NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

DEPARTMENT OF MECHANICAL ENGINEERING

SCHEME OF INSTRUCTION AND SYLLABI

FOR M.TECH. PROGRAM IN

AUTOMOBILE ENGINEERING

Effective from 2014-15

NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

VISION

Towards a Global Knowledge Hub, striving continuously in pursuit of excellence in Education, Research, Entrepreneurship and Technological services to the society

MISSION

- Imparting total quality education to develop innovative, entrepreneurial and ethical future professionals fit for globally competitive environment.
- Allowing stake holders to share our reservoir of experience in education and knowledge for mutual enrichment in the field of technical education.
- Fostering product oriented research for establishing a self-sustaining and wealth creating centre to serve the societal needs.

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

To be a global knowledge hub in mechanical engineering education, research, entrepreneurship and industry outreach services.

MISSION

- Impart quality education and training to nurture globally competitive mechanical engineers.
- Provide vital state-of-the-art research facilities to create, interpret, apply and disseminate knowledge.
- Develop linkages with world class educational institutions and R&D organizations for excellence in teaching, research and consultancy services.

GRADUATE ATTRIBUTES

The Graduate Attributes are the knowledge skills and attitudes, which the students have at the time of graduation. These attributes are generic and are common to all engineering programs. These Graduate Attributes are identified by National Board of Accreditation.

1. **Scholarship of Knowledge**: Acquire in-depth knowledge of various manufacturing processes on a wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.
2. **Critical Thinking**: Analyze complex engineering problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.
3. **Problem Solving**: Think laterally and originally, conceptualize and solve manufacturing engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, societal and environmental factors in the core areas of expertise.
4. **Research Skill**: Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.
5. **Usage of modern tools**: Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.
6. **Collaborative and Multidisciplinary work**: Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.
7. **Project Management and Finance**: Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economic and financial factors.
8. **Communication**: Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to

comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

9. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
10. **Ethical Practices and Social Responsibility**: Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
11. **Independent and Reflective Learning**: Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

CURRICULAR COMPONENTS FOR ALL M. TECH. PROGRAMS IN MECHANICAL ENGINEERING

Category	**Sem – I**	**Sem – II**	**Sem – III**	**Sem – IV**	**Total No. of credits to be earned**
Core courses	16	12	--	--	**28**
Electives	06	09	--	--	**15**
Lab Courses	04	04	--	--	**08**
Comprehensive Viva-Voce	--	--	04	--	**04**
Seminar	--	02	--	--	**02**
Dissertation	--	--	08	18	**26**
Total	**26**	**27**	**12**	**18**	**83**

DEPARTMENT OF MECHANICAL ENGINEERING

M.TECH IN AUTOMOBILE ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES

Program Educational Objectives (PEOs) are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve. They must be consistent with the mission of the Institution and Department. Department faculty members must continuously work with stakeholders (local employers, industry and RD advisors, and the alumni) to review the PEOs and update them periodically. The number of PEOs should be manageable and small in number, say 4±1, and should be achievable by the program.

PEO1	Apply concepts of engineering to analyze automotive systems.
PEO2	Develop innovative automotive technologies to address specific needs of performance, comfort, safety and eco-friendliness.
PEO3	Apply computational tools for comprehensive understanding of the complex systems in automotive engineering.
PEO4	Communicate effectively and support constructively towards team work
PEO5	Engage in lifelong learning for career and professional growth with ethical concern for society and the environment

MAPPING OF MISSION STATEMENTS WITH PROGRAM EDUCATIONAL OBJECTIVES:

Mission	PEO1	PEO2	PEO3	PE04	PEO5
Impart quality education and training to nurture globally competitive mechanical engineers.	3	3	3	2	2
Provide vital state of the art research facilities to create, interpret, apply and disseminate knowledge.	3	2	3	2	2
Develop linkages with world class educational institutions and R&D organizations for excellence in teaching, research and consultancy services.	3	2	2	3	3

1: Slightly 2: Moderately 3: Substantially

MAPPING OF PROGRAM EDUCATIONAL OBJECTIVