M. Tech. (Mechanical Engineering) Curriculum Structure

Specialization: Automotive Technology

(w. e. f. 2015-16)

List of Abbreviations

OEC- Institute level Open Elective Course

PSMC – Program Specific Mathematics Course

PCC- Program Core Course

DEC- Department Elective Course

LLC- Liberal Learning (Self learning) Course

MLC- Mandatory Learning Course (Non-credit course)

LC- Laboratory Course

Semester I

Sr. No.	Course Type/Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	OEC	Open Elect– I	3	--	--	3
2.	PSMC	Computational Methods in Engineering (COEP)	3		--	3
3.	PCC-I	Automotive Fuels & Emission (ARAI)	3	--	--	3
4.	PCC-II	Automotive Engineering Systems (ARAI)	3	1	--	3
5.	DEC-I	**Elective-I** 1. Automotive Materials & Composites (COEP) 2. Combustion Engineering (COEP) 3. Automotive Tribology (COEP) 4. Automotive Safety and Lighting (ARAI) 5. Hybrid and Electric vehicles (ARAI) 6. Automotive NVH (ARAI) 7. Modeling of Automotive Systems (COEP)	3	-	--	3
6.	LC-I	Communication Skill and Seminar	2	--	2	3
7.	LC-II	Auto Lab-I: NVH (ARAI & COEP)	--	--	4	2

8.	MLC-I	Research Methodology	1	--	--	--
9.	MLC-II	Humanities	1	--	--	--
		Total	**19**	**1**	**6**	**20**

Semester II

Sr. No.	Course Code/Type	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	PCC-III	Vehicle Dynamics (COEP)	3		--	3
2.	PCC-IV	Automotive Electronics (ARAI)	3		--	3
3.	PCC-V	I. C. Engine Modelling (COEP)	3	1	--	3
4.	PCC-VI	Automotive Engine Design (COEP)	3			3
5.	DEC-II	**Elective – II** 1. Auto Testing and certification **2.** Finite Element Method 3. Computational Fluid Dynamics 4. Automotive Aerodynamics **5.** Automotive systems Design **6.** Automotive HVAC	3	--	--	3
6.	LC-III	Mini Project			4	2
7.	LC-IV	Automotive Lab-II	--		4	2
8.	MLC-III	Intellectual Property Rights	1	--	--	--
9.	LLC	Liberal Learning Course	1	--	--	1
		Total	**17**	**1**	**8**	**20**

Semester-III

Sr. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	Dissertation	Dissertation Phase- I	--	--	14	14
		Total	**--**	**--**	**14**	**14**

Semester-IV

Sr. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	Dissertation	Dissertation Phase - II	--	--	18	18
		Total	**--**	**--**	**18**	**18**

SEMESTER I

(PSMC) Computational Methods in Engineering

Teaching Scheme

Lectures: 3 hrs/week

Examination Scheme

T1, T2: 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Students will be able to understand the mathematical models and methodologies to solve those models
2. Students will be able to analyze and develop the mathematical model of an engineering system.
3. Students will be able to solve differential equations using numerical techniques.

Syllabus Contents:

- Roots of Equations: Bracketing methods, open methods and case studies.
- Linear Algebraic Equations: Gauss Elimination, LU decomposition and matrix inversion, special matrices and Gauss-Seidel method, case studies.
- Numerical Differentiation and Integration: Newton-Cotes integration formulas, integration of equations, numerical differentiation, case studies.
- Ordinary Differential Equations: Runge-Kutta methods, stiffness and multistep methods, boundary value and eigen value problems, case studies.
- Partial Differential Equations: Finite difference methods for elliptic and parabolic equations, case studies.

References:

1. J.B. Doshi, “Differential Equations for Scientists and Engineers”, Narosa, 2010.
2. Peter O'Neil, “Advanced Engineering Mathematics”, Seventh Edition, Cengage Learning, 2012 (Indian Edition).
3. Michael Greenberg, “Advanced Engineering Mathematics”, Second Edition, Pearson Education, 2002 (Indian Edition).
4. Jennings. A., Matrix Computation for Engineers and Scientists. John Wiley and Sons, 1992.
5. Prem.K.Kythe, Pratap Puri, Michael R.Schaferkotter, Introduction to Partial Differential Equations and Boundary Value problems with Mathematics, CRC Press, 2002.
6. Kreyszig, Erwin, I.S., Advanced Engineering Mathematics, Wiley, 1999.
7. Ramamurthy. V., Computer Aided Design in Mechanical Engineering., Tata McGraw Hill Publishing Co., 1987
8. Fundamental Concepts in the Design of Experiments, 5th Ed., by Hicks and Turner
9. Devore, Jay L., Probability and Statistics for Engineering and the Sciences, 5th edition, Brooks- Cole (1999)

(PCC I) Automotive Fuels and Emission

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2: 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Able to implement the different fuels and their feasibility as an automotive fuels
2. Able to predict and compare the performance characteristics of engine with different alternate fuels.
3. Able to evaluate and compare of performance of single and multi cylinder diesel and petrol engines vis-à-vis
4. Able to follow the emission tests procedure of an automobile
5. Understand selection of fuel on basis of power output, emission norms, engine size &

applications.

Syllabus Contents:

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

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

Emissions from SI & CI Engines and its Control: Emission formation in S.I. engines – Hydrocarbons – Carbon monoxide – Nitric Oxide, Lead particulates – Polynuclear aromatic hydro carbon emission – Effects of design and operating variables on emission formation in spark ignition engines – Controlling of pollutant formation in engines – Thermal reactors – After-treatment Devices DOC , DPF , NSC , SCR - Charcoal Canister Control for evaporative emission – Positive crank case ventilation system for UBHC emission reduction. EGR Systems Valve types , EGR Circuit types , EGR Cooler types, EGR- Types Internal , Low pressure , High pressure - ECU Functionalities and its architecture - how it controls engine.

Chemical delay – Significance – Intermediate compound formation – Pollutant formation on incomplete combustion – effect of operating variables on pollutant formation – Controlling of emissions – Driving behaviour – Fumigation – Exhaust gas recirculation – Air injection – Cetane number effect.

Emission Measurement and Test procedure: Measurement of CO, CO_2, by NDIR. Hydrocarbon by FID – Chemiluminescent detector for NO_x 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:

Text Book :

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.
6. Ganesan.V, Internal Combustion Engines, Tata McGraw Hill, 1994.
7. Crouse.W.M, Anglin.A.L., Automotive Emission Control, McGraw Hill 1995.

Reference Books :

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.

(PCC II) Automotive Engineering Systems

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2, – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand vehicle chassis structure
2. Understand the components of transmission systems
3. understand automotive suspension systems
4. differentiate between conventional and advanced braking systems\
5. analyze steering systems

Syllabus Contents:

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 tube 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.

References:

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", DhanpatRai& Sons, New Delhi, 2000.
1. Dr. N. K. Giri, "Automobile Mechanics", Seventh reprint, Khanna Publishers, Delhi, 2005
7. Automotive Hand book/ Robert Bosch, SAE, 2003.
8. 2. K.K. Ramalingam, "Automobile Engineering ", Scitech Publications (India) PVT.

(DEC I) Automotive Materials and Composites

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2: 20 marks each, End-Sem Exam - 60

Course Outcomes:

On completion of this module the student should be able to:

1. Evaluate and arrive at material properties for automotive components and select appropriate materials
2. Recommend suitable manufacturing process to produce a component
3. Evaluate and match materials and manufacturing processes.
4. Evaluate the cause for failure of the automotive component.

Syllabus Contents:

Automotive, Automotive Components and Materials: Components categories, Classification of materials, Functionality considerations, Factors influencing selection of such materials

Metallic Materials in Automotive Components: Influence of material properties on functionality and forming, Strengthening mechanisms and their need in automotive environment, Ferrous and nonferrous metals, Analysis of the relative merits and demerits of metallic materials for automotive applications, High strength metallic materials for light weight considerations.

Advanced Manufacturing Process of Automotive Components: Metal casting and forging processes, Powder metallurgy, Sheet-metal Forming etc., Application of non-conventional machining technologies like Ultrasonic machining, Water jet cutting, Electrochemical processing, Laser cutting etc., Joining technologies like resistance spot welding, Plasma technique, Laser welding, Adhesive joining etc. for automotive components.

Non-metallic Materials for Automotive Components: Properties of polymers, Thermo plastic and thermosets usage based on the functionality requirement, Ceramic materials: Need for ceramics, Properties and their applications in automotive components, Advantages and limitations of nonmetallic materials in automotive environments and Remedies to overcome the disadvantages

Processing of Non-metallic Materials for Automotive Components: Processing of polymer materials for automotive components like Injection moulding, Extrusion, Thermo forming, Foam moulding and Tooling, Processing of ceramics like Slip casting, Powder metallurgy

technique etc.

Composites in Automotive Environment: Need for composites, Properties of engineering composites and their limitations, Significance of Polymer, Metal and Ceramic matrix composite systems, Property correlation with reinforcement shape and distribution, Processing and application of different composites for automotive components

Analysis of Component Failures Due to Materials and Processes: Case studies on failure analysis of some components, Analysis of failure and identification of causes for failure and suitable remedies for the same from material and process perspective

Selection of Materials and Manufacturing techniques: Correlation of functionality of the component with material properties, Derivation of performance index based on the functionality of the component, Selection of materials and processes based on the functionality, Manufacturing feasibility, Adoption of suitable joining technique

References:

