Construction details of steering linkages. Different types of steering gear box. Steering linkages layout for conventional and independent suspensions. Turning radius, instantaneous centre, wheel wobble and shimmy. Over-steer and under-steer. Power and power assisted steering.

Braking & Suspension

Type of brakes, Principles of shoe brakes. Constructional details – materials, braking torque developed by leading and trailing shoes. Disc brake, drum brake theory, constructional details, advantages, Brake actuating systems. Factors affecting brake performance, Parking & Exhaust brakes, power & power assisted brakes, Antilock Breaking System (ABS). Testing of brakes, thermal Considerations.

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

Electrical System

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

Text Books:

1. K. Newton, W.Steeds and T.K.Garret, "The Motor Vehicle", 13th Edition, Butterworth Heinemann, India, 2004.
2. P.M.Heldt, "Automotive Chassis", Chilton Co., New York, 1982.
3. W.Steed, "Mechanics of Road Vehicles", Illiffe Books Ltd., London. 1992.
4. Heinz Heisler, "Advanced Vehicle Technology", second edition, Butterworth – Heinemann, New York, 2002.

References:

1. William Crouse, "Automobile Engineering "
2. Harban Singh Rayat, "The Automobile", S. Chand & Co. Ltd, New Delhi, 2000.
3. G.J.Giles, "Steering Suspension and Tyres", Illiffe Books Ltd., London, 1975.
4. Kirpal Singh, "Automobile Engineering", Standard publishers, Distributors, Delhi, 1999.
5. G.B.S.Narang, "Automobile Engineering", Khanna Publishers, Twelfth reprint New Delhi, 2005.
6. R.P.Sharma, "Automobile Engineering", Dhanpat Rai & Sons, New Delhi, 2000.
7. Dr. N. K. Giri, "Automobile Mechanics", Seventh reprint, Khanna Publishers, Delhi, 2005
8. Automotive Hand book/ Robert Bosch, SAE, 2003.
9. 2. K.K. Ramalingam, "Automobile Engineering ", Scitech Publications (India) PVT.

COMBUSTION ENGINEERING
(Department Elective-I)

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
	End Sem Exam – 50 marks

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

Chemical Kinetics of Combustion
Fundamentals of combustion kinetics, rate of reaction, equation of Arrhenius, activation energy. Chemical thermodynamic model for Normal Combustion.

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

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

References

1. Combustion Engineering – Gary L. Borman, Kenneth W. Ragland, McGraw Hill
2. Spalding.D.B., "Some fundamental of Combustion", Butterworth Science Publications, London, 1985.
3. Lewis.B., Pease.R.N. and Taylor.H.S., "Combustion Process High Speed Gas Dynamics and Jet Propulsion Series ", Princeton University Press, Princeton, New Jersey, 1976.
4. Taylor.E.F. "The Internal Combustion Engines ", International Text Book Co., Pennsylvania, 1982.
5. V.Ganesan, 'Internal combustion Engines', Tata McGraw Hill Book Co, Eighth Reprint, 2005.
6. Ashley Campbel, "Thermodynamic analysis of combustion engine", John book company, Newyork, 1979.
7. J.l.Ramos, "Modeling of Internal Combustion Engine", Mcgraw hill book company New york 1990
8. John. B. Heywood,'Internal Combustion Engines'", Tata McGraw Hill Co., Newyork, 1988.
9. Ganesan.V. "Computer Simulation of Spark Ignition Engine Process", Wiley eastern India Ltd,1996.

AUTOMOTIVE PASSION & SOFT SKILLS
(Department Elective-I)

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
	End Sem Exam – 50 marks

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

Communication and Skill Building
Communication Skills, Verbal Communication, Written communication, Body Language, Event Management, How to write Report & SAE Papers, Paper Review, Book Review, Presentation, Intelligence Building, Emotional Quotient, Intelligence Quotient & Memory Improvement, Cracking Written tests, Interviews & Group Discussions.

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

Soft Skills at Workplace:
How an Industry Works, Various Departments of Industry, Industry Review, Team building & Motivation, Auto Passion, Confidence Building, Product Development Cycle, Customer Satisfaction and Benchmarking.

Business/Work Success:
Time Management, Interpersonal Skills, Negotiation Skills, Delegating Skills, Executive Summary & Business Report, Handling of Difficult People, Business Analysis, Business Strategy, Meeting Skills, Stress Management & Meditation, Knowledge Management, Project Management, Performance Management System, Total Quality Management.

