UNIVERSITY OF PUNE

Structure and Syllabus

FOR

M.E. Mechanical Engineering (Automotive Engineering) 2013-Course

UNDER FACULTY OF ENGINEERING

EFFECTIVE FROM July 2013

M.E. Mechanical Engineering (Automotive Engineering) – (2013 Course)

SEMESTER I

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Lect. / Pr	Paper		TW	Oral/ Presentation	Total	
			In Sem. Assessment	End Sem. Assessment				
507201	**Advanced Mathematics**	4	50	50	-	-	100	4
502302	**Automotive Engine Design**	4	50	50	-	-	100	4
502303	**Automotive Safety and Regulations**	4	50	50	-	-	100	4
502304	**Research Methodology**	4	50	50	-	-	100	4
502305	**Elective – I**	5	50	50	-	-	100	5
502306	**Lab Practice – I**	4			50	50	100	4
Total		**25**	**250**	**250**	**50**	**50**	**600**	**25**

SEMESTER II

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Lect./ Pr	Paper		TW	Oral/ Presentation	Total	
			In Sem. Assessment	End Sem. Assessment				
502307	**Engine Combustion Technology**	4	50	50	-	-	100	4
502308	**Noise Vibration and Harshness**	4	50	50	-	-	100	4
502309	**Automotive Chassis Design**	4	50	50	-	-	100	4
502310	**Elective – II**	5	50	50	-	-	100	5
502311	**Lab Practice – II**	4	-	-	50	50	100	4
502312	**Seminar – I**	4	-	-	50	50	100	4
Total		**25**	**200**	**200**	**100**	**100**	**600**	**25**

Elective I: Common to All M.E. Mechanical Programmes**

SEMESTER III

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Lect. / Pr	Paper		TW	Oral/ Presentation	Total	
			In Sem. Assessment	End Sem. Assessment				
602313	**Vehicle Dynamics**	4	50	50	-	-	100	4
602314	**Autotronics**	4	50	50	-	-	100	4
602315	**Elective – III**	5	50	50	-	-	100	5
602316	**Seminar II**	4	-	-	50	50	100	4
602317	**Project Stage I**	8	-	-	50	50	100	8
Total		**25**	**150**	**150**	**100**	**100**	**500**	**25**

SEMESTER IV

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME				CREDITS
		Lect. / Pr	Paper	TW	Oral/ Presentation	Total	
602306	Seminar III	5	-	50	50	100	5
602307	Project Work Stage II	20	-	150	50	200	20
Total		**25**	**-**	**200**	**100**	**300**	**25**

Lab Practice I & II:

The laboratory work will be based on completion of assignments confined to the courses of that semester.

SEMINAR:

The student shall deliver the seminar on a topic approved by authorities.

Seminar I: shall be on state of the art topic of student's own choice approved by authority. The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned Guide and head of the department/institute.

Seminar II: shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization based on the electives selected by him/her approved by authority. The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned Guide and head of the department/institute.

Seminar III: shall be extension of **seminar II.** The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned Guide and head of the department/institute.

PROJECT WORK:

The project work shall be based on the knowledge acquired by the student during the coursework and preferably it should meet and contribute towards the needs of the society. The project aims to provide an opportunity of designing and building complete system or subsystems based on area where the student likes to acquire specialized skills.

Project Work Stage – I

Project work Stage – I is the integral part of the project Work. In this, the student shall complete the partial work of the Project that will consist of problem statement, literature review, project overview, scheme of implementation (UML/ERD/block diagram/ PERT chart, etc.) and Layout & Design of the Set-up. The candidate shall deliver a presentation as a part of the progress report of Project work Stage-I, on the advancement in Technology pertaining to the selected dissertation topic.

The student shall submit the progress report of Project work Stage-I in standard format duly certified for satisfactory completion of the work by the concerned guide and head of the department/Institute.

Project Work Stage - II

In Project Work Stage – II, the student shall complete the balance part of the Project that will consist of fabrication of set up required for the project, conducting experiments and taking results, analysis & validation of results and conclusions.

The student shall prepare the final report of Project work in standard format duly certified for satisfactory completion of the work by the concerned guide and head of the department/Institute.

Note: Institute must submit the list of candidates, guide and project details (title, area, problem definition, and abstract - clearly indicating objectives and scope, sponsorship details, if any) to the university within month of commencement of third semester. The guide must be approved/qualified teacher of the institute. A guide can guide at the most 8 students per year.

Semester – I

Advanced Mathematics [507201]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
507201	4	50	50	-	-	100	4

1. **Inner Product Spaces, Orthogonality:**
   Inner products, Cauchy-Schwartz inequality, Orthogonal projections, Gram-Schmidt orthogonalization, Matrix representation of inner product, Least square solutions.

2. **Complex Analysis:**
   Complex variables, Complex differentiation, Harmonic functions, Conformal mapping, Complex integration, Cauchy's integral formulae and Calculus of residues.

3. **Transforms:**
   Concept of transforms, Fourier transforms, Applications to partial differential equations, Discrete Fourier transform, Laplace transforms and its inverse, Laplace transform of special functions: Unit step, Unit impulse, Periodic and Error. Applications to initial value problem and wave equation using transform techniques.

4. **Differential Equation:**
   Series Solution of differential equations, Bessel's and Legendre's differential equations, Mass spring systems of multi degree freedom, Matrix formulation for differential equations in vibration theory, Normal mode solution, Numerical computation of Eigen value.

5. **Numerical Analysis:**
   Finite difference analysis, Explicit and Implicit finite difference scheme, Stability of finite difference method, Applications of finite difference analysis in boundary value problems, one dimensional diffusion equation, Wave equation, Laplace equation.

6. **Calculus of Variation:**
   Introduction, Functional, Euler's equation, Isoperimetric Problem, Functional involving higher order derivative, Approximate solution of boundary value problem, Rayleigh –Ritz method, Galerkin's method, Lagranges principal.

Reference books:

1. Advanced Engineering Mathematics, 9e, by Erwin Kreyszig (Wiley India).
2. Higher Engineering Mathematics by Dr. B. S. Grewal (Khanna Publishers Delhi).
3. Linear Algebra by Jin Ho Kwak and Sungpyo Hong (Springer international edition).
4. Mechanical Vibration by Singiresu S. Rao (Pearson Education, Inc).
5. Applied Numerical Analysis by Curtis F.Gerald and Patrick O. Wheatley (Pearson Education, Inc).
6. Essential Mathematical Methods for Physicists by Hans J. Weber and G. B. Arfken (Academic Press).

Semester - I

Automotive Engine Design [502302]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502302	4	50	50	-	-	100	4

1. **Engineering Fundamentals of IC Engine:**
   Introduction, history – timeline of development, SI and CI engine cycles, engine parameters, operating characteristics, engine efficiencies, emissions.

2. **Fuel System:**
   Thermochemistry of fuels, octane number, cetane number, alternate fuels, knocking, air and fuel induction, types of combustion chamber, fluid motion in combustion chamber, mathematical models.

3. **Emissions and Air Pollution:**
   Air pollution, hydrocarbon, carbon monoxide, oxides of nitrogen, particulate, after treatment, catalytic converters, EGR.

4. **Engine Component Loading:**
   Mechanical and thermal loading of components, heat transfer and thermal loads, kinematics and dynamics of crank mechanism, piston stroke, speed, acceleration, gas pressure forces, inertial forces, total forces, balancing of crankshaft assembly masses, torsional vibrations.

5. **Design of Principal Parts:**
   Prerequisites, design conditions, material selection, service life, engine friction, design of piston assembly, design of connecting rod assembly, design of crankshaft, design of engine structure, design of valve gear.

6. **Engine Systems:**
   Turbocharger design – compressor and turbine, design of fuel system, design of lubricating system, design of cooling system.

Reference Books:

1. Handbook of Diesel Engines, Mollenhauer Klaus, Tschöke Helmut (Eds.), Springer
2. Engineering Fundamentals of the Internal Combustion Engine, Willard W. Pulkrabek, Prentice Hall
3. Diesel Engine Reference Book, Bernard Challen & Rodica Baranescu, Butterworth-Heinemann
4. Diesel Engine Design, H.F.P. Purday, D. Van Nostrand Company, Cornell University Library
5. Internal Combustion Engine Fundamentals, John B. Heywood, McGraw Hill, Inc.

Semester – I
Automotive Safety and Regulations [502303]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502303	4	50	50	-	-	100	4

1. **Safety and Crash Testing:**
   Introduction - Active and passive safety, characteristics of vehicle structures, Optimization of vehicle structures for crash worthiness - Types of crash / roll over Tests, Regulatory requirements for crash testing, Instrumentation, high speed photography, Image Analysis.

2. **Pedestrian Safety and Ergonomics:**
   Importance of Ergonomics in Automotive safety- Locations of controls- Anthropometry- Human impact tolerance- Determination of Injury thresholds, Severity Index, Study of comparative tolerance. Study of crash dummies.

3. **Vehicle Safety systems:**
   Survival space requirements, Restraint systems used in automobiles
   - Types of safety belts- Head restraints, Air bags
   - Use of energy absorbing systems - Impact protection from steering controls
   - Design of seats for safety- types of seats-Importance of Bumpers - Damageability criteria in bumper designs.
   - Types of safety glass and their requirements, rearward field of vision in automobiles
   - Types of rear view mirrors and their assessment - Warning devices - Hinges and latches, etc.
   - External Projections, Door locks & retension systems Rear/front/side under run protection devices.

4. **Automotive Lighting and Light Signalling Devices:**
   Automotive lamps, types, design, construction, material, performance
   - Light signalling devices such as stop lamp, rear position lap, direction indicator, reverse lamp, reflex reflector, position lamp, number plate lamp, etc.
   - New technology in automobile lighting-Gas Discharge lamp, LED, Adoptive Front Lighting System (AFLS), Daylight Running Lamps (DRL).

5. **Safety regulations:**
   As issued from time to time by Government of India as per AIS 037 (Automotive Indian Standard)

Reference Books:

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.
4. Prasad, Priya and Belwafa Jamel, "Vehicles Crashworthiness and Occupant Protection”, American Iron and Steel Institute, USA.
5. Edward A., “Lamps and Lighting” Hodder & Stoughton, London 1993.