1. M. F. Ashby and H. Shercliff, D. Cubon, (2007) *Materials Engineering Science, Processing and Design,* Butterworth Publications
2. C. Brian, G. Patrick and J. Colin. (2007) *Automotive Engineering: Light Weight, Functional and Novel Materials*, Taylor & Francis
3. M. P. Groover. (2005)*Fundamentals of Modern Manufacturing: Materials, Processes, and Systems*, 2nd edition, John Wiley & Sons
4. W. D. Callister. (2005) *Materials Science and Engineering an Introduction*, 6th edition, John Wiley & Sons
5. H. Yamagata. (2005) *The Science and Technology of Materials in Automotive Engines*, Yamaha Motor Co. Ltd., Japan Woodhead Publishing Limited
6. G. Davies. (2003)*Materials for Automobile Bodies*, Butterworth-Heinemann Publications
7. S. Kalpakjian and S. R. Schmid. (2003) *Manufacturing Engineering and Technology*, Pearson Education
8. K. G. Budinski and M. K. Budinski. (2002) *Engineering Materials Properties and Selection*, 7th edition, Prentice-Hall of India

(DEC I) Combustion Engineering

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2: 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand basic principles and concepts of fuel combustion.
2. Build knowledge of theories of fuel combustion.
3. Analyze the thermal cycles .
4. Mathematically model the combustion of fuel.

Syllabus Contents:

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:

Text Book :

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, “Modelling 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.

(DEC I) Automotive Tribology

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2, – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Able to visualize and interpret nature of friction and wear in various vehicle components like Engine, Transmission system, Tyres.
2. Able to predict complete lubrication requirement of an automobile
3. Able to develop the lubrication system for automobile system
4. Able to evaluate the performance of automotive lubrication systems
5. Able to study the effect of tyre construction on friction between tyre and road and tyre wear.

Syllabus Contents:

Introduction to Tribology: Friction, wear and lubrication principles of tribology, thick film

lubrication, boundary layer lubrication.

Friction and wear: Laws of friction, causes of friction, types of wear and mechanisms of wear, wear properties of friction and anti-friction metallic and non-metallic materials.

Lubricants: Solid lubricants, liquid lubricants, properties of lubricants. selection for general applications and special applications such as low temperature, high temperature, extreme pressure, corrosion resistance etc.

Hydrodynamic lubrication: basic concepts, Reynolds equation, plane bearings. design of journal bearings- short and finite bearings, design of bearings with steady load, varying load and varying speed.

Lubrication of automobile systems: Engine lubricating systems, lubrication of piston, piston rings and cylinder liners, lubrication of cam and followers, lubrication of involutes gears, hypoid gears and worm gears, friction aspects of clutch, brakes and belt drive.

Pneumatic tyres: creep and slip of an automobile tyre, functions of tyre, design features of the tyre surface, mechanism of rolling and sliding, tyre performance on wet road surface.

References:

1. Principles and applications of tribology – Desmond F. Moore
2. Tribology in machine Design – T.A. Stolarski
3. Introduction to Tribology of Bearings – B.C. Majumdar
4. Vehicle Dynamics – Dr Georg Rill

(DEC I) Automotive Safety and Lightening

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2: 20 marks each, End-Sem Exam - 60

Course Outcomes:

Upon completion of this course the student will be able to:

1. Identify different safety systems and its role in automobiles

2. Determine vehicle structural crashworthiness
3. Analyze and simulate vehicle in barrier impacts
4. Determine injury thresholds and apply trauma for analysis of crash injuries
5. Analyze pedestrian safety by use of pedestrian simulator
6. Design vehicle safety systems

Syllabus Contents:

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, modelling 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, Behaviour of specific body structures in crash testing, Photographic analysis of impact tests, Regulatory requirements for crash testing, side and Frontal Pole Impact, Pedestrian Impact.

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

Vehicle safety system: 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, Hinges and latches etc., active safety.

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. JullianHappian-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.
8. Matthew Huang, “Vehicle Crash Mechanics”.
9. David C. Viano, “Role of the Seat in Rear Crash Safety”.
10. Jeffrey A. Pike, “Neck Injury”.

11. Ching-Yao Chan, “Fundamentals of Crash Sensing in Automotive Air Bag Systems”.
12. Rollover Prevention, Crash Avoidance, Crashworthiness, Ergonomics and Human Factors”, SAE Special Publication, November 2003.

(DEC I) Hybrid and Electrical Vehicles

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2, – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:1. Understand the basic components of the hybrid systems
2. Understand the variations (different types) of hybrid configurations
3. Develop understanding of batteries, and motors
4. Design and develop the hybrid and electric vehicles
5. Understand the speed control mechanisms for electric motors and generators

Syllabus Contents:

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of

Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle

References:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

(DEC I) Automotive Noise, Vibrations and Harshness

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2, – 20 marks each, End-Sem Exam - 60

Course Outcomes:

Upon completion of this course the student will be able to:

1. Identify sources of noise and vibration
2. Measure sound intensity and human sensitivity
3. Carryout statistical energy analysis and simulators

4. Determine active control techniques
5. Carryout statistical and frequency analysis

Syllabus Contents:

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.

References:

1. Norton M P, Fundamental of Noise and Vibration, Cambridge University Press,1989
2. Munjal M.L., Acoustic Ducts and Mufflers, John Wiley, 1987
3. Baxa, Noise Control of Internal Combustion Engine, John Wiley, 1984.
4. Ewins D. J., Model Testing: Theory and Practice, John Wiley,1995.
5. Boris and Kornev, Dynamic Vibration Absorbers, John Wiley, 1993.
6. McConnell K, “Vibration Testing Theory and Practice”, John Wiley, 1995.

(DEC I) Modeling of Automotive Systems

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2, – 20 marks each, End-Sem Exam - 60

Course Outcomes:

Upon completion of this course the student will be able to:

1. Model every automotive system for its performance
2. Model the control systems of an automotive
3. Carry out mathematical investigations of the system models

Syllabus Contents:

System model representation: Configuration form, State-space representation, input-output equation, Transfer function, State-space representation from the input-output equation. Linearization, Determination of operating point, Numerical solution of Nonlinear model.

Mechanical system modeling: Translational systems, Rotational systems, Mixed rotational and translational systems and Gear train systems. Modeling of Electromechanical systems, Thermal systems, Pneumatic systems and Hydraulic systems. Transient response of First-order systems and Second-order systems. Open loop and close loop control systems, Block diagrams. Signal flow graph, Mason's gain formula. Feedback characteristic of control systems.

Controller components: Sensors, Differencing and amplification, Actuators. Electrical components, Hydraulic components and Pneumatics components. Time resonance of Second-order systems, Time response specifications. Steady state error for Unit step input, Unit ramp input and Unit parabolic input. Types of feedback control systems. Type-0 system, Type-1 system and Type-2 system.

Design specifications of second order system, Derivative error compensation, Derivative output compensation, Integral error compensation, Proportional plus Integral plus Derivative compensation.

System stability: Algebraic criterion, Hurwitz stability criterion, Routh stability criterion. Automobile vehicle Driveline model. ABS Control systems. Complete vehicle model.

References:

1. Dynamic Systems – Hung V. Vu , Ramin S. Esfandiari
2. Control Theory – I. J. Nagrath
3. Automotive Control Systems –U. Kiencke, L. Nielsen
4. Vehicle Dynamics – Ellis

(LC I) Communication Skills and Seminar

Teaching Scheme	**Examination Scheme**
Lectures: 2 hrs/week, Practical: 2hr/week	T1, T2, – 20 marks each, End-Sem Exam - 60

Course Outcomes:

1. Understanding the essence of Soft Skills
2. Understand "What is meant by Passion?"
3. The Concept of Personal Brand.
4. Understand self, self-confidence, self-esteem, and self-assessment.
5. Identify professional & personal goals and plan for its achievements.
6. Build on your strengths and estimate ones weaknesses through SWOT analysis.
7. Learn the fundamentals of leadership & skills needed to become a real and effective leader, Motivate and energize one's team. Achieve confidence. Improve productivity.
8. Demonstrate independent learning ability
9. Become self-disciplined, self- responsibility in the pursuit of studies and professional motivated, demonstrating personal successful.

Syllabus Contents:

Introduction: Introduction to soft Skills, Personality Development and Human Values, Self Awareness & Esteem, Perception and Attitudes, Self Assessment& WSOT 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 and Industry Works, Various Departments of Industry, Industry Review, Team building & Motivation, Auto Passion, Confidence Building, Product Development Cycle, Customer Satisfaction & Quality Function Deployment (QFD), Benchmarking, Design for Failure Mode Effects Analysis (DFMEA), Design Review, Vehicle Review.

Business/Work Success: Time Management, Inter personal 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

References:

Text Books

1. Narian Ram, Twelve Management Sill 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.

Reference Books

1. ARAI & SAEINDIA W.S. Proceedings, 3 day Certificate Course on Quality Function Deployment
2. ARAI & SAEINDIA W.S. Proceedings, 3 day Certificate Course on Design Failure Mode & Effect Analysis.

Note: 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.

The candidate shall be assessed for the communication and other soft skills for which two hour teaching per week will be conducted at ARAI, Pune and there shall be two hours of contact period in a week between candidate and his guide.

(LC II) Automotive Laboratory I

Teaching Scheme	**Examination Scheme**
Practical: 2 hrs/week	Term work submission: 100 marks

Course Outcome:

1. Able to demonstrate the significance of experimentation and explore the possibility of carrying out engineering investigations
2. Able to acquire hands on experience on the various test-rigs, Experimental set up.
3. Able to measure the various technical parameters by instrument and by mathematical relationship.
4. Able to identify the effect of various parameters on the system and able to co- relate them.
5. Understand selection of fuel on basis of power output, emission norms, engine size and applications.

Syllabus Contents:

Any six practical from the given list will be conducted as a part of Automotive Lab I

AUTOMOTIVE FUELS AND EMISSION

1. Performance & emission test on Heavy duty diesel engine (Transient Dynamometer)
2. Performance test on Gasoline engine
3. Performance & emission test on Tractor / Genset diesel engine (Eddy Dynamometer)
4. Swirl & Flow tests of ports on steady state flow-bench
5. Performance & combustion characterization test on Diesel engine

6. Study of emission test for SI engine 2/3/4 wheels on chassis dynamometer
7. Analysis of carbonyl compound from exhaust emission using HPLC.
8. Chemical characterization of Gasoline Fuel.
9. Chemical characterization of Diesel Fuel.

NOISE, VIBRATION AND HARSHNESS

1. Demonstration and calibration of various noise and vibration measuring instruments.
2. Acoustic Material Characterization
3. Modal Analysis
4. Sound absorption coefficient-normal incidence
5. Sound transmission loss measurement
6. Sound power level measurement of noise source
7. Vehicle pass by noise measurement

AUTOMOTIVE SAFETY AND LIGHTING LABORATORY

1. Study of "H" point measurement on 3-D manikin.
2. Study on air bags
3. Anthropometric measurement using 3d scanner
4. Study of dummy calibration
5. Rear view mirror testing
6. Study of signaling devices and performance evaluation
7. Study of legal requirements, testing and evaluation of lighting devices.
8. G lock testing of seat belt
9. Impact testing of bumpers
10. Study of seat belt anchorage

(MLC I) Research Methodology

Teaching Scheme	**Examination Scheme**
Lectures: 1 hrs/week	T1, T2, – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. develop understanding of the basic framework of research process
2. develop an understanding of various research designs and techniques
3. identify various sources of information for literature review and data collection
4. develop an understanding of the ethical dimensions of conducting applied research
5. appreciate the components of scholarly writing and evaluate its quality.

Syllabus Contents:

Unit 1: Research Problem

Meaning of research problem, Sources of research problem, Criteria / Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

Unit 2: Basic instrumentation

Instrumentation schemes, Static and dynamic characteristics of instruments used in experimental set up, Performance under flow or motion conditions, Data collection using a digital computer system, Linear scaling for receiver and fidelity of instrument, Role of DSP is collected data contains noise.

Unit 3: Applied statistics

Regression analysis, Parameter estimation, Multivariate statistics, Principal component analysis, Moments and response curve methods, State vector machines and uncertainty analysis.

Unit 4: Modelling and prediction of performance

Setting up a computing model to predict performance of experimental system, Multiscale modelling and verifying performance of process system, Nonlinear analysis of system and asymptotic analysis, Verifying if assumptions hold true for a given apparatus setup, Plotting family of performance curves to study trends and tendencies, Sensitivity theory and applications.

Unit 5: Developing a Research Proposal

Format of research proposal, Individual research proposal, Institutional proposal

Proposal of a student – a presentation and assessment by a review committee consisting of Guide and external expert only. Other faculty members may attend and give

Suggestions relevant to topic of research.

References:

1. Stuart Melville and Wayne Goddard, Research methodology: an introduction for science & engineering students
2. Wayne Goddard and Stuart Melville, Research Methodology: An Introduction
3. Ranjit Kumar, Research Methodology: A Step by Step Guide for Beginners', 2nd Edition
4. Dr. C. R. Kothari, Research Methodology: Methods and Trends.
5. Dr. S.D. Sharma, Kedar Nath Ram Nath & co., Operational Research

(MLCII) Humanities

Teaching Scheme	Examination Scheme
Lectures: 1 hrs/week	T1, T2, – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Knowledge and Thinking Skills- the student will be able to offer insight into the relationships between humanities and culture and will be able to recall important information so that comparisons and analyses can be made.
2. Communication Skills- vocabulary will be enhanced and ideas organized so the student can present an argument clearly, in written form.
3. Critical Thinking- the student will be able to make personal interpretations of events and motives as well as gaining the ability to analyze their own ideas critically.

Syllabus Contents:

These are the lists from which students can choose the topic. Please note that within the COE restrictions, you are free to choose randomly. For instance, all of your course can be from one list, or it can be from multiple lists.

- Arts and Literature
- Historical Studies
- International Studies
- Philosophy and Values

- Social and Behavioral Sciences
- Approved Foreign Languages

References:

Richard Paul Janaro and Thelma C. Altshuler, The Art of Being Human: Humanities as a Technique for Living, Pearson, ISBN: 10: 0-205-02247-2

SEMESTER II

(PCC-III) Vehicle Dynamics

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2: 20 marks each, End-Sem Exam - 60

Course outcome :

At the end of the course, students will demonstrate the ability to:

1. Able to interpret the importance of rubber tyres in vehicles, tyre construction and working
2. Able to understand the dynamics of the automotive systems and its performance.
3. Able to analyze dynamics systems such as suspension systems, body vibrations, steering.
4. Able to interpret the vehicle stability.
5. Able to identify comfort and Road holding.

Syllabus Contents:

Tyres: Necessity of rubber tyres in road vehicles. Functions of tyres. Tyre adhesion. Tyre construction. Cross-ply and radial-ply tyres. Tubed and tubeless tyres. Tyre elasticity. Cornering power. Self aligning torque.

Steering and Wheel Alignment: Steering geometry. Ackermannmechanism and Davis mechanism. Steering gears. Power steering. Camber, castor, kingpin inclination and toe-in, toe-out. Scrub radius. Moments on steering wheels.

Suspension system: Functions of suspension system. Rigid axle and independent suspension system. Hotchkiss drive, torque-tube drive and radius rods. Types of suspension springs and their characteristics. Design of leaf spring and coil spring. Anti-roll bar. Wheel balancing. Oscillations of steerable wheels. Shock absorber.

Body vibrations: Bouncing and pitching. Doubly conjugate points. Body rolling. Roll center and roll axis. Stability against body rolling.

Handling Characteristics: Over steer and under steer. Vehicle stability while braking. Dynamic axle loads. Anti-squat, anti-pitch and anti-dive suspension geometry.

2-D Stability of Automobile Vehicles: Steady state response to steering input, side force input and yawing moment input. Transient responses.

References:

1. J. R. Ellis. 'Vehicle Dynamics'
2. P.M. Heldt. 'Automotive Chassis'
3. W. Steeds. 'Mechanics of Road Vehicles'
4. J. G. Giles: 'Steering, Suspension, Tyres'.
5. Heinz Heisler. 'Vehicle and engine technology'
6. T. D. Gillespie. 'Fundamentals of Vehicle Dynamics'

(PCC-IV) Automotive Electronics

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2: 20 marks each, End-Sem Exam - 60

Course Outcome:

Upon completion of this course the student will be able to:

1. Understand the basic components of electronic controls and control theory
2. Understand the basics of sensors, actuators and its interaction with automotive parameters
3. Understand the fundamental elements of instrumentation, measurement and control systems.
4. Handle various instruments for engineering applications
5. Design and set a data acquisition system for automotive application

Syllabus Contents:

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 & CI 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. Advantages of electronic ignition systems.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.

Applications for other domains: Applications in suspensions, AFS, Brakes, ABS, EPAS, ECTC, ESP

References:

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.

(PCC-V) I C Engine Modelling

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2: 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Learn about advanced concepts beign pursued for modeling of IC Engine.
2. Determine engine performance characteristics for IC Engine by Applying thermo chemical principles of energy and chemical balances through appropriate modeling.
3. Identify engineering problems, formulate model and solve the problems using knowledge of mathematics science and engineering.
4. Create and analyse zero dimensional thermodynamic model of IC Engine combustion
5. Use and analyse of one dimensional commercial software.

Syllabus Contents:

Fundamentals: Governing equations, Equilibrium charts of combustion chemistry, Chemical reaction rates, Approaches of Modelling, 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. Injection Energy model for mixing and combustion in diesel engines.

Modelling 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. Impingement of vapor air mixture on the walls

Mathematical Models of SI Engines: Simulation of Otto cycle at full throttle, part throttle and supercharged conditions, progressive combustion, Auto ignition Modelling, 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.

Modelling of Pollutant Formation: Nitrogen oxides-thermal, prompt and fuel NO, Soot development-semi-global mechanisms, detailed chemistry mechanism. Modelling of CO and HC, Mathematical modelling of catalytic converters - One dimensional model, 2D axisymmetric model of monolithic reactor- computation of chemical reactions. Commercially available software packages, modelling Selective catalyst reduction technique for NOx, wall flow diesel filters

References:

1. Internal Combustion Engine Fundamentals, John B Heywood, McGraw-Hill, 1988.
2. Internal Combustion Engine Modeling, J.I. Ramos, Hemisphere Publishing Corporation, 1989.
3. Turbocharging the Internal Combustion Engine, N. Watson and M.S. Janota, John Wiley & Sons, New York, 1982. (is it in print?)
4. Simulating Combustion: Simulation of combustion and pollutant formation for engine, Günter P. Merker, Christian Schwarz, Gunnar Stiesch, Frank Otto, Springer, 2008.
5. Modeling Engine Spray and Combustion Processes, G. Stiesch, Springer Verlag, 2003.
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. .(is it in print?)
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. .(is it in print?)
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. "Thermodynamics & Gas Dynamics in I.C.Engines, Vol I & II by Benson & Horlock" and "A Treatise on the Phenomenology of Combustion". Requesting Dr PAL to send the details of the later.
17. Modelling Diesel Combustion, Lakshminarayanan, P. A., Aghav, Yoghesh V., Mechanical Engineering Series, Springer, 2010.

(PCC-VI) Automotive Engine Design

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2: 20 marks each, End-Sem Exam - 60

Course outcome:
At the end of the course, students will demonstrate the ability to:
1. Able to find the required engine power for given vehicle.
2. Able to select type of engine and it's layout for given vehicle.

3. Able to find basic dimensions of main engine parts like piston, connecting rod, crank shaft and valve gear.
4. Able to design inlet and exhaust system for optimum engine performance.
5. Able to gain basic knowledge of designing engine foundation and cooling system.

Syllabus Contents:

Determination of engine power, selection of engine type, engine swept volume, engine balancing: longitudinal and lateral forces, rolling, pitching and yawing moment, balancing of in-line and V-engines, Number of cylinders, stroke, bore

Combustion chamber design for SI and CI engines

Piston design: piston crown, piston skirt, skirt ovality, piston clearance, cylinder liners, piston pin, piston pin offset, piston rings, number of rings, position of rings

Connecting rod design: materials, CR length, shank design, small end design, end cap design, failure of CR, CR cap bolts

Crank shaft design: Firing order, crank shaft layout, journal design, web design, and crank pin design.

Cylinder block design: wall thickness, liner, water jacket

Crank case design, cylinder head design, inlet and outlet manifold

Design of cooling system: radiator

Engine foundations

Silencer design foundation

References:

1. P.M. Heldt, High Speed Engine Design
2. Gile, Engine Design
3. Biezenov and Grammel, Engine Balancing
4. Obert, IC Engines
5. Kovakh, Motor Vehicle Engine
6. Howerth, CI Engine design
7. Crouse, Engine Design

(DEC-II) Automotive Testing and Certification

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2: 20 marks each, End-Sem Exam - 60

Course Outcomes:

On completion of this course, the students will be able to

1. Classify the vehicle and identify the regulations governing for each vehicle type
2. Perform and analyze the Static & Dynamic test of any vehicle
3. Perform various test related to vehicle engine emissions
4. Test and analyze the performance of vehicle components
5. Perform the tests to be done on the vehicle lighting system

Syllabus Contents:

Introduction: Specification & Classification of Vehicles (including M, N and O layout), Homologation & its Types, Regulations overview (EEC, ECE, FMVSS, AIS, CMVR), Type approval Scheme, Homologation for export, Conformity of Production, various Parameters, Instruments and Types of test tracks.

Static Testing of Vehicle: Photographs, CMVR physical verification, Tyre Tread Depth Test, Vehicle Weightment, Horn installation, Rear view mirror installation, Tell Tales, External Projection, Wheel Guard, Arrangement Of Foot Controls For M1 Vehicle, Angle & Dimensions Measurement of Vehicle, The Requirement Of Temporary Cabin For Drive – Away – Chassis

Dynamics Testing of Vehicle: Hood Latch, Gradeability, Pass-by Noise, Interior Noise, Turning Circle Diameter & Turning Clearance Circle Diameter, Steering Effort, Constant Speed Fuel Consumption, Cooling Performance, Speedo-meter Calibration, Range Test, Maximum Speed, Acceleration Test, Coast-down test, Brakes Performance ABS Test, Broad band / Narrow band EMI Test. Engine power test (petrol & diesel), Indian driving cycle, Vehicle mass emission, Evaporative emission (petrol vehicles)

Vehicle Component Testing: Horn Testing, Safety Glasses Test: Windscreen laminated and toughened safety glass, Rear View Mirror Test, Hydraulic Brakes Hoses Fuel Tank Test: Metallic & Plastic, Hinges and Latches Test, Tyre& Wheel Rim Test, Bumper Impact Test,

Side Door Intrusion, Crash test with dummies, Demist test, Defrost Test, Interior Fittings, Steering Impact test (GVW<1500 kg), Body block test, Head form test, Driver Field Of Vision, Safety belt assemblies, Safety belt anchorages, Seat anchorages & head restraints test, Airbag Test, Accelerator Control System.

Vehicle Lighting Testing: Installation requirement for lighting, signalling & reflective devices Installation, Conspicuity & Reflective Marking, Photometry Test: Performance requirement for lighting, signalling and reflective devices - Head lamp, Front lamp, direction indicator lamp, signalling lamp and Warning triangles.

References:

1. Robert Bosch GmbH, Bosch Automotive Handbook
2. Motor Vehicle Manual
3. Safety Regulations- Society of Indian Automobile Manufacturers.
4. Mrs. Rashmi Urdhwareshe, Automotive Industry: Regulations Scenario in India Senior Deputy Director, ARAI, ISA Vision Summit 2013

DEC-II) Finite Element Methods

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2: 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand the discretization procedure of the governing equations
2. Prepare the problem definition of a given engineering problem
3. Decide the governing equations, boundary conditions, intial conditions etc for the given problem
4. To carry out the simulations and obtain the results in terms of dependent variables
5. Analyze the FEM results through post processing to obtain engineering parameters

Syllabus Contents:

Steps in finite element method, discretization, 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:

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.

(DEC-II) Computational Fluid Dynamics

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2: 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand the discretization procedure of the governing equations
2. Prepare the problem definition of a given fluid flow heat transfer problem
3. Decide the governing equations, boundary conditions, initial conditions etc for the given problem
4. To carry out the simulations and obtain the results in terms of dependent variables
5. Analyze the CFD results through post processing to obtain engineering parameters

Syllabus Contents:

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 Modelling 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

References:

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.

(DEC-II) Automotive Aerodynamics

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2: 20 marks each, End-Sem Exam - 60

Course outcome:

1. Able to predict the drag and lift coefficients in the given case of fluid flow situation
2. Able to devise an experiment for carrying out aerodynamic analysis of the vehicle
3. Able to carry out numerical simulations by devising a fluid flow problems
4. Able to Predict variation in Aerodynamic forces and moments acting on vehicle body with changes in body shape
5.Able to understand effect of body shape on vehicle soiling

Syllabus Contents:

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 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.

References:

Textbook:

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

Reference Books:

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.

(DEC-II) Automotive System Design

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2: 20 marks each, End-Sem Exam – 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand the basic failure theories for all the systems
2. Design the automotive systems and check its failures.

Syllabus Contents:

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 modelling 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.

References:

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.

(DEC-II) Automotive Heating, Ventilation and Air Conditioning

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2: 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Able to Understand the requirements of HVAC in automobile applications
2. Able to Understand the refrigerant and air managements
3. Able to Develop the control system
4. Able to Diagnosis the problems with HVAC systems

Syllabus Contents:

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: Modelling 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.

References:

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.

(LC-III) Mini Project

Teaching Scheme	**Examination Scheme**
Contact hours: 4 hrs/week	Presentation/demonstration–100 ESE

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Carry out the given engineering problem independently.
2. Present the engineering analysis effectively.
3. Learn to write technical reports.

Syllabus Contents:

Mini project includes a small dissertation work which shall cover topics such as design, fabrication, analysis, simulations, field study, market survey and case study etc.

(LC-IV) Automotive Lab II

Teaching Scheme	**Examination Scheme**

Practical: 3 hrs/week T1, T2: 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Able to demonstrate the significance of experimentation and explore the possibility of carrying out engineering investigations
2. Able to acquire hands on experience on the various test-rigs, Experimental setup.
3. Able to measure the various technical parameters by instrument and by mathematical relationship.
4. Able to identify the effect of various parameters on the system and able to co- relate them
5. To demonstrate the algorithm, its coding and its use for automotive application

Syllabus Contents:

The term work shall consist of minimum eight exercises approved by the PCC teachers. Minimum two exercises from each course based on preferably experimental measurements.

List of Experiments:

Automotive Electronics :

1. Full wave rectifier
2. IC555 Timer Circuit
3. Introduction to Arduino Uno
4. Variation of LED intensity and blinking using Arduino and Potentiometer
5. Distance measurement using ultrasonic sensor and Arduino
6. Automatic lights using LDR and Arduino
7. Study of CAN bus and ECU system
8. 2 wheeler fuel injection system and ECU modes

(MLC-III) Intellectual Property Rights

Teaching Scheme **Examination Scheme**

Lectures: 1 hrs/week T1, T2: 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. understand the entire process of obtaining IPR and its significance

Syllabus Contents:

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

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

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

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

Registered and unregistered trademarks, design, concept, idea patenting

References:

- 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

Liberal Learning Course

Teaching Scheme	Examination Scheme
Lectures: 1 hrs/week	T1, T2: 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Take up a area of his choice and develop the learning at his/her own

Syllabus Contents:

The candidate has to select the course from the list declared at institute level. He/she has to develop the learning himself/herself under the supervisor allotted by the department. The examination as decided by the supervisor shall be conducted.

References:

The candidate may use the resources as per their convenience

Semester III

(Dissertation) Dissertation I

Teaching Scheme	Examination Scheme
Practical: 3 hrs/week	End-Sem Exam - 100

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Able to critically read, interpret & evaluate current literature in the discipline.
2. Able to integrate and synthesize ideas within the field.
3. Able to demonstrate comprehensive knowledge of the literature in the field
4. Able to critically evaluate empirical evidence.
5. Able to demonstrate a comprehensive understanding of techniques critical to the field
6. Able to communicate clearly and effectively to specialist and non-specialist audiences

Syllabus Contents:

The dissertation work will start in semester III and should preferably be a live problem in industry or an 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 thesis format. The oral presentation as an examination shall be conducted with the help of approved external examiner

(Dissertation) Dissertation II

Teaching Scheme	Examination Scheme
Practical: 3 hrs/week	End-Sem Exam - 100

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. To critically apply the research techniques such as experimental, computational or analytical to resolve the engineering problem in automotive engineering.
2. To carry out the validation of technique of his choice using existing literature.
3. To analyze his own results to derive an engineering parameters as a function of governing parameters
4. To present his engineering results in a generalized fashion.

Syllabus Contents:

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 thesis format. The oral examination shall be conducted with the help of approved external examiner