Reference Books:

1. Narian Ram, Twelve Management Sills for Success, Viva Books, 2006.
2. Dr Bond Allan, Your Masters Thesis, Viva Books, 2006.
3. Verity Judith, Succeeding at Interviews, Viva Books.
4. High Jana L., High Tech Etiquettes, Viva Books.
5. Haynes Marion E., Effective Meeting Skills, Viva Books.

ENGINE TRIBOLOGY
(Department Elective-I)

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
	End Sem Exam – 50 marks

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

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

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

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

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

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

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

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

Reference Books

1. Friction and Lubrication, Bowden F.P. & Tabor D., Heinemann Edu. Books Ltd. 1974
2. Friction & Wear of Material, Ernest Rabinowiez
3. A. Cameron, “Basic Lubrication Theory”, Ellis Horwood Ltd, 1981.
4. A. Cameron, “The principles of lubrication”, Longmans Green & Co. Ltd, 1966.

5. D.D. Fuller, “Theory and Practice of Lubrication for Engineers”, John Wiley and Sons, 1984.
6. T.A. Stolarski, “Tribology in Machine Design”.

AUTOMOTIVE FUELS AND EMISSIONS
(Department Elective-I)

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
	End Sem Exam – 50 marks

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

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

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

Emissions from SI & CI Engines and its Control: Emission formation in S.I. engines – Hydrocarbons – Carbon monoxide – Nitric Oxide, Lead particulates – Polyneculear aromatic hydro carbon emission – Effects of design and operating variables on emission formation in spark ignition engines – Controlling of pollutant formation in engines – Thermal reactors – Catalytic converters – Charcoal Canister Control for evaporative emission – Positive crank case ventilation system for UBHC emission reduction.
Chemical delay – Significance – Intermediate compound formation – Pollutant formation on incomplete combustion – effect of operating variables on pollutant formation – Controlling of emissions – Driving behavior – Fumigation – Exhaust gas recirculation – Air injection – Cetane number effect.

Emission Measurement and Test procedure: Measurement of CO, CO2, by NDIR. Hydrocarbon by FID – Chemiluminescent detector for NOx measurement, Smoke meters – Dilution tunnel technique for particulate measurement. Procedures on Engine and Chassis
Constant Volume Sampling procedures –Emission Test– Sampling probes and valves – Quantifying emissions – Dynamometers.

References:

1. Ganesan.V, Internal Combustion Engines, Tata McGraw Hill, 1994.
2. Crouse.W.M, Anglin.A.L., Automotive Emission Control, McGraw Hill 1995.
3. Springer.G.S, Patterson.D.J, Engine Emissions, pollutant formation, Plenum Press, 1986
4. Patterson, D.J, Henin.N.A, Emissions from Combustion engines and their Control, Anna Arbor Science, 1985. Linden.D, Handbook of Batteries and Fuel Cells, McGraw Hill, 1995.
5. Maxwell et al, Alternative Fuel : Emission, Economic and Performance, SAE, 1995
6. Watson, E.B., Alternative fuels for the combustion engine, ASME, 1990
7. Bechtold, R., Alternative fuels guidebook, 1998.
8. Joseph, N., Hydrogen fuel for structure transportation, SAE, 1996.
9. Holt and Danniel, Fuel cell powered vehicles: Automotive technology for the future, SAE, 2001.

SEMINAR

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

AUTOMOTIVE LAB-I (NVH Lab.)

Teaching Scheme	Examination Scheme
Lectures: 4 hrs/week	Term Work / Tutorials 100

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

1. Study of sound and vibration instrumentation, measurement and analysis.
2. Modal Analysis of Automotive components
3. Evaluation of Sound Power Level Measurement by Sound Pressure Level.
4. Evaluation of Sound Power using Sound Intensity Mapping.
5. Measurements of Tail Pipe Noise as per IS 10399
6. Vehicle Pass by Noise Measurement as per IS 3028
7. Evaluation of Normal Incidence Sound Absorption Coefficient
8. Evaluation of Sound absorption coefficient-Random incidence ISO354
9. Evaluation of Sound Transmission Loss of glass.
10. Noise reduction in muffler.

Books & References:

1. Tail pipe noise measurement as per IS 10399
2. Vehicle Pass by Noise Measurement as per IS 3028
3. Fatigue & Vibration Testing of Vehicle Components & Assembles, Wright, D.H. MIRA Publication.
4. Vibration testing : Theory and Practice, McConnell, Kenneth G., John Wiley and Sons, 2008
5. Modal Testing and Analysis, Carne J G and Simonis J. C., ASME, 1987.
6. Modal Testing : Theory and Practice, Ewins, D. J., Research Studies Press Ltd.,1984.
7. Shock and Vibation Handbook Vol 2 : Data Analysis, Testing and Methods of Control, Harries C M ed & Crede C E Ed, McGraw Hill Book Company, 1961.

Semester-II

VEHICLE DYNAMICS

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
	End Sem Exam – 50 marks

Basic of Vibration

Classification of vibration, definitions, mechanical vibrating systems, mechanical vibration and human comfort. Modeling and simulation studies. Single degree of freedom, free, forced and damped vibrations. Magnification factor and transmissibility. Vibration absorber. Vibration measuring instruments. Two degree of freedom system. modal analysis.

Tyres

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

Performance Characteristics of Vehicle
Equation of motion and maximum tractive effort. Aerodynamics forces and moments. Power plant and transmission characteristics. Prediction of vehicle response to braking, crashworthiness of a vehicle.

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

Dynamics of Suspension System
Requirements of suspension system. Spring mass frequency, wheel hop, Wheel wobble, wheel shimmy, choice of suspension spring rate. Calculation of effective spring rate. Vehicle suspension in fore and aft, Hydraulic dampers and choice of damping characteristics. Compensated suspension systems. Human response to vibration, vehicle ride model. Load distribution. Stability on a curved track, banked road and on a slope.

Textbook:

1. Rao J.S and Gupta. K "Theory and Practice of Mechanical Vibrations", Wiley Eastern Ltd., 2002.
2. J.Y.Wong,' Theory of ground vehicle', John Wiley and Sons Inc., Newyork, 1978
3. Dr. N. K. Giri, "Automobile Mechanics", Seventh reprint, Khanna Publishers, Delhi, 2005

References:

1. Groover, "Mechanical Vibration", 7th Edition, Nem Chand &Bros, Roorkee, India, 2003.
2. W.Steeds, 'Mechanics of road vehicle' Illiffe Books Ltd, London 1992
3. JG.Giles, 'Steering, Suspension tyres', Illife Books Lid London 1975
4. P.M.Heldt, 'Automotive chassis', Chilton Co ., Newyork, 1982
5. J. R. Ellis, 'Vehicle Dynamics', Business Books, London, 1969.

AUTOMOTIVE ELECTRONICS

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
	End Sem Exam – 50 marks

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

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

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

SI Engine Management
feedback carburetor system, throttle body injection and multi point fuel injection system, injection system controls, advantage of electronic ignition systems, three way catalytic converter, conversion efficiency versus lambda. Layout and working of SI engine management systems like Bosch Monojetronic, L-Jetronic and LH-Jetronic. Group and

sequential injection techniques. Working of the fuel system components. Advantages of electronic ignition systems. Types of solid state ignition systems and their principle of operation, Contactless electronic ignition system, Electronic spark timing control.

CI Engine Management
Fuel injection system, parameters affecting combustion, noise and emissions in CI engines. Pilot, main, advanced, post injection and retarded post injection. Electronically controlled Unit Injection system. Layout of the common rail fuel injection system. Working of components like fuel injector, fuel pump, rail pressure limiter, flow limiter, EGR valve control in electronically controlled systems.

Reference Books:

1. Automobile Electrical & Electronic Equipments - Young, Griffitns - Butterworths, London.
2. Understanding Automotive Electronics, Wiliam B. Ribbens, 5th Edition, Newnes, Butterworth–Heinemann.
3. Diesel Engine Management by Robert Bosch, SAE Publications, 3rd Edition, 2004
4. Gasoline Engine Management by Robert Bosch, SAE Publications, 2nd Edition, 2004
5. Understanding Automotive Electronics – Bechfold SAE 1998
6. Automobile Electronics by Eric Chowanietz SAE.
7. Fundamentals of Automotive Electronics - V.A.W.Hilliers - Hatchin, London
8. Automotive Computer & Control System – Tomwather J. R., Cland Hunter, Prentice Inc. NJ
9. Automotive Computers & Digital Instrumentation – Robert N. Brandy, Prentice Hall
10. Eaglewood, Cliffs, NJ
11. The Fundamentals of Electrical Systems - John Hartly - Longman Scientific & Technical
12. Automobile Electrical & Electronic Systems – Tom Denton, Allied Publishers Pvt. Ltd.

IC ENGINE MODELING

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Mid-Sem – 30, Assignments/Quiz- 20
Tutorial: 2 hrs/Week	End Sem Exam – 50 marks

Fundamentals: Governing equations, Equilibrium charts of combustion chemistry, Chemical reaction rates, Approaches of modeling, Model building and integration methods. Gas exchange through valves, engine and porting geometry, exhaust gas recirculation, valve lift curves.

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

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

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

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

Text Books

1. Internal Combustion Engine Fundamentals, John B Heywood, McGraw-Hill, 1988.
2. Internal Combustion Engine Modeling, J.I. Ramos, Hemisphere Publishing Corporation, 1989.
3. Modeling Engine Spray and Combustion Processes, G. Stiesch, Springer Verlag, 2003.

Reference Books:

4. Turbocharging the Internal Combustion Engine, N. Watson and M.S. Janota, John Wiley & Sons, New York, 1982.
5. Simulating Combustion: Simulation of combustion and pollutant formation for engine, Günter P. Merker, Christian Schwarz, Gunnar Stiesch, Frank Otto, Springer, 2008.
6. Introduction to Modeling and Control of IC Engine Systems, Guzzella Lino, Springer Verlag, 2004.
7. Internal Combustion Engines, R.S. Benson and N.D. Whitehouse, Volumes 1 and 2, Pergamon Press, Inc. 1979.
8. The Thermodynamics and Gas Dynamics of Internal Combustion Engines, R.S. Benson, Volume I and II, Edited by J.H. Horlock and D.E. Winterbone, Clarendon Press, Oxford, 1982. .
9. Thermodynamic analysis of combustion engines, Ashley, S, Campbell, John Wiley and Sons, 1980.
10. Combustion Modeling in Reciprocating Engines, J. N. Mattavi and C. A. Amann, Plenum press 1980.
11. Theory of Engine Manifold Design, D.E. Winterbone and R.J. Pearson, SAE, 2000.
12. Design Techniques for Engine Manifolds, D.E. Winterbone and R.J. Pearson, SAE, 1999.
13. Design and Simulation of Four-Stroke Engines, G. P. Blair, SAE, 1999.
14. Automotive Control Systems for Engine, Driveline and Vehicle, Uwe Kiencke and Lars Nielsen, 2e, Springer, 2005.
15. Bosch Handbook
16. Modelling Diesel Combustion, Lakshminarayanan, P. A., Aghav, Yoghesh V., Mechanical Engineering Series, Springer, 2010.

AUTOMOTIVE TESTING AND CERTIFICATION
(Department Elective-II)

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
	End Sem Exam – 50 marks

INTRODUCTION:

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

4 WHEELER PASSENGER VEHICLES-M1 CATEGORY (Vehicle Related Tests):

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

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

Engine power *(petrol engine)*, Vehicle - mass emission, Evaporative emission *(petrol vehicles only)*, Broad band / Narrow band EMI test, Safety belt assemblies, Safety belt anchorages, Seat anchorages and head restraints., Engine power petrol, Engine power Diesel, Crash test with Dummy, OBD I, Certification Charges,

4 WHEELER PASSENGER VEHICLES-M1 CATEGORY (Component Related Tests):

Size and Ply rating of tyres, Safety Glasses: 1. Windscreen laminated safety glass 2. Side window / door glass 3. Back light / rear toughened glass; Windscreen wiping system, Wiper Blade, Reflector, Horn, Automotive lamps, Hydraulic brake hose, Hydraulic brake fluid, Wheel rims, Rear View Mirror Specifications(Exterior), Rear View Mirror Specifications(Interior),

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

BOOKS & REFERENCES:

1. Bosch Automotive Handbook
2. Motor Vehicle Manual
3. ECE,
4. EEC,
5. FMVSS,
6. AIS,
7. CMVR,
8. ADR

GLOBAL PRODUCT DEVELOPMENT
(Department Elective-II)

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
	End Sem Exam – 50 marks

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

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

Product Development Processes: Concepts of product development processes – Concurrent Engineering – Reverse Engineering – ethics – Competition intellectual rights – Patents – Product safety, liability and compensation, Advance Product Quality Planning (APQP).

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

Design and Process FMEA: Design for Failure Mode Effects Analysis (DFMEA), Design Review, Vehicle Review.

Quality Assurance and Design for Manufacturing: Design for quality. Process behavior over time. Concept of statistical process control (SPC). Process capability study. Tolerance. Measurement system analysis. Implication of customer satisfaction and profitability. Including Applications of probability and statistics in design reliability and quality control.

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

Fatigue in Mechanical Design: A broad treatment of stress, strain, and strength with reference to engineering design and analysis. Major emphasis is placed on the analytical and experimental determination of stresses in

relationship to the fatigue strength properties of machine and structural components. Also considered are deflection, post-yield behavior, residual stresses, temperature and corrosion effects.

References

1. ARAI & SAEINDIA W.S. Proceedings, 3 Day Certificate Course on Quality Function Deployment, May 2007.
2. ARAI & SAEINDIA W.S. Proceedings, 3 Day Certificate Course on Design Failure Mode & Effect Analysis, May 2007.
3. David G. Ullman, The Mechanical Design Process, McGraw Hill, 1997.
4. William H. Middendroff, Design of Devices and Systems, Maecell Dekker Inc, New York, 1998.

AUTOMOTIVE AERODYNAMICS
(Department Elective-II)

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
	End Sem Exam – 50 marks

Introduction

Scope – historical development trends – Fundamentals of fluid mechanics – Flow phenomenon related to vehicles – External & Internal flow problems – Resistance to vehicle motion – Performance – Fuel consumption and performance – Potential of vehicle aerodynamics.

Aerodynamic Drag of Cabs

Car as a bluff body – Flow field around car – drag force – types of drag force – analysis of aerodynamic drag – drag coefficient of cars – strategies for aerodynamic development – low drag profiles.

Shape Optimization Of Cabs

Front and modification – front and rear wind shield angle – Boat tailing – Hatch back, fast back and square back – Dust flow patterns at the rear – Effect of gap configuration – effect of fasteners.

Vehicle Handling

The origin of force and moments on a vehicle – side wind problems – methods to calculate forces and moments – vehicle dynamics Under side winds – the effects of forces and moments – Characteristics of forces and moments – Dirt accumulation on the vehicle – wind noise – drag reduction in commercial vehicles.

Wind Tunnels For Automotive Aerodynamics

Introduction – Principles of wind tunnel technology – Limitation of simulation – Stress with scale models – full scale wind tunnels – measurement techniques – Equipment and transducers – road testing methods – Numerical methods.

Textbook:

1. Hucho, W.H., Aerodynamics of Road vehicles, Butterworths Co. Ltd., 1997.

References:

1. Pope, A, Wind Tunnel Testing, John Wiley & Sons, 2nd Edn., New York, 1994.
2. Automotive Aerodynamics: Update SP-706, SAE, 1987.
3. Vehicle Aerodynamics, SP-1145, SAE, 1996.

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

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
	End Sem Exam – 50 marks

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

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

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

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

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

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

Textbooks:

1) Tom Birch, “Automotive Heating and Air Conditioning” Pearson Education Inc., 2003.
2) Boyce H. Dwiggins, Jack Erjavec., “Automotive Heating and Air-Conditioning”, Delmer publisher., 2001.
3) William H Crouse and Donald L Anglin, “Automotive air conditioning”, McGraw - Hill Inc., 1990

References:

1) Goings. L.F., “Automotive air conditioning”, American Technical services, 1974
2) Paul Weiser, “Automotive air conditioning”, Reston Publishing Co Inc., 1990.
3) MacDonald, K.L., “Automotive air conditioning”, Theodore Audel series, 1978.
4) James D. Halderman, “Automotive Heating, Ventilation, and Air Conditioning Systems”, Pearson Education Inc., 2004.
5) SAE paper No: 931121,900084, 850040,931137,870029 etc.
6) Vehicle Service Manuals.
7) ASHRAE Handbook, All four volumes.

AUTOMOTIVE LAB - II

Teaching Scheme	Examination Scheme
Lectures: 4 hrs/week	Term Work / Tutorials 100

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

Engine:

1. Performance test on Gasoline engine
2. Performance & emission test on Genset diesel engine
3. Performance & emission test on CNG engine
4. Swirl & Flow tests of ports on steady state flow-bench.

Emission:

5. Performance & emission test on Heavy duty diesel engine (transient Dyno)
6. Study of Emission test for SI Engine 2 wheelers on Chassis Dynamometer.
7. Study of Emission test for SI Engine 3 wheelers on Chassis Dynamometer.
8. Study of Emission test for SI Engine 4 wheelers on Chassis Dynamometer.