6. Keitz H. A. E. “Light calculations and Measurements”, Macmillan 1971.
7. Olson L. P., “Forensic aspects of driver perception and response, Lawyers and Judges 1996.
8. Pantazis M., “Visual instrumentation: Optical design & engineering Principles, McGraw - Hill 1999.
9. Handbook of Applied Photometry – OSA, AIP Press (1997)
6. Born M and Wolf E “Principles of Optics”, 1999, Cambridge University Press
7. McCluney W.R. “Introduction to Radiometry and Photometry”
8. Walsch JWT, “Photometry”, Dover Publication
9. Central motor vehicle rules and standards.
10. Recent Development in Automotive Safety Technology. SAE International Publication. Editor: Daniel J Helt.
11. Updated CDs of AIS 037, giving procedure for type approval and estimating Conformity of production for safety of critical components, published by ARAI Pune.

Semester – I
Research Methodology [502304]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502304	4	50	50	-	-	100	4

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.

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 in data collection in noisy environment.

3. Applied statistics

Regression analysis, Parameter estimation, Multivariate statistics, Principal component analysis, Moments and response curve methods, State vector machines and uncertainty analysis, Probable errors in the research, Error analysis.

4. Modelling and prediction of performance

Setting up a computing model to predict performance of experimental system, Multi-scale 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.

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.

In semester assessment is to be carried out by two internal tests and five assignments one on each unit.

Reference Books:

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

Semester – I

Elective – I (502305)

[Elective I Common to All M.E. Mechanical Courses]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502305	5	50	50	-	-	100	5

Modules of 2 Credits (Select any Two)			
Code No.	**Title**	**Code No.**	**Title**
ME2I – M1	**Energy Audit and Management**	**ME2I – M6**	**Operation Management**
ME2I – M2	**Financial Management**	**ME2I – M7**	**Engineering Economics**
ME2I – M3	**Financial Costing**	**ME2I – M8**	**Technology Forecasting**
ME2I – M4	**Project Management**	**ME2I – M9**	**Technology Transfer**
ME2I – M5	**Energy Efficient Technologies in Electrical Systems**	**ME2I – M10**	**Human Rights**
Modules of 1 Credit (Select any One)			
Code No.	**Title**	**Code No.**	**Title**
ME1I – M11	**Environmental Pollution and Control**	**ME1I – M12**	**Intellectual property Rights**

Note: For e.g., ME2I-M1 indicates
ME – Common to all M.E. Mechanical Course, 2 – 2 Credits, I – Elective I, M1 – Module 1

ME2I – M1 Energy Audit and Management

Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments

Ref. Books: Guide Books, Bureau of Energy Efficiency

ME2I – M2 Financial Management

Investment-need, Appraisal and criteria, Financial analysis techniques- Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis, Financing options, Energy performance contracting and role of Energy Service Companies (ESCOS).

Ref. Books: Guide Books, Bureau of Energy Efficiency

ME2I – M3 Financial Costing

Significance, Traditional absorption costing, Marginal costing, Contract costing, Activity based costing, Process costing

Ref. Books: Cost Accounting, N K Prasad, Book Syndicate Pvt. Ltd.

ME2I – M4 Project Management

Definition and scope of project, Technical design, Financing, Contracting, Implementation and performance monitoring. Implementation plan for top management, Planning Budget, Procurement Procedures, Construction, Measurement & Verification.

Ref. Books: Guide Books, Bureau of Energy Efficiency

ME2I – M5 Energy Efficient Technologies in Electrical Systems

Maximum demand controllers, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic ballast, Occupancy sensors, Energy efficient lighting controls.

Ref. Books: Guide Books, Bureau of Energy Efficiency

ME2I – M6 Operation Management

Introduction, Importance, Operating systems models, key decisions, Planning and controlling, Strategic approach, Processes and systems, supply chain or network approach, Technology and knowledge management, Quality Management, Operations - Challenges, Opportunities, Excellence, risk management and sustainability, Case studies

Ref. Books:1) Operations Management - An Integrated Approach, Danny Samson and Prakash J. Singh, :Cambridge University Press, 2) Modern production/Operations Management, 8th Edition, E.S. Buffa and R. K. Sarin, John Wiley & Sons.

ME2I – M7 Engineering Economics

Fundamentals, Markets and Government in a Modern economy, Basic Elements of Supply and Demand, Demand and Consumer Behaviour, Analysis of Perfectly Competitive Markets, Unemployment, Inflation and Economic policy

Ref. Books: Economics, Samuelson Nordhaus, Tata McGraw Hill

ME2I – M8 Technology Forecasting

Approaches, Technology Performance Parameters, Use of Experts in Technology Forecasting, Planning, Technology Progress. Morphological Analysis of a Technology System.

Ref. Books: 1) Gerard H. Gaynor, Hand Book of Technology Management, Mc Graw Hill.

ME2I – M9 Technology Transfer

Definition, Source of Technology Transfer [TT], Model of TT with Public and Private Enterprises, Success and Failure Factors in Technology Transfer. The concepts of Invention and Innovation, Definition and classifications of Research and Development, New Product Development, Challenges in Commercializing Research Results.

Ref. Books: 1) Gerard H. Gaynor, Hand Book of Technology Management, Mc Graw Hill.

ME2I – M10 Human Rights

Human Rights – Concept, Development, Evolution, Philosophical, Sociological and Political debates, Benchmarks of Human Rights Movement. Human Rights and the Indian Constitution Human Rights & State Mechanisms, Police & Human Rights, Judiciary & Human Rights, Prisons & Human Rights, National and State Human Rights Commissions, Human Rights of the Different Sections and contemporary issues, Citizens' Role and Civil Society, Human Rights and the international scene Primary Information with reference to Engineering Industry

Ref. Books: 1)Study material on UNESCO,UNICEF web site, 2)HUMAN RIGHTS IN INDIA A MAPPING,Usha Ramanathan, 3)Introduction to International Humanitarian Law by Curtis F. J. Doebbler - CD Publishing , 2005 .This book is an introductory text on international humanitarian law (the laws of war) that provides the basics of law, including excerpts from some of the leading treaty texts. Perfect for a short course in the law -- one to five weeks, 4) Freedom of Information by Toby Mendel - UNESCO , 2008

ME1I – M11 Environmental and Pollution control

Pollution and Environmental Ethics, Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards Environmental impact and economic aspects, Emission standards and regulations for Automobiles.

Ref. Books: 1) Environmental Pollution and Control, J. Jeffrey Peirce, P Aarne Vesilind, Ruth Weiner, Butterworth-Heinemann, 2) Environmental Pollution Control Engineering, C.S. Rao, New Age International

ME1I – M12 Intellectual property Rights

Patentable and non-patentable inventions, statutory exceptions, Persons entitled to apply for patents.

Ref. Books: 1) Satyawrat Ponkshe, The Management of Intellectual Property, by, Ponkshe & Bhate Publications, Pune.

Semester – I
Lab Practice – I [502306]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pr/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502306	4	-	-	50	50	100	4

Lab work or Assignments have to be carried out at respective labs as mentioned in the syllabus of respective subjects excluding Elective. It is to be submitted as term work at the end of semester after continuous assessment of each by respective teacher. Assessment of term work has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System. (Refer University web site)

The Term work shall consist of following experiments /assignments;

1. Computer program to estimate dynamic forces on crankshaft of multi-cylinder engine.
2. Dynamic force analysis of crank train assembly using suitable MDB software.
3. Fatigue life estimation of crankshaft using suitable FEM software.
4. Assignment on crash analysis.
5. Assignment on lighting system in automobiles.
6. Assignment on complex analysis.
7. Assignment on transforms.
8. Assignment on numerical analysis.
9. Visit to an automotive industry to see the latest manufacturing and assembly of System.

Semester - II

Engine Combustion Technology [502307]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502307	4	50	50	-	-	100	4

1. Combustion Principles:

Thermodynamics - concepts of combustion – combustion equations - heat of combustion theoretical flame temperature - chemical equilibrium and dissociation, equilibrium constant for ideal gas mixture. Chemical thermodynamics, chemical reaction, fuels and combustion, enthalpy of formation and enthalpy of combustion, 1st law analysis of reacting systems, adiabatic flame temperature.

2. Chemical Kinetics:

Theories of combustion - pre-flame velocities - reaction rates - laminar and turbulent flame propagation in engines.

3. Combustion in S.I. Engines:

Initiation of combustion - flame velocities – flame propagation - normal and abnormal combustion - knocking combustion - pre-ignition - knock and engine variables - features and design consideration of combustion chambers - stratified charge combustion - concepts of lean burn engines - heat release correlations. Flow visualization and modeling, concept of combustion quality, ignition and its effect.

4. Combustion in C.I. Engines:

Various stages of combustion - vaporization of fuel droplets and spray formation – air motion - swirl measurement - delay period correlations and affecting variables, diesel knock and engine variables, features and design considerations of combustion chambers - swirl, squish and tumble Flow visualization and modelling.

5. Combustion in Gas Turbine:

Flame stability, re-circulation zone and requirements - combustion chamber configuration. Various combustion chambers and their analysis. I. C. Engine simulation, programming introduction.

Reference books:

1. Ganesan, V., Internal Combustion Engines, Tata McGraw Hill Book Cop.,1995.
2. John, B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill Book, 1998.
3. Mathur M. L., and Sharma, R. P., A Course in Internal Combustion Engines, Dhanpat Rai Publications Pvt. New Delhi-2, 1993.
4. Obert, E. F., Internal Combustion Engine and Air Pollution, International Text Books Publishers, 1983.
5. Cohen, H. Rogers, G, E. C. and Saravanamutto, H. I. H., Gas Turbine Theory, Longman Group Ltd, 1980.
6. C. R. Ferguson and A. T. Kirkpatrick, "I C Engine (Applied thermosciences)" Wiley India Pvt. Limited, New Delhi – 110002.

Semester - II

Noise Vibration and Harshness [502308]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502308	4	50	50	-	-	100	4

1. **Introduction to Automotive NVH:**
   Natural vibration of Single Degree of Freedom System (SDOF) and Multi Degree of Freedom System (MDOF), Undamped, damped and forced vibrations and Vibration of beams, plates & shells. Automotive NVH sources, NVH a Measure of Vehicle Ride Comfort, Noise sources, generation and radiation, Pass-by noise limits, Interior noise of vehicles, Sound quality, Ride comfort, Noise and vibration control in vehicles.

2. **Noise Fundamentals:**
   Sound propagation, Quantification of sound- frequency and wave length, sound pressure level, sound intensity level, Octave & 1/3 octave bands, A weighting, Room criterion, Radiation efficiency, Noise induced hearing losses. Interior Noise of Automobiles - Interior noise sources, Structure borne noise, Airborne noise, Refinement techniques, Sound insulation.

3. **Vibration & Noise measurement:**
   Vibration transducers, microphones & calibrators, Excitation devices, Frequency analysis, Sound pressure measurement, Sound power measurement, Sound intensity measurement, Sound intensity probes, Data acquisition system, Digital signal processing, Noise specifications & standards.

4. **Noise and Vibration Analysis: Transfer Path Analysis-**
   Single source structure-borne noise transmission path analysis, Multiple reference transmission path analysis, Use of mechanical-acoustic reciprocity, Air-borne source quantification, Impedance modelling, Frequency and order domain analysis, Sound intensity and sound power mapping and Introduction to array techniques - Acoustic holography & beam forming.

5. **Modal Analysis:**
   Definition of Modal Properties, Modal analysis theory, FE & Experimental modal analysis, Excitation sources, Applications of Modal Analysis.

   Passive Noise Treatments:
   A. Ducts & Mufflers -Types of mufflers, performance parameters – acoustics and backpressure, Reactive and absorptive silencers and Overall design considerations.
   B. Acoustic Material Characterization -Sound transmission, absorption and damping, Behaviour of acoustic material wrt sound absorption and transmission, Standard methods for evaluating sound absorption coefficient and transmission loss, Types of sound absorbers, Prediction of transmission loss and flanking transmission, Damping materials and their applications.

6. NVH Legislations:

Psycho-acoustics and effect of noise on human beings, Ambient air quality standards, Noise specifications for automotive vehicles – pass-by & stationary and Noise specifications for generator sets, fire crackers and household articles.

Reference Books:

1. Theory of Vibrations with Applications: W T Thomson CBS Publishers Delhi
2. Mechanical Vibrations: S SRao Addison-Wesley Publishing Co.
3. Fundamentals of Vibration : Leonard Meirovitch , McGraw Hill International Edison.
4. Principles of Vibration Control :Asok Kumar Mallik, Affiliated East- West Press.
5. Mechanical Vibrations A H Church ,John Wiley & Sons Inc
6. Mechanical Vibrations J P Den Hartog, McGraw Hill.
7. Mechanical Vibration Analysis: Srinivasan, McGraw Hill.
8. Mechanical Vibrations: G K Groover.
9. Vibration and Noise for Engineers: Kewal Pujara ,Dhanpat Rai And co.

Semester - II
Automotive Chassis Design [502309]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502309	4	50	50	-	-	100	4

1. **Design of Suspension System:**
   Springs, Types of Springs, Stress Deflection equation for helical springs, Wahl factor, Design of helical springs, Buckling of springs, Types of leaf springs, Steering effect of leaf spring Variable rate springs, rubber springs, air springs, Independent Suspension system, Camber, Castor, Roll Center, Double transverse link, McPherson Strut system, Single Transverse link, Single trailing/ leading link, Double Trailing link, Rear suspension (Dead Axle) Active Suspension.

2. **Automotive Steering System:**
   Wheel Alignment, Checking and Adjustments, Fundamental Condition of True rolling, Ackerman Steering gear, Davis Steering Gear, Turning circle radius, Power Steering system, Centre point steering, Steering characteristics, Rear wheel steering , Steering Column , Reversible & irreversible steering , steering connections.

3. **Automotive Brakes:**
   Introduction, Function of brakes, Elementary theory of Shoe Brakes, Brake Shoe Adjustments, Disc Brakes, Self Energizing disc brake, Brake linings, Hydraulic Brakes, Dual Brakes, Servo Power assisted brake system , Vacuum brake, Bendix Hydrovac, Direct acting vacuum servos, Power assisted brakes, Brake limiting devices, The load conscious valve, Apportioning valve.

4. **Wheels and Tyres:**
   Introduction , wheel tyre assemblies, wheels, rims, Wheel fixing, Tyres, Constructional details, Tread Design, Noise, Aspect Ratio, Tread Design consideration, Run Flat Tyes , Materials ,Retrading And Manufacturing.

5. **Six Wheel Vehicles:**
   Introduction, The rigid Six Wheelers, Suspension, Transmission of six wheelers , a Scammell Design, Spring Stresses in rigid Six wheeler, Scammell articulated trailers , Scammell Route ness.

Reference Books:

1. T.K.Garrette, Steeds, Newton, “The Motor Vehicle”, Butterworth Heinemann.
2. Crouse / Anglin, “Automotive Mechanics”, TMH Edition.
3. Jack Erjarn, “Automotive Technology”, Delmar Thomson Learning
4. Schwaller, “Motor Automotive Technology” , Delmar Thomson Learning
5. N.K.Giri, “Automotive Mechanics”, Khanna Publications

Semester – II
Elective – II [502310]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502310	5	50	50	-	-	100	5

Modules of 2 Credits (Select any Two)			
Code No.	**Title**	**Code No.**	**Title**
AE2II-M1	Finite Element Method – I	**AE2II-M6**	Vehicle Aerodynamics – II
AE2II-M2	Finite Element Method - II	**AE2II-M7**	Automotive Materials – I
AE2II-M3	Computational Fluid Dynamics - I	**AE2II-M8**	Automotive Materials – II
AE2II-M4	Computational Fluid Dynamics - II	**AE2II–M9**	Advanced Heat Transfer – I
AE2II-M5	Vehicle Aerodynamics – I	**AE2II–M10**	Advanced Heat Transfer – II
Modules of 1 Credit (Select any One)			
Code No.	**Title**	**Code No.**	**Title**
AE1II-M11	Finite Element Method - III	**AE1II-M14**	Automotive Materials – III
AE1II-M12	Computational Fluid Dynamics- III	**AE1II–M15**	Advanced Heat Transfer – III
AE1II-M13	Vehicle Aerodynamics – III		

Note: For e.g., AE2II-M1 indicates
AE – Automotive Engineering, 2 – 2 Credits, II – Elective II, M1 – Module 1
For e.g., AE1II-M15 indicates
AE – Automotive Engineering, 1 – 1 Credit, II – Elective II, M15 – Module 15

AE2II - M1: Finite Element Method – I

1. Introduction, How FEM works, Brief history, Example case studies, Available solvers.
2. General concepts of FEM, Procedures, Linear Spring element, Assembling spring elements, Element types, Structural, Assembling matrices, Global connectivity, Boundary conditions, Solution methods, Commercial FEA systems.
3. A simple example in FEA, Geometry creation, Mesh generation, Solving and examining the results.

Reference Books:

1. Segerling L.J. – 'Applied finite elements analysis' John Wiley and Sons.
2. Bathe- 'Finite Element Methods' Prentice Hall of India (P) Ltd, New delhi.
3. O.C. Zienkiewicz 'Finite Element Method' Tata Mc Graw Hill, New Delhi.
4. J.N. Reddy- 'An Introduction to FEM', Mc Graw Hill International Edition
5. C.S. Krishnamoonthy-'Finite Element Analysis – Theory and Programming', Tata Mc Graw Hill Publishing Co. Ltd, New Delhi.

AE2II - M2: Finite Element Method - II

1. Element types and their selection, Basic elements, Types of nodes, Degrees of freedom, Interpolation, Automatic mesh generation, Selection of parameters, Boundary conditions, Specifying loading.

2. Plane stress/strain modeling techniques, Trusses, Definition and stiffness matrix, Verification of results, Some examples, 2D truss, 2D truss with different, two dimensional problems, Plane stress and plane strain, Axisymmetric Plates and shells.
3. Solving axial member problems, Beam stiffness matrix, Different loading conditions, Formulation using Algor, Verification of results, Frames, Plane frame, Space frame, Verification of results.

Reference Books:

1. Segerling L.J. – 'Applied finite elements analysis' John Wiley and Sons.
2. Bathe- 'Finite Element Methods' Prentice Hall of India (P) Ltd, New delhi.
3. O.C. Zienkiewicz 'Finite Element Method' Tata Mc Graw Hill, New Delhi.
4. J.N. Reddy- 'An Introduction to FEM', Mc Graw Hill International Edition
5. C.S. Krishnamoonthy-'Finite Element Analysis – Theory and Programming', Tata Mc Graw Hill Publishing Co. Ltd, New Delhi.

AE2II - M3: Computational Fluid Dynamics - I

1. Introduction to CFD

Governing equations: the continuity equation, momentum equation and energy equations, convective forms of the equations and general description, Reynolds transport theorem.

Classification of partial differential equations; physical examples of elliptic, parabolic and hyperbolic equations. Mathematical nature of the flow equations& their boundary conditions.

2. Discretization

Basic discretization techniques applied to model equations and systems of equations: finite difference, finite volume and finite element methods.

Finite difference methods: Taylor series expansion, different means for formulating finite difference equation; accuracy of finite difference method.

Finite Volume Methods: Finite volume methods; approximation of surface and volume integrals; interpolation methods; central, upwind and hybrid formulations and comparison for convection-diffusion problem.

Analysis of numerical schemes: concept of consistency, accuracy, stability and convergence; Error and stability analysis; some applications.

Reference Books

1. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press.
2. Anderson, J.D. Computational Fluid Dynamics, McGraw Hill, 1995.
3. Hirsch,C. Numerical Computation of Internal and External Flows, Vol.I, John Wiley, 1990.
4. Jiyuan Tu, Guan – Heng Yeoh, Chaoqun Liu, Computational Fluid Dynamics – A practica approach, Butterworth Heinemann.
5. Leveque, R.J., Numerical Methods for Conservation Laws, BirkhauserVerlag, 1990.
6. Anderson,D.A., Tannehill,J.C. and Pletcher,R.H., Computational Fluid Dynamics and Heat Transfer, McGraw Hill, 1984.
7. Pradip Niyogi, S.K. Chakraborty, M.K. Laha, Introduction to Computational Fluid Dynamics, Pearson
8. Oleg Zikanov, Essential Computational Fluid Dynamics, John Wiley
9. Pieter Wesseling, Principles of Computational Fluid Dynamics, Springer, 2004.
10. S. V. Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill.

11. John C. Tannehill, Dale A. Anderson and Richard H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor &Francis.
12. Versteeg, H. K. and Malalasekara, W. (2008). Introduction to Computational Fluid Dynamics: The Finite Volume Method. Second Edition (Indian Reprint) Pearson Education.
13. David C. Wilcox Turbulence Modeling for CFD, Publisher: D C W Industries, Nov 1, 2006

AE2II – M4: Computational Fluid Dynamics - II

1. **Numerical Grid Generation**
   Introduction, Structured and Unstructured mesh generation techniques
   - Structured grid generation: a)Algebraic method, b) Elliptic generation systems.
   - Unstructured grid generation: a)Voronoi diagram and Delaunay triangulation; b) Advancing front grid generation.
2. **Solution to Eulers equations**
   Formulations of Euler equations, Discretization methods for Euler equations. High resolution schemes and TVD.
3. **Navier-Stokes Equations**
   Governing equations, Properties of Navier-Stokes equations; Discretization of NS equations; Boundry conditions; Convergence acceleration techniques.

Reference Books

1. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press.
2. Anderson, J.D. Computational Fluid Dynamics, McGraw Hill, 1995.
3. Hirsch,C. Numerical Computation of Internal and External Flows, Vol.I, John Wiley, 1990.
4. Jiyuan Tu, Guan – Heng Yeoh, Chaoqun Liu, Computational Fluid Dynamics – A practica approach, Butterworth Heinemann.
5. Leveque, R.J., Numerical Methods for Conservation Laws, BirkhauserVerlag, 1990.
6. Anderson,D.A., Tannehill,J.C. and Pletcher,R.H., Computational Fluid Dynamics and Heat Transfer, McGraw Hill, 1984.
7. Pradip Niyogi, S.K. Chakraborty, M.K. Laha, Introduction to Computational Fluid Dynamics, Pearson
8. Oleg Zikanov, Essential Computational Fluid Dynamics, John Wiley
9. Pieter Wesseling, Principles of Computational Fluid Dynamics, Springer, 2004.
10. S. V. Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill.
11. John C. Tannehill, Dale A. Anderson and Richard H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor &Francis.
12. Versteeg, H. K. and Malalasekara, W. (2008). Introduction to Computational Fluid Dynamics: The Finite Volume Method. Second Edition (Indian Reprint) Pearson Education.

AE2II – M5: Vehicle Aerodynamics – I

1. **Fundamental of aerodynamics:**
   Scope, historical development trends, fundamental of fluid mechanics, flow phenomenon related to vehicles, external and internal flow problems, performance of cars, light vans, resistance to vehicle motion, drag cars as bluff body - flow field around car – drag force –

type of drag force – analysis of aerodynamic drag coefficient of car – strategies for aerodynamic development of car – optimization of car bodies for low drag.

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

Reference Books

1. W.H.Hucho – "aerodynamic of road vehicle"
2. Schlichting H "boundary layer theory"
3. Pope A " low speed wind tunnel testing" joho wiley and sons.

AE2II – M6: Vehicle Aerodynamics – II

1. **Wind tunnels and test techniques:**
   Principles of wind technology – limitation of simulation – stress with scale models - Existing automobile wind tunnel – full scale wind tunnels – climatic tunnels - measuring equipments and transducers - measurement techniques – velocity measurements – flow visualization techniques – road test method – numerical method – wind noise measurements .
2. **Application of CFD:**
   Introduction - method of solve Navier stoke equation – forces acting in fluid element – compressibility effect in flow field - inviscide flow – governing equations – irrotational Flow field and consequences – potential flows – boundary layer methods – numerical modeling of fluid flow around vehicle body.

Reference Books

1. W.H.Hucho – "aerodynamic of road vehicle"
2. Schlichting H "boundary layer theory"
3. Pope A " low speed wind tunnel testing" joho wiley and sons

AE2II – M7: Automotive Materials – I

1. **Metallic Materials:**
   Effect of alloying additions, solid solutions, substitutional & interstitial alloying, eutectic, pearlitic, eutectoid reactions, classifications of steels and cast irons, High Strength Low Alloy Steels (HSLA), copper base alloys, aluminium base alloys, zinc base alloys, titanium alloys, typical properties of alloy grades, methods of identification of alloy grades.

2. **Heat treatment:**
   Definitions, Full annealing, stress relief, recrystallisation and spheroidizing, normalising, hardening and Tempering of steel. Isothermal transformation diagrams, cooling curves, Hardenability, Jominy end quench test, Austempering, martempering, case hardening, carburising, nitriding, cyaniding, carbonitriding, Flame and Induction hardening, precipitation hardening of non-ferrous alloys, importance of heat treatment in design of components.
3. **Manufacturing processes:**
   steel melting practices, manufacturing of aluminium alloys, metal forming operations - rolling, extrusion, casting, forging, welding, soldering, brazing, powder metallurgy.

4. **Non-metallic materials – Polymers:**
   Types of polymer, commodity and engineering polymers – Properties and auto applications of PE, PP, PS, PVC,PMMA, PET, PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE Polymers – Urea and Phenol formaldehydes.
   Elastomers – natural and synthetic rubbers, tires,properties of rubbers and auto applications.

Reference Books

1. Kenneth G.Budinski and Michael K.Budinski "Engineering Materials" Prentice-Hall of India Private Limited, 4th Indian Reprint 2002.
2. Raghavan.V.Materials Science and Engineering, Prentice Hall of India Pvt. Ltd., 1999.
3. Sydney H.Avner "Introduction to Physical Metallurgy" McGraw-Hill Book Company, 1994.
4. C. Daniel Yesudian, D. G. Harris Samuel "Material Science and Metallurgy", SPI Publication, 2006
5. Donald R Askeland, P. P. Phule "Essentials of Materials Science and Engineering, cengage Learning, 2008

AE2II – M8: Automotive Materials – II

1. **Composites:**
   Fiber reinforced plastics (FRP), engineering ceramics, metalmatrix /composites, nano-composites.
2. **Plastic and composite component manufacturing methods:**
   Hand moulding, compression moulding, Reaction Injection moulding (RIM), blow moulding, filament winding, pultrusion, pulforming, SMC & DMC.
3. **Other Materials:**
   Electrical insulating materials. Gaskets, automotive glasses, Sound insulating materials, Protective coating materials - Paints, primers, varnishes, enamels, anodizing, blackodizing, electro plating, CVD and PVD, Sealant and adhesives, smart materials, Refractory materials.
4. **Pysico-chemical properties of Automotive fluids and their importance:**
   Type of fluids - gasoline & diesel fuels, alternate fuels, engine oils, gear oils, greases, transmission fluids, brake fluids, antifreeze engine coolants, effects on vehicle performance.

Reference Books:

1. Kenneth G.Budinski and Michael K.Budinski "Engineering Materials" Prentice-Hall of India Private Limited, 4th Indian Reprint 2002.
2. Raghavan.V.Materials Science and Engineering, Prentice Hall of India Pvt. Ltd., 1999.
3. Sydney H.Avner "Introduction to Physical Metallurgy" McGraw-Hill Book Company, 1994.
4. C. Daniel Yesudian, D. G. Harris Samuel "Material Science and Metallurgy", SPI Publication, 2006
5. Donald R Askeland, P. P. Phule "Essentials of Materials Science and Engineering, Cengage Learning, 2008

AE2 II – M9: Advanced Heat Transfer – I

1. **Introduction to Modes and Laws of Heat Transfer:**
   Simultaneous Heat Transfer Mechanism, Steady and Transient Heat Transfer, Multidimensional Heat Transfer, Thermal Conductivity, Thermal diffusivity, Various

Boundary and Initial Conditions, General Heat Conduction Equation, Thermal Resistance, Generalized Thermal Resistance Networks, Thermal Contact Resistance

2. **Transient Heat Conduction:**
   Lumped capacitance and its validity, General lumped capacitance analysis, spatial effects. Problems related with conventional geometries.
3. **Principle of Fluid flow and Convective heat transfer:**
   Concept of velocity and thermal boundary layers: Laminar and Turbulent flow. Navier-stokes equations and convection equation. Boundary layer approximations and special conditions. Boundary layer similarity. The normalized convection transfer equations. Dimensionless parameters & physical significance. Reynolds analogy, Chilton-Colburn analogy.

Reference books:

1. Fundamentals of Heat and Mass Transfer, Incropera, Dewitt, John Wiley and sons.
2. Heat and Mass Transfer, Yunus Cengel, Afshin Ghajar, Tata Mc Graw Hill.
3. Heat transfer - A basic approach, M.N. Ozisik, Mc Graw Hill Int.
4. Convective Heat transfer, A Bejan, John Wiley and sons.
5. Heat transfer, J.P. Holman, Mc Graw Hill
6. Heat transfer, S.P. Sukhatme, University Press

AE2 II – M10: Advanced Heat Transfer – II

1. **External Forced Convection:**
   Parallel flow over Flat plates, Flow across cylinders and spheres, Flow across tube banks
   Internal Forced Convection
   Entrance region, Constant surface heat flux, Constant surface temperature, Laminar and Turbulent flow in tubes
2. **Natural Convection:**
   Physical Mechanism, Equation of motion and Grashof Number, Natural Convection over surfaces, Natural convection from finned surfaces and PCBs, Natural Convection inside enclosures (Rectangular, Cylinder and Sphere), Combined Natural Convection and Radiation, Combined Natural and Forced Convection.
3. **Boiling and Condensation:**
   Boiling modes, the boiling curve, modes of pool boiling, correlations. Forced convection boiling. Two phase flow.

   Condensation: Physical mechanisms, laminar film condensation on a vertical plate. Turbulent film condensation, film condensation on radial systems, film condensation in horizontal tubes, on banks of tubes, Dropwise condensation correlations.

Reference books:

1. Fundamentals of Heat and Mass Transfer, Incropera, Dewitt, John Wiley and sons.
2. Heat and Mass Transfer, Yunus Cengel, Afshin Ghajar, Tata Mc Graw Hill.
3. Heat transfer - A basic approach, M.N. Ozisik, Mc Graw Hill Int.
4. Convective Heat transfer, A Bejan, John Wiley and sons.
5. Heat transfer, J.P. Holman, Mc Graw Hill
6. Heat transfer, S.P. Sukhatme, University Press.

AE1II – M11: Finite Element Method – III

Post processing, Stresses, Strains, Displacement, Animation, Plotting, Interfacing with CAD and 3D analysis, Modeling techniques, Solid elements, Element refinement, Formulation of problem, Interfacing with CAD systems, Examples with Pro-Engineer, Inventor.

Reference Books:

1. Segerling L.J. – 'Applied finite elements analysis' John Wiley and Sons.
2. Bathe- 'Finite Element Methods' Prentice Hall of India (P) Ltd, New delhi.
3. O.C. Zienkiewicz 'Finite Element Method' Tata Mc Graw Hill, New Delhi.
4. J.N. Reddy- 'An Introduction to FEM', Mc Graw Hill International Edition
5. C.S. Krishnamoonthy-'Finite Element Analysis – Theory and Programming', Tata Mc Graw Hill Publishing Co. Ltd, New Delhi.
6. Nitin Gokhale, Deshpande-'Practical Finite Element Analysis, Finite to Infinite Pune.

AE1II – M12: Computational Fluid Dynamics – III

1. Turbulence Modeling

Introduction, Statistical representation of turbulent flows: General Properties of turbulent quantities, Closure problem: Necessity of turbulence modeling, Reynolds average Navier stokes (RANS) equation,

Different types of turbulence model: Eddy viscosity models, Mixing length model, Turbulent kinetic energy and dissipation, The κ-ε model, Advantages and disadvantages of κ-ε model, Two-equation models: κ-ε model and κ-ω model, Reynolds stress equation model (RSM).

Reference Books:

1. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press.
2. Anderson, J.D. Computational Fluid Dynamics, McGraw Hill, 1995.
3. Hirsch,C. Numerical Computation of Internal and External Flows, Vol.I, John Wiley, 1990.
4. Jiyuan Tu, Guan – Heng Yeoh, Chaoqun Liu, Computational Fluid Dynamics – A practica approach, Butterworth Heinemann.
5. Leveque, R.J., Numerical Methods for Conservation Laws, BirkhauserVerlag, 1990.
6. Anderson,D.A., Tannehill,J.C. and Pletcher,R.H., Computational Fluid Dynamics and Heat Transfer, McGraw Hill, 1984.
7. Pradip Niyogi, S.K. Chakraborty, M.K. Laha, Introduction to Computational Fluid Dynamics, Pearson
8. Oleg Zikanov, Essential Computational Fluid Dynamics, John Wiley
9. Pieter Wesseling, Principles of Computational Fluid Dynamics, Springer, 2004.
10. S. V. Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill.
11. John C. Tannehill, Dale A. Anderson and Richard H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor &Francis.
12. Versteeg, H. K. and Malalasekara, W. (2008). Introduction to Computational Fluid Dynamics: The Finite Volume Method. Second Edition (Indian Reprint) Pearson Education.

AE1II – M13: Vehicle Aerodynamics – III

Aerodynamic design: Development and simulation methods –cars, buses, trucks.

Reference Books:

1. W.H.Hucho – "aerodynamic of road vehicle"
2. Schlichting H "boundary layer theory"
3. Pope A " low speed wind tunnel testing" joho wiley and sons

AE1II – M14: Automotive Materials – III

1. **Selection of materials:**
   Selection criteria for auto components – cylinder block, Cylinder head, piston, piston ring, Gudgeon pin, connecting rod, crank shaft, crank case, cam, cam shaft, engine valve, gear wheel, clutch plate, axle, bearings, chassis, spring, shock absorber, propeller shaft, body panel, radiator, brake liners and brake pads, batteries, fuel tank, seats, application of non-metallic materials such as plastics, composites, ceramics, etc.

2. **Metallurgical Failure Analysis:**
   Approach to analysis, types of failures, fracture mechanisms, types of defects in metals & cracks, types of fatigue, importance of endurance life, corrosion – causes, effects and preventions, wear & tear, hydrogen embrittlement, interpretation of tests & results, case studies.

3. **Quality Control:**
   Testing & validation of materials & components, National & International specifications, Testing & Characterization, Safety and environment impacts, ISO 9001, TQM, OSHA standards.

Reference Books:

1. Kenneth G.Budinski and Michael K.Budinski "Engineering Materials" Prentice-Hall of India Private Limited, 4th Indian Reprint 2002.
2. Raghavan.V.Materials Science and Engineering, Prentice Hall of India Pvt. Ltd., 1999.
3. Sydney H.Avner "Introduction to Physical Metallurgy" McGraw-Hill Book Company, 1994.
4. C. Daniel Yesudian, D. G. Harris Samuel "Material Science and Metallurgy", SPI Publication, 2006
5. Donald R Askeland, P. P. Phule "Essentials of Materials Science and Engineering, Cengage Learning, 2008

AE2 II – M15: Advanced Heat Transfer – III

1. **Thermal Radiation:**
   Thermal radiation, Blackbody radiation, Radiation intensity, Radiation properties, Atmospheric and Solar radiation, Shape factor, Radiation heat transfer in two surface enclosures, Radiation shields, Radiation exchange between Emitting and Absorbing gases.

Reference books:

1. Fundamentals of Heat and Mass Transfer, Incropera, Dewitt, John Wiley and sons.
2. Heat and Mass Transfer, Yunus Cengel, Afshin Ghajar, Tata Mc Graw Hill.
3. Heat transfer - A basic approach, M.N. Ozisik, Mc Graw Hill Int.
4. Convective Heat transfer, A Bejan, John Wiley and sons.
5. Heat transfer, J.P. Holman, Mc Graw Hill
6. Heat transfer, S.P. Sukhatme, University Press.

Semester – II
Lab Practice – II [502311]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pr /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502311	4	-	-	50	50	100	4

Lab work or Assignments have to be carried out at respective labs as mentioned in the syllabus of respective subjects excluding Elective. It is to be submitted as term work at the end of semester after continuous assessment of each by respective teacher. Assessment of term work has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System.

The Term work shall consist of any nine experiments / assignments of following;

1. Study of ABS system and draw a complete system diagram with costing for a passenger vehicle.
2. Experiment on chassis dynamometer to study deflection, spring rate and stress analysis on various components.
3. Study of latest suspension system e.g. active suspension system and their application.
4. Experiment on actual sound and vibrations measurements on a vehicle mounted on a chassis dynamometer.
5. Study of noise legislation issued by Govt. of India and actual measurement of pass by noise.
6. Experimental modal analysis of cantilever beam by using FFT analyzer.
7. Mat lab programming for determination of natural frequency and mode shape of beam.
8. Study of Bharat I/II/III/IV/V norms, applications in Indian conditions especially in large cities.
9. Study & measurement of exhaust gas emissions using Exhaust gas analyzer.
10. Assignment on latest trends in design of combustion chambers for I C Engines.

Seminar – I, II and III [502312, 602316, 602318]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pr /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502312	4	-	-	50	50	100	4
602316	4	-	-	50	50	100	4
602318	5	-	-	50	50	100	5

Assessment of Seminar has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System.

INSTRUCTIONS FOR SEMINAR REPORT WRITING

It is important that the procedures listed below be carefully followed by all the students of M.E. (Mechanical Engineering).

1. Prepare 3 **COPIES** of your manuscript.

2. Limit your project report to preferably

   a) 15-20 manuscript pages for Seminar I
   b) 20-25 manuscript pages for Seminar II
   c) 25-30 manuscript pages for Seminar III

3. The footer must include the following:
   Institute Name, M.E. Mechanical (Automotive Engineering) Times New Roman 10 pt. and centrally aligned.

4. Page number as second line of footer, Times New Roman 10 Pt, centrally aligned.

5. Print the manuscript using
   a) Letter quality computer printing.
   b) The main part of manuscript should be Times New Roman 12 pt. and justified**.**
   c) Use 1.5 line spacing.
   d) Entire report shall be one chapter. No chapters for Seminar I, II and III.
   e) Seminar I shall not have last section as Conclusions, it will be summary only.

6. Use the paper size **8.5'' × 11''** or **A4 (210 × 197 mm).** Please follow the margins given below.

Margin Location	Paper 8.5'' × 11''	Paper A4 (210 × 197 mm)
Top	1''	25.4 mm
Left	1.5''	37 mm
Bottom	1.25''	32 mm
Right	1''	25.4 mm

7. All paragraphs will be 1.5 line spaced with a one blank line between each paragraph. Each paragraph will begin without any indentation.

8. Section titles should be bold with 14 pt typed in all capital letters and should be left aligned.

9. Sub-Section headings should be aligning at the left with 12 pt, bold and Title Case (the first letter of each word is to be capitalized).

10. Illustrations (charts, drawings, photographs, figures) are to be in the text. Use only illustrations really pertinent to the text. Illustrations must be sharp, clear, **black and white. Illustrations downloaded from internet are not acceptable.**
    a) Illustrations should not be more than **two** per page. One could be ideal
    b) Figure No. and Title at bottom with **12 pt**
    c) Legends below the title in **10 pt**
    d) Leave proper margin in all sides
    e) Illustrations as far as possible should not be Xeroxed.

11. **Photographs** if any should be of glossy prints

12. Please use **SI** system of units. If students would like to add the equivalent in inch-pound (British) units, they must be stated in parenthesis after the **SI** units. In case the final result comes out in any other units (say due to empirical formula etc.) covert the unit to **SI** unit.

13. Please **number the pages** on the front side, centrally below the footer

14. **References** should be either in order as they appear in the thesis or in alphabetical order by last name of first author

15. **Symbols** and **notations** if any should be included in nomenclature section only

16. Following will be the order of report

    i. **Cover page** and **Front page** as per the specimen on separate sheet
    ii. **Certificate** from the Institute as per the specimen on separate sheet
    iii. **Acknowledgement**
    iv. **List of Figures**
    v. **List of Tables**
    vi. **Nomenclature**
    vii. **Contents**
    viii. **Abstract** (A brief abstract of the report not more than **150 words**. The heading of abstract i.e. word "Abstract" should be **bold, Times New Roman, 12 pt** and should be typed at the **centre.** The contents of abstract should be typed on new line without space between heading and contents. Try to include one or two sentences each on **motive, method, key-results** and **conclusions** in the Abstract)
    ix. Section: Introduction
    x. References

17. All section headings and subheadings should be numbered. For sections use numbers **1, 2, 3, ….** and for subheadings **1.1**, **1.2**, **….** etc and section subheadings **2.1.1**, **2.1.2, ….** etc.

18. **References** should be given in the body of the text and well spread. No verbatim copy or excessive text from only one or two references. If **figures** and **tables** are taken from any reference then indicate source of it. Please follow the following procedure for references

Reference Books

Collier, G. J. and Thome, J. R., Convective boiling and condensation, 3rd ed., Oxford University Press, UK, 1996, pp. 110 – 112.

Papers from Journal or Transactions

Jung, D. S. and Radermacher, R., Transport properties and surface tension of pure and mixed refrigerants, *ASHRAE Trans*, 1991, 97 (1), pp. 90 – 98.

Bansal, P. K., Rupasinghe, A. S. and Jain, A. S., An empirical correction for sizing capillary tubes, *Int. Journal of Refrigeration*, 1996, 19 (8), pp.497 – 505.

Papers from Conference Proceedings

Colbourne, D. and Ritter, T. J., *Quantitative assessment of flammable refrigerants in room air conditioners*, Proc. of the Sixteenth International Compressor Engineering Conference and Ninth International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, Indiana, USA, 2002, pp. 34 – 40.

Reports, Handbooks etc.

United Nations Environmental Programme, Report of the Refrigeration, Air Conditioning and Heat Pumps, Technical Option Committee, 2002, Assessment - 2002.

ASHRAE Handbook: Refrigeration, 1994 (Chapter 44)

Patent

Patent no, Country (in parenthesis), date of application, title, year.

Internet

www.(Site) [Give full length URL]

Format for front page and Certificate

A Seminar I / II / III on (TNR, 16pt, centrally aligned)

Title (TNR, 27pt, Bold, Centrally Aligned, Title Case)

By (TNR, 16pt, Centrally Aligned)

Mr. Student's Name (TNR, 16pt, Centrally Aligned)

Guide (TNR, 16pt, Centrally Aligned)

Guide's Name (TNR, 16pt, Centrally Aligned)

Institute

Logo

Department of Mechanical Engineering

Name of the Institute

[2011-12](TNR, 22pt, Title Case Centrally Aligned)

Name of the Institute

Institute

Logo

C E R T I F I C A T E

This is to certify that *Mr*. ..... has successfully completed the seminar-I/II/III entitled "Performance analysis of……." under my supervision, in the partial fulfilment of Master of Engineering - Mechanical Engineering (Automotive Engineering) of University of Pune.

Date :

Place :

Guide's Name
Guide

_____
Head
Department and
Institute Name

External Examiner

Seal

_____
Principal,
Institute Name

Semester - III
Vehicle Dynamics [602313]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
602313	4	50	50	-	-	100	4

1. **Tire Characteristics:**
   Tire – types, axis system, mechanics of pneumatic tires - tire forces and moments, rolling resistance of tires, tractive (braking) effort and longitudinal slip (skid), cornering properties of tires, slip angle and cornering force, slip angle and aligning torque, camber and camber thrust, characterization of cornering behaviour of tires, performance of tires on wet surfaces, ride properties of tires.

2. **Performance characteristics of road vehicles:**
   Equation of motion and maximum tractive effort, aerodynamic forces and moments, vehicle power plant and transmission characteristics, acceleration time and distance, gradability, engine and transmission matching, Electronic Stability Control (ESC), Braking characteristics of a two-axle vehicle, braking efficiency and stopping distance, antilock brake systems, traction control systems, Electronic Brake force Distribution (EBD), Electronic Brake assist System (EBS).

3. **Suspension Kinematics:**
   Terminology, definitions – reference frame, toe-in, toe-out, wheel camber, caster and kingpin angle, steering offset, types of dependent and independent suspensions, equivalent mechanisms (front view / side view), anti-dive and squat geometry, roll center analysis, steering geometry, error, steering force and moments.

4. **Handling characteristics of vehicle:**
   Steady-state handling characteristics of a two-axle vehicle, steady-state response to steering input, testing of handling characteristics, transient response characteristics, directional stability, steering of tracked vehicles.

5. **Vehicle ride characteristics:**
   Calculation of spectral densities, RMS values, relation to ride comfort, vehicle ride models - two-degree-of-freedom vehicle model for sprung and un-sprung mass, numerical methods for determining the response of a quarter-car model to irregular surface profile excitation, two-degree-of-freedom vehicle model for pitch and bounce, active and semi-active suspension.

6. **Road and Suspension Modeling:**
   Road – modelling aspects, deterministic profile, random profile, auto-correlation function, spectral density, relation between input and output spectral densities, effect of wheelbase, modelling of springs, anti-roll bars, torsion bar, air springs, dampers, bump stop.

Reference Books:

1. Road Vehicle Dynamics: Fundamentals and Modeling, Georg Rill, CRC Press, 2011
2. Theory of Ground Vehicles, J Y Wong, John Wiley & Sons
3. Road Vehicle Dynamics, Rao V. Dukkipati, Jian Pang, Mohamad S. Qatu, Gang Sheng, Zuo Shuguang, SAE
4. Fundamentals of Vehicle Dynamics, Thomas Gillespie, SAE

Semester – III
Autotronics [602314]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
602314	4	50	50	-	-	100	4

1. **Introduction to Electronic Systems Introduction**: Difference between Electrical and Electronic Systems The Role of Electronics in the Automobile, Basic Automotive Computer Concepts, Introduction to Common Electronic Components Summary, Computer Systems, Introduction, Analog and Digital Principles, Signal Conditioning and Conversion, Microprocessor, Computer Logic, Inputs 66, Outputs, High-Side and Low-Side Drivers, Duty Cycle and Pulse, Width, MOSFET Technology, Varistors, Amplifier Circuits, Voltage-to-Current Signal Conversion, Summary.

2. **Common Components for Computerized Engine Control Systems**: Objectives , Common Features, Sensing Devices, Actuators, System Diagnosis and Service, Summary Common Operating Principles For Computerized Engine Control Systems : Objectives, Electronic Fuel Injection System Operating Principles, Ignition System Operating Principles, Emission Control Systems, Variable Valve Timing, 42-Volt Systems, Summary.

3. **Diagnostic Concepts:** Objectives, Types of Faults, Diagnostic Trouble Codes (DTCs), Data Streams, Functional Tests, Pinpoint Testing, Flowcharts, Electrical Schematics, Other General Diagnostic Concepts, Summary. Diagnostic Equipment: Objectives, Scan Tools, Breakout Boxes, Non-Powered Test Lights, Logic Probes, Digital Volt-Ohmmeters (DVOMs), Digital Storage Oscilloscopes (DSOs), Safety Considerations When Using a DVOM or DSO, Gas Analyzers, Summary.

4. **Case & Duct System:** Construction & working of Air intake section, core section & distribution section. Construction & working of Downstream, upstream, split & hybrid. Construction & working of rear heating & cooling system Air Conditioning System : General layout of Air conditioning system, Construction & working of following refrigeration sub systems – thermostatic expansion valve, fixed orifice tube & rotary vane air cycle system, Construction & working of evaporator, condenser, accumulator. Receiver driers & accumulator- Types, construction & working, Construction & working of reciprocating, scroll & rotary vane compressors. Drive systems for compressors.

5. **Driver Assistance Systems:** Introduction, Gauges and Displays, Digital Instrumentation, Vision Systems, Visual Imaging Systems, System Examples, Head-up Display, Tire Pressure Monitoring Systems, Summary. Vehicle Communication Networks, Introduction, Multiplexing Communication Protocols, Supplemental Data Bus Networks, Summary. Driver and Passenger Comfort Systems, Introduction, Introduction to Automatic Temperature Control, ATC System Operation, Sensor Operation, Outputs, Output Controls, Feedback Signals, Thermoelectric, Summary.

6. **Electronic Stability and Rollover Mitigation Systems**: Introduction, Electronic Stability Program System Operation, Overview, Rollover Mitigation System Overview, Additional Optional Features, Sensors, Outputs, Summary. Supplemental Air Bag

Systems, Introduction, Air Bag Systems, Side-Impact Air Bag Systems, Overview, Air Bag System Sensors, ACM Overview, Rollover Protection Systems, Active Headrests, Summary.

Reference Books:

1. Computerized Engine Controls, Steve V. Hatch, Edition 8, Cengage Learning, 2008, ISBN 1428399968, 9781428399969 (http://books.google.co.in/books?id=14yiO4tp2jwC&printsec=frontcover#v=onepage&q=contents&f=false)
2. Automotive electricity and electronics, Today's technician, Barry Hollembeak, Jack Erjavec, Edition 2, Delmar Publishers, 1997, ISBN 0827376359, 9780827376359 (http://www.cengagebrain.co.uk/shop/content/hollembeak38147_1111038147_01.01_toc.pdf)
3. Automotive electronics and electrical equipment, William Harry Crouse, Edition 10, Gregg Division, McGraw-Hill, 1986, ISBN 0070148953, 9780070148956
4. Automotive tuneup, Automotive Technology Series, William Harry Crouse, Donald L. Anglin, Publisher McGraw-Hill Gregg Division, 1977, ISBN0070148104, 9780070148109
5. Automotive electrical and electronic systems, Frank C. Derato, Edition 2, Glencoe, 1994, ISBN 0028004124, 9780028004129 (http://www.amazon.co.uk/Automotive-Electrical-Electronic-Systems-Derato/dp/toc/0028004027)
6. Automobile Electronics and Basic Electrical Systems, Volume 1, Ken Layne. Wiley, 1989 ISBN 0471617636, 9780471617631 (http://www.pearsonhighered.com/educator/academic/product?ISBN=0130597759)
7. Automotive Air Conditioning, Boyce H. Dwiggins, Edition 8, Delmar Thomson Learning, 2001, ISBN 0766807886, 9780766807884
8. Automotive electrical and electronic systems, Volume 2, Harper & Row/Chek-Chart automotive series, Roger Fennema, Chek-Chart (Firm), Edition 2, HarperCollins Canada, Limited, 1987 ISBN 0064540146, 9780064540148 (http://www.pearsonhighered.com/educator/product/Automotive-Engine-Performance-Tuneup-Testing-and-Service-Volume-IIPractice-Manual/9780130611772.page)

Semester – III
Elective – III (602315)

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
602315	5	50	50	-	-	100	5

Modules of 2 Credits (Select any Two)			
Code No.	**Title**	**Code No.**	**Title**
AE2III – M1	Automotive Control Systems – I	AE2III – M5	Automotive Air Conditioning - I
AE2III – M2	Automotive Control Systems – II	AE2III – M6	Automotive Air Conditioning - II
AE2III – M3	Alternative Fuels – I	AE2III – M7	Industrial Tribology - I
AE2III – M4	Alternative Fuels – II	AE2III – M8	Industrial Tribology - I
Modules of 1 Credit (Select any One)			
Code No.	**Title**	**Code No.**	**Title**
AE1III – M9	Automotive Control Systems – III	AE1III – M11	Automotive Air Conditioning-III
AE1III – M10	Alternative Fuels – III	AE1III – M12	Industrial Tribology - I

Note: For e.g., AE2III - M1 indicates
AE – Automotive Engineering, 2 – 2 Credits, III – Elective III, M1 – Module 1
For e.g., AE1II-M10 indicates
AE – Automotive Engineering, 1 – 1 Credit, III – Elective III, M15 – Module 10

AE2 III – M1: Automotive Control Systems – I

1. **Planning & Measurement**: Instrumentation – Selection of measuring instrument, requirements of measurement such as precision, accuracy, errors, sensitivity, readability and reliability.
2. **Measurement of thermo physical properties:** Devices to measure temperature and pressure of the working fluid, coolant, air and fuel flow into the engine.
3. **Indicating and recording instruments:** Vibrometer, Accelerometer, vibration and pressure pickups, vibration test methods, Counters, stroboscopes, charge amplifiers, cathode ray oscillographs. FFT analyzer.

Textbook:

1. Engineering Experimentation – Ernest O. Doeblin
2. Experimental Methods for Engineers – Holman J.P., McGraw Hill Book Co.

References:

1. Measurement Systems, Applications & Design– Ernest Doeblin, McGraw Hill Book Co.
2. Modern Electric Equipments for Automobiles – Judge A. W., Chapman Hall, London
3. Applied Instrumentation in Process Industries – Andrews W. G.

AE2 III – M2: Automotive Control Systems – II

1. **Data acquisition and processing**:
   General data acquisition system examples, storage, processing, recording and display devices. Factors affecting engine and vehicle performance and their fuel consumption ISI

codes for testing automotive engines, Laboratory dynamometer testing systems of power train and vehicle under simulated conditions, Test tracks – Instrumentation for testing vehicles – for performance and endurance trails.

2. **Warning and alarm instruments:**
   Brake actuation warning system, traficators, flash system, oil pressure warning system, engine over heat warning system, air pressure warning system, speed warning system, door lock indicators, gear neutral indicator, horn design, permanent magnet horn, air & music horns.

Textbook:

1. Engineering Experimentation – Ernest O. Doeblin
2. Experimental Methods for Engineers – Holman J.P., McGraw Hill Book Co.

References:

1. Measurement Systems, Applications & Design – Ernest Doeblin, McGraw Hill Book Co.
2. Modern Electric Equipments for Automobiles – Judge A. W., Chapman Hall, London
3. Applied Instrumentation in Process Industries – Andrews W. G.

AE2 III – M3: Alternative Fuels – I

1. **Need for Alternative Fuels:**
   An introduction to hydrocarbon fuels, Estimate of petroleum reserve and availability, Petroleum refining process, Physio-chemical characteristics of fuels, fuel additives, Need for alternative fuels, applications, types, study of availability, manufacture, storage, handling and dispensing, safety aspects.
2. **Engine performance and Emission characteristics:**
   Principle of combustion, Engine performance parameters, Operating variables that affect SI and CI engine performance, efficiency and emissions, Emission formation in SI and CI engines - UBHC, NOx, CO, CO_2, Particulate emissions, Aldehydes, SOx. Emission effects on health and environment, Emission Norms.
3. **Alternative liquid fuels:**
   Alcohol fuels - ethanol & methanol, Vegetable oils, Fuel composition, Fuel induction techniques, Blending and fumigation of fuels, applications to engines.

Reference Books:

1. John B. Haywood, Internal Combustion Engine Fundamentals, McGraw-Hill Book Company, 1988
2. Richard L. Bechtold, Alternate Fuels – Transportation Fuels for Today and Tomorrow, Society of Automotive Engineers (SAE) - 2002
3. Thipse. S. S., Alternative Fuels; Concepts, Technologies and Developments, Publisher: Jaico Book Distributors.
4. "Alcohols as Motor Fuels", SAE, 1980
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. I Mech E, "Alternatively fuelled vehicles", 2000.

10. Sofer, Samir S. (ed.), Zaborsky, R. (ed.), "Biomass Conversion Processes for Energy and Fuels", New York, Plenum Press, 1981
11. Crouse, W.M. and. Anglin, A.L, 'Automotive Emission Control', McGraw Hill 1995.
12. Springer, G.S. and Patterson, D.J., 'Engine Emissions, pollutant formation', Plenum Press, 1986.
13. Patterson, D.J and Henin, N.A., 'Emissions from Combustion engines and their Control', Anna Arbor Science, 1985.
14. John Twidell and Tony Weir, Renewable Energy Resources, Taylor and Francis Group 2007

AE2 III – M4: Alternative Fuels – II

1. Gaseous fuels:

LPG and LNG, CNG, Producer gas, components, mixtures and kits, fuel supply system, Hydrogen combustion characteristics, safety aspects and system development, HCNG, Fuel cells, Introduction to Synthetic fuels: GTL, BTL.

2. Biofuels:

Oxygenated fuels, Biodiesel formulation techniques, Transesterification, Application in diesel engines, DME (Dimethyl ether), DEE (Diethyl ether), properties, fuel injection consideration. Biomass: generation, characterization, use as energy source, Biogas: aerobic and anaerobic bio-conversion processes, microbial reactions, purification, properties of biogas (composition and calorific value), Storage and enrichment.

Reference Books:

1. John B. Haywood, Internal Combustion Engine Fundamentals, McGraw-Hill Book Company, 1988
2. Richard L. Bechtold, Alternate Fuels – Transportation Fuels for Today and Tomorrow, Society of Automotive Engineers (SAE) - 2002
3. Thipse S. S., Alternative Fuels; Concepts, Technologies and Developments, Publisher: Jaico Book Distributors.
4. "Alcohols as Motor Fuels", SAE, 1980
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. I Mech E, "Alternatively fuelled vehicles", 2000.
10. Sofer, Samir S. (ed.), Zaborsky, R. (ed.), "Biomass Conversion Processes for Energy and Fuels", New York, Plenum Press, 1981
11. Crouse, W.M. and. Anglin, A.L, 'Automotive Emission Control', McGraw Hill 1995.
12. Springer, G.S. and Patterson, D.J., 'Engine Emissions, pollutant formation', Plenum Press, 1986.
13. Patterson, D.J and Henin, N.A., 'Emissions from Combustion engines and their Control', Anna Arbor Science, 1985.
14. John Twidell and Tony Weir, Renewable Energy Resources, Taylor and Francis Group 2007
15. G. N. Tiwari and M. K. Ghosal, Renewable Energy Resources Basic Principles and Application, Narosa Publishing House 2005.

AE2 III – M5: Automotive Air Conditioning – I

1. **Introduction** :
   Air Refrigeration System and its applications, Refrigerants for automotive applications, Automobile air conditioning, Air conditioning for passengers, isolated vehicles, transport vehicles, Applied Psychometric, Psychrometric processes using chart.
2. **Air Conditioning Systems:**
   Classification and layouts **,** Central / unitary air conditioning systems Components like compressors, evaporators, condensers, expansion devices, fan blowers, heating systems etc.
3. **Load Estimation**:
   Load Analysis, Outside & inside design consideration, Factors forming the load on air conditioning systems, Cooling & heating load calculations, Load calculations for Automobiles, Equivalent Temperature Difference Method, Cooling Load Temperature Difference, and Radiance Method, Effect of air conditioning load on engine performance, solar heat gain, study of various sources of the internal and external heat gains, heat losses, etc.

Reference books:

1. ASHRAE Handbooks
2. Norman C. Harris, Modern air conditioning
3. Handbook of Air Conditioning System Design, Carrier Incorporation, McGraw Hill Book Co., USA.
4. Trane air conditioning manual,
5. Jones W. P., Air conditioning Engineering, Edward Arnold Publishers Ltd, London, 1984.
6. Hainer R. W., Control System for Heating, Ventilation and Air Conditioning, Van Nastrand Reinhold Co., New York, 1984.
7. Refrigeration and Air conditioning- C P Arora, Tata McGraw Hill Publication,
8. New Delhi.
9. McQuiston, Faye; Parker, Jerald; Spitler, Jeffrey 2000, Heating, Ventilating and Air Conditioning-Analysis and Design, 5th ed. John Wiley & Sons.

AE2 III – M6: Automotive Air Conditioning – II

1. **Air Distribution**:
   Air Distribution Systems Fundamentals of air flow in ducts, pressure drop calculations, design ducts by velocity reduction method, equal friction method and static regain method, duct materials and properties, insulating materials, types of grills, diffusers, ventilation, noise level etc. Layout of duct systems for automobiles and their impact on load calculations, Air Routine & Temperature Control, evaporator care air glow through the dash recirculating unit, Automatic temperature control , Controlling flow, Control of air handling Systems.
2. **Sound Control**:
   Definitions of various terms like level, pitch, attenuation, frequency, sources of noise in air conditioning plants, design procedure for noise prevention, noise and vibration study and elimination techniques (description only).
3. **Ventilation and Infiltration**:
   Requirement of ventilation air, various sources of infiltration air, ventilation and infiltration as a part of cooling load. Fans and Blowers: Types, performance characteristics, series and parallel arrangement, selection procedure.

Reference books:

1. ASHRAE Handbooks
2. Norman C. Harris, Modern air conditioning
3. Handbook of Air Conditioning System Design, Carrier Incorporation, McGraw Hill Book Co., USA.
4. Trane air conditioning manual,
5. Jones W. P., Air conditioning Engineering, Edward Arnold Publishers Ltd, London, 1984.
6. Hainer R. W., Control System for Heating, Ventilation and Air Conditioning, Van Nastrand Reinhold Co., New York, 1984.
7. Refrigeration and Air conditioning- C P Arora, Tata McGraw Hill Publication, New Delhi.

AE2 III – M7: Industrial Tribology - I

1. Friction and wear:

Friction control and wear prevention, boundary lubrication, tribological properties of bearing materials and lubricants, theories of friction and wear, instabilities and stick-slip motion.

2. Lubrication of bearings:

Mechanics of fluid flow, Reynold's equation and its limitations, idealized bearings, infinitely long plane pivoted and fixed show sliders, infinitely long and infinitely short (narrow) journal bearings, lightly loaded infinitely long journal bearing (Petroff's solution), finite bearings - hydrostatic, hydrodynamic and thrust oil bearings, heat in bearings.

Reference Books

1. Cameron A., "Basic Lubrication Theory", Wiley Eastern Ltd.
2. B. C. Majumdar, "Introduction to Tribology and Bearings", S.Chand and Company Ltd. New Delhi
3. Fuller D. D., "Theory and Practice of Lubrication for Engineers", John Wiley and Sons
4. Halling J., "Principles of Tribology", McMillan Press Ltd.
5. B. Bhushan, B.K. Gupta, "Handbook of tribology: materials, coatings and surface treatments", McGraw-Hill
6. V.B. Bhandari., "Design of Machine Elements" Tata McGraw Hill Pvt Ltd.

AE2 III – M8: Industrial Tribology -II

1. Hydrostatic squeeze film:

Circular and rectangular flat plates, variable and alternating loads, piston pin lubrications, application to journal bearings.

2. Elasto-hydrodynamic lubrication:

Pressure-viscosity term in Reynold's equation, hertz theory, Ertel-Grubin equation, lubrication of spheres.

Reference Books

1. Cameron A., "Basic Lubrication Theory", Wiley Eastern Ltd.
2. B. C. Majumdar, "Introduction to Tribology and Bearings", S.Chand and Company Ltd. New Delhi
3. Fuller D. D., "Theory and Practice of Lubrication for Engineers", John Wiley and Sons
4. Halling J., "Principles of Tribology", McMillan Press Ltd.
5. B. Bhushan, B.K. Gupta, "Handbook of tribology: materials, coatings and surface treatments", McGraw-Hill
6. V.B. Bhandari., "Design of Machine Elements" Tata McGraw Hill Pvt Ltd.

AE2 III – M9: Automotive Control Systems – III

1. **Dash board amenities:**
   Car radio and stereo, courtesy lamp, time piece, cigar lamp,
   car fan, wind shield wiper, window washer, instrument wiring system and electromagnetic interference suppression, wiring circuits for instruments, electronic instruments, dash board illumination.

Textbook:

a. Engineering Experimentation – Ernest O. Doeblin
b. Experimental Methods for Engineers – Holman J.P., McGraw Hill Book Co.

References:

1. Measurement Systems, Applications & Design – Ernest Doeblin, McGraw Hill Book Co.
2. Modern Electric Equipments for Automobiles – Judge A. W., Chapman Hall, London
3. Applied Instrumentation in Process Industries – Andrews W. G

AE2 III – M10: Alternative Fuels – III

Engine Modifications:

1. Bi-fuel, Dual fuel automotive engine conversions, Engine/vehicle modifications required for alternative fuels and durability. Introduction to HCCI, PCCI engines. Discussion on Electric, Solar, Hybrid, Air and Water vehicles.

Reference books:

1. John B.Haywood, Internal Combustion Engine Fundamentals, McGraw-Hill Book Company, 1988
2. Richard L. Bechtold, Alternate Fuels – Transportation Fuels for Today and Tomorrow, Society of Automotive Engineers (SAE) - 2002
3. Thipse S. S., Alternative Fuels; Concepts, Technologies and Developments, Publisher: Jaico Book Distributors.
4. "Alcohols as Motor Fuels", SAE, 1980
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. I Mech E, "Alternatively fuelled vehicles", 2000.
10. Sofer, Samir S. (ed.), Zaborsky, R. (ed.), "Biomass Conversion Processes for Energy and Fuels", New York, Plenum Press, 1981
11. Crouse, W.M. and. Anglin, A.L, 'Automotive Emission Control', McGraw Hill 1995.
12. Springer, G.S. and Patterson, D.J., 'Engine Emissions, pollutant formation', Plenum Press, 1986.

AE2 III – M11: Automotive Air Conditioning - III

1. **Air Conditioning Equipments and Controls**:
   Chillers, Condensing units, Cooling coils, bypass factors, Air Conditioning Controls, humidifiers, dehumidifiers, various types of filters, air washers, thermostat, humidistat,

control dampers, Pressure cut-outs and relays cycling and sequence controls, modern control of parity, odour and bacteria, Air filtration- Study of different types of filters. .Air conditioner maintenance & service - servicing heater system. Removing & replacing components, Trouble shooting of air conditioning system Compressor service, methods of dehydration, charging & testing.

2. **Automotive Air conditioning systems**:
   Classification, central and unitary systems, design of typical air conditioning systems for automobile, warm air system, hot water systems.

Reference books:

1. ASHRAE Handbooks
2. Norman C. Harris, Modern air conditioning
3. Handbook of Air Conditioning System Design, Carrier Incorporation, McGraw Hill Book Co., USA.
4. Trane air conditioning manual,
5. Jones W. P., Air conditioning Engineering, Edward Arnold Publishers Ltd, London, 1984.
6. Hainer R. W., Control System for Heating, Ventilation and Air Conditioning, Van Nastrand Reinhold Co., New York, 1984.
7. Refrigeration and Air conditioning- C P Arora, Tata McGraw Hill Publication, New Delhi.
8. McQuiston, Faye; Parker, Jerald; Spitler, Jeffrey 2000, Heating, Ventilating and Air Conditioning-Analysis and Design, 5th ed. John Wiley & Sons.

AE2 III – M12: Industrial Tribology - III

1. **Air lubricated bearings:**
   Tilting pad bearings, hydrostatic, hydrodynamic and thrust bearings with air lubrication.
2. **Tribological aspects of rolling motion:**
   Mechanics of tire-road interaction, road grip and rolling resistance, tribological aspects of wheel on rail contact, tribological aspects of metal rolling, drawing and extrusion.

Reference Books

7. Cameron A., “Basic Lubrication Theory“, Wiley Eastern Ltd.
8. B. C. Majumdar, “Introduction to Tribology and Bearings“, S.Chand and Company Ltd. New Delhi
9. Fuller D. D., “Theory and Practice of Lubrication for Engineers“, John Wiley and Sons
10. Halling J., “Principles of Tribology“, McMillan Press Ltd.
11. B. Bhushan, B.K. Gupta, “Handbook of tribology: materials, coatings and surface treatments”, McGraw-Hill
12. V.B. Bhandari., “Design of Machine Elements” Tata McGraw Hill Pvt Ltd.

Project Stage – I and II [602317, 602319]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
602317	8	-	-	50	50	100	8
602319	20	-	-	150	50	200	20

Assessment of Project stage-I has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System.

INSTRUCTIONS FOR DISSERTATION WRITING

It is important that the procedures listed below be carefully followed by all the students of M.E. (Mechanical Engineering).

1. Prepare **Three Hard Bound Copies** of your manuscript.

2. Limit your Dissertation report to 80 – 120 pages (preferably)

3. The footer must include the following:
   Institute Name, M.E. Mechanical (Automotive Engineering) Times New Roman 10 pt. and centrally aligned.

4. Page number as second line of footer, Times New Roman 10 Pt, centrally aligned.

5. Print the manuscript using
   a. Letter quality computer printing.
   b. The main part of manuscript should be Times New Roman 12 pt. with alignment - justified**.**
   c. Use 1.5 line spacing.
   d. Entire report shall be of 5- 7 chapters.

6. Use the paper size **8.5'' × 11''** or **A4 (210 × 197 mm).** Please follow the margins given below.

Margin Location	Paper 8.5'' × 11''	Paper A4 (210 × 197 mm)
Top	1''	25.4 mm
Left	1.5''	37 mm
Bottom	1.25''	32 mm
Right	1''	25.4 mm

7. All paragraphs will be 1.5 line spaced with a one blank line between each paragraph. Each paragraph will begin with without any indentation.

8. Section titles should be bold with 14 pt typed in all capital letters and should be left aligned.

9. Sub-Section headings should be aligning at the left with 12 pt, bold and Title Case (the first letter of each word is to be capitalized).

10. Illustrations (charts, drawings, photographs, figures) are to be in the text. Use only illustrations really pertinent to the text. Illustrations must be sharp, clear, **black and white. Illustrations downloaded from internet are not acceptable.**
    a. Illustrations should not be more than **two** per page. One could be ideal
    b. Figure No. and Title at bottom with **12 pt**
    c. Legends below the title in **10 pt**
    d. Leave proper margin in all sides
    e. Illustrations as far as possible should not be photo copied.

11. **Photographs** if any should of glossy prints

12. Please use **SI** system of units only.

13. Please **number the pages** on the front side, centrally below the footer

14. **References** should be either in order as they appear in the thesis or in alphabetical order by last name of first author

15. **Symbols** and **notations** if any should be included in nomenclature section only

16. Following will be the order of report
    i. **Cover page** and **Front page** as per the specimen on separate sheet
    ii. **Certificate** from the Institute as per the specimen on separate sheet
    iii. **Acknowledgements**
    iv. **List of Figures**
    v. **List of Tables**
    vi. **Nomenclature**
    vii. **Contents**
    viii. **Abstract** (A brief abstract of the report not more than **150 words**. The heading of abstract i.e. word "Abstract" should be **bold, Times New Roman, 12 pt** and should be typed at the **centre.** The contents of abstract should be typed on new line without space between heading and contents. Try to include one or two sentences each on **motive, method, key-results** and **conclusions** in Abstract

1 Introduction (2-3 pages) (TNR – 14 Bold)
1.1 Problem statement (TNR – 12)
1.2 Objectives
1.3 Scope
1.4 Methodology
1.5 Organization of Dissertation

2 Literature Review (20-30 pages)
Discuss the work done so far by researchers in the domain area and their significant conclusions. No derivations, figures, tables, graphs are expected.

3 This chapter shall be based on your own simulation work (Analytical/ Numerical/FEM/CFD) (15- 20 pages)

4 Experimental Validation - This chapter shall be based on your own experimental work (15-20 pages)

5 Concluding Remarks and Scope for the Future Work (2-3 pages)

References

ANNEXURE (if any)
(Put all mathematical derivations, Simulation program as Annexure)

17. All section headings and subheadings should be numbered. For sections use numbers **1, 2, 3, ….** and for subheadings **1.1**, **1.2**, **….** etc and section subheadings **2.1.1**, **2.1.2, ….** etc.

18. **References** should be given in the body of the text and well spread. No verbatim copy or excessive text from only one or two references. If **figures** and **tables** are taken from any reference then indicate source of it. Please follow the following procedure for references

Reference Books

Collier, G. J. and Thome, J. R., Convective boiling and condensation, 3rd ed., Oxford University Press, UK, 1996, pp. 110 – 112.

Papers from Journal or Transactions

Jung, D. S. and Radermacher, R., Transport properties and surface tension of pure and mixed refrigerants, *ASHRAE Trans*, 1991, 97 (1), pp. 90 – 98.

Bansal, P. K., Rupasinghe, A. S. and Jain, A. S., An empirical correction for sizing capillary tubes, *Int. Journal of Refrigeration*, 1996, 19 (8), pp.497 – 505.

Papers from Conference Proceedings

Colbourne, D. and Ritter, T. J., *Quantitative assessment of flammable refrigerants in room air conditioners*, Proc. of the Sixteenth International Compressor Engineering Conference and Ninth International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, Indiana, USA, 2002, pp. 34 – 40.

Reports, Handbooks etc.

United Nations Environmental Programme, Report of the Refrigeration, Air Conditioning and Heat Pumps, Technical Option Committee, 2002, Assessment - 2002.

ASHRAE Handbook: Refrigeration, 1994 (Chapter 44)

Patent

Patent no, Country (in parenthesis), date of application, title, year.

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