Fuel:

9. Analysis of Carbonyl Compound from exhaust emission using HPLC.
10. Chemical Characterization of Gasoline and Diesel Fuel.

Reference Books:

1. SAE SP-582 : Engine Testing, SAE Publication, 1984.
2. Facilities for engine testing of fuels and lubricants, SP-350, SAE Publication, 1968
3. Engine Testing : Theory and Practice, Plint, Michael a Martyr, Anthony, SAE Publication, 3rd Ed. 2007.
4. Statistics for Engine Optimization, Edwards, S P, Professional Engineering Publishing Limited, 2000.
5. Introduction to engine testing and development SAE R-344, Atkins, Richard D, SAE Publisher, 2009
6. Automotive Engine Performance : Tune up, Testing and Service, Layne, Ken, Prentice Hall, 1986.
7. Automobile Engines : In Theory, Design, Construction, Operation, Testing and Maintenance, Judge, Arthur W, Chapman and Hall Ltd., 1946

INTELLECTUAL PROPERTY RIGHTS

Teaching Scheme	**Examination Scheme**
Lectures : 1 hr/week	End-Sem Exam- 50

Unit 1 **(02)**

Introduction: Nature of Intellectual Property: Patents, Designs, Trademarks and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development.

Unit 2 **(02)**

International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 3 **(03)**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit 4 **(03)**

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

Unit 5 **(03)**

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

Reference Books

- Resisting Intellectual Property by Halbert ,Taylor & Francis Ltd ,2007
- Industrial Design by Mayall, Mc Graw Hill
- Product Design by Niebel, Mc Graw Hill
- Introduction to Design by Asimov, Prentice Hall
- Intellectual Property in New Technological Age by Robert P. Merges, Peter S. Menell, Mark A. Lemley
- Intellectual Property Rights Under WTO by T. Ramappa, S. Chand.

Mini Project

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

Semester-III

ENVIRONMENTAL SCIENCES

Teaching Scheme **Examination Scheme**

Lectures : 1 hr/week End-Sem Exam- 50

Unit 1 **(02)**

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

Unit 2 **(03)**

Natural Resources :

Renewable and non-renewable resources: Natural resources and associated problems.

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

Unit 3 **(02)**

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

Unit 4 **(03)**

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

Unit 5 **(03)**

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

Text Books

- Hazardous Waste Incineration by Brunner R.C.1989, McGraw Hill Inc. 480p
- Marine Pollution by Clark R.S. Clanderson Press Oxford
- Environmental Chemistry by De A.K., Wiley Eastern Ltd.
- Water in Crisis, Pacific Institute for Studies in Dev., Environment & Security by Gleick, H.P. 1993. Stockholm Env. Institute Oxford Univ. Press. 473p
- Global Biodiversity Assessment by Heywood, V.H & Waston, R.T. 1995.. Cambridge Univ. Press

1140p.

Reference Books

- The Biodiversity of India by Bharucha Erach, Mapin Publishing Pvt. Ltd., Ahmedabad –380 013, India, Email:mapin@icenet.net
- Handbook of Environmental Laws by Trivedi R.K.,Rules Guidelines, Compliances and Standards, Vol I and II, Enviro Media

CONSTITUTION OF INDIA

Teaching Scheme | **Examination Scheme**

Lectures : 1 hr/week | End-Sem Exam- 50

Unit 1 **(02)**

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

Unit 2 **(02)**

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

Unit 3 **(03)**

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

Unit 4 **(02)**

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

Unit 5 **(02)**

Constitutional Provisions for Scheduled Castes & Tribes, Women & Children & Backward classes. Emergency Provisions.

Unit 6 **(02)**

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

Text Books

- Introduction to the Constitution of India by Durga Das Basu (Students Edn.) Prentice – Hall EEE, 19th/20th Edn., 2001.
- Engineering Ethics by Charles E.Haries, Michael. S.Pritchard and Michael J.Robins Thompson Asia, 2003-08-05.

Reference Books

- An Introduction to Constitution of India by M.V. Pylee, Vikas Publishing, 2002.

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AUTOMOTIVE MATERIALS AND MANUFACTURING

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
	End Sem Exam – 50 marks

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

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

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

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

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

Global Manufacturing and Supply Chain Management. Globalization and manufacturing paradigms. Product-process-business integration. Product invention strategy. Customized, personalized and reconfigurable products. Mass production and lean production. Mathematical analysis of mass customization. Traditional manufacturing systems. Reconfigurable manufacturing systems. Reconfigurable machines. System configuration analysis. Responsive business models. Enterprise globalization strategies. The global integrated enterprise.

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

Laser Materials Processing: Application of lasers in materials processing and manufacturing. Laser principles and optics. Fundamental concepts of laser/material interaction. Laser welding, cutting, surface modification, forming, and rapid prototyping. Modeling of processes, microstructure and mechanical properties of processed materials. Transport phenomena. Process monitoring.

Assembly Modeling for Design and Manufacturing: Assembly on product and process. Assembly representation. Assembly sequence. Datum flow chain. Geometric Dimensioning and Tolerancing. Tolerance analysis. Tolerance synthesis. Robust design. Fixturing. Joint design and joining methods. Stream of variation. Auto body assembly case studies.

COMPUTATIONAL MODELING AND SIMULATION

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
Tutorial: 2 hrs/Week	End Sem Exam – 50 marks

Introduction to CFD: Computational approach to Fluid Dynamics and its comparison with experimental and analytical methods, Basics of PDE: Elliptic, Parabolic and Hyperbolic Equations.

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

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

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

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

Solution of N-S Equations for Incompressible Flows: Semi-Explicit and Semi-Implicit Algorithms for Staggered Grid System and Non Staggered Grid System of N-S Equations for Incompressible Flows

Reference Books

1. Computational Fluid Dynamics, The Basic with applications by John A. Anderson, Jr., McGraw Hill International editions, Mechanical Engineering series.
2. Numerical Methods in Fluid Flow & Heat Transfer by Dr. Suhas Patankar.
3. An Introduction to Computational Fluid Flow (Finite Volume Method), by H.K. Versteeg, W.Malalasekera, Printice Hall
4. Computational Methods for Fluid Dynamics by Ferziger and Peric, Springer Publication.
5. An Introduction to Computational Fluid Mechanics by Chuen-Yen Chow, Wiley Publication.
6. Computational Fluid Flow & Heat Transfer by Murlidhar and Sundarrajan, Narosa Publication.

AUTOMOTIVE DESIGN
(Department Elective-III)

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
	End Sem Exam – 50 marks

Introduction to Design Process:, Factors – Materials selection direct - Bending and Torsional stress equation - Impact and Shock loading - Stress concentration factor - Size factor - Surface limits factor - Factor of safety - Design stress - Theories of failures – Problems.

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

Design of Couplings: Design and drawings of couplings – Rigid – Flexible – Design and Drawings of Cotter joints - Knuckle joints, Computer aided design of machine elements.

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

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

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

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

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

Text Books :

1. Joseph Edward Shigley and Charles, R. Mischke, (2000), Mechanical Engineering Design, McGraw –Hill International Editions.
2. Pandya and Shah, Machine design,Charotar Publishing House.

Reference Books:

1. DTB Donkins, Elements of Motor Vehicles Design, TMH
2. P. Lukin, Automobile Chasis Design and calculations, Mir Publishers
3. K. M. Agrawal,Autodesign Problems,Satyaprakashan.
4. N.K.Giri, Automotive Mechanics,Khanna Publishers.

AUTOMOTIVE SAFETY AND LIGHTING
(Department Elective-III)

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
	End Sem Exam – 50 marks

Introduction to safety and Vehicle structural crashworthiness & Crash testing

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

Ergonomics and Human response to Impact: Importance of Ergonomics in Automotive safety, Locations of controls, Anthropomerty, Human impact tolerance, Determination of Injury thresholds, Severity Index, Study of comparative tolerance, Application of Trauma for analysis of crash injuries. Injury criteria's and relation with crash and modeling and simulation studies in dummy.

Vehicle safety systems: Survival space requirements, Restraints systems used automobiles, Types of safety belts, Head restraints, Air bags used in automobiles, Use of energy absorbing systems in automobiles, Impact protection from steering controls, Design of seats for safety, types of seats used in automobiles. Importance of Bumpers in automobiles, Damageability criteria in bumper designs. Introduction to the types of safety glass and their requirements and rearward field of vision in automobiles, Types of rear view mirrors and their assessment. Warning devices, indicators, hinges, latches, wipers, horns, etc.

Fundamentals of light, vision and colour: Electromagnetic radiation and light, Propagation of light, Spectral sensitivity of light,Measures of radiation and light, Standard elements for optical control. Illuminant calculations, Derivation of luminous flux from luminous intensity, flux transfer and inter reflection, luminance calculations, discomfort glare, eyes as an optical system, visual processing, lighting for results, modes of appearance, Pointers for lighting devices. Nature of the colour, Tri-chromatic Colorimetry, Surface colour, colour spaces and colour solids,, colour rendering.

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

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

References :

1. Watts, A. J., et al "Low speed Automobile Accidents" Lawyers and Judges 1996
2. Jullian Happian-Smith ‘An Introduction to Modern Vehicle Design’ SAE, 2002
3. Johnson, W., and Mamalis, A.G., "Crashworthiness of Vehicles, MEP, London, 1995
4. Edward .A, Lamps and Lighting, Hodder & Stoughton, London, 1993.
5. Keitz H. A. E, Light calculations and Measurements, Macmillan, 1971.
6. Olson L. P, Forensic aspects of driver perception and response, Lawyers and Judges 1996.
7. Pantazis. M, Visual instrumentation: Optical design & engineering Principles, McGraw - Hill 1999.

FINITE ELEMENT METHOD
(Department Elective-III)

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
	End Sem Exam – 50 marks

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

References Books:

1. Cook R.D. “Concepts and applications of finite element analysis” Wiley, New York, 1981.
2. Bathe K.J., Cliffs, N.J. “Finite element procedures in Engineering Analysis”, Englewood. Prentice Hall, 1981.
3. Reddy J. N., Finite Element Method, Tata McGrawHill Edition, 2E, 2003.

4. Chandrupatla and Belegundu “Introduction to finite elements in Engineering”, Prentice Hall of India Pvt. Ltd. New Delhi, 2001.

AUTOMOTIVE ENABLING TECHNOLOGIES AND SIMULATION
(Department Elective-III)

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
	End Sem Exam – 50 marks

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

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

Advanced Computational Fluid Dynamics: Finite volume scheme, Eigenvalues and Eigenvectors, Method of Characteristics, Upwind Schemes, Flux Vector Splitting, Flux Difference Splitting, Explicit and Implicit Schemes, Flux Jacobians, Newton Methods, Boundary Conditions, Weak Solutions, TVD, PISO Methods.

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

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

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

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

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

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

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

Enabling Technology Tools for Scientists. Computational methods and tools for simulations and modeling of mechanical and biomedical applications. Numerical geometry, numerical mesh generation, and scientific visualization tools will be introduced and applied.

Parallel Computational Simulations. Parallel algorithms for high fidelity simulations will be covered using domain decomposition strategies. Performance evaluation and metrics will be developed. MPI, OpenMP, PVM, and other parallel message passing languages will be described. Shared and distributed memory machines will be considered.

APPLIED PHYSICS
(Department Elective-III)

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Mid-Sem – 30, Assignments/Quiz- 20
	End Sem Exam – 50 marks

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

Quantum Physics: Dual nature of electron magnetic radiation - de Broglie waves - Compton effect experimental verification -Heisenberg uncertainty principle - Schrodinger equation - application - particle in a box (ID) - Spectroscopy. Application of Quantum Mechanics - Scanning Tunneling Microscope - Atomic Force Microscope problems.

Laser: Laser characteristics, Einstein's coefficients- its significance, population inversion, three levels, four level laser – Schawlow and Townes condition- Nd. YAG, He-Ne-$C0_2$ laser welding, drilling, cutting- optical disk systems, recording data readout from optical disks, Holography, Recording and Reconstruction- Problems.

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

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

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

Reference Books:

1. B.B. Laud, Lasers and Non-Linear Optics, 2ndEdition, New Ages International.
2. Ghatak and K. Thyagarajan (2002), Introduction to Fiber Optics, Cambridge University Press.
3. William Silfvast (2002), Laser Fundamentals, Cambridge University Press.
4. Djafar K. Mynbaeu (2004), Fibre Optic Communication Technology, Pearson Education Asia.
5. Kittel (2001), Solid State Physics, 7iliEdition, John Wiley & Sons.
6. K.C. Gupta (2002), Microwaves, New Age International.
7. Arthur Beiser (2003), Concepts of Modern Physics, 6thEdition, Tata-McGraw Hill.
8. Charles P. Poole, ,Jr. and Frank J. Owens (2003), Introduction to Nanotechnology, John Wiley & Sons.
9. Edward 1. Wolf (2006), Nano Physics and Nanotechnology - An introduction to Modern Concepts in Nanosciehce, Wiley VCH verlagambh & Co., Weinheim'. .

DISSERTATION STAGE – I

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

Semester-IV

DISSERTATION STAGE-II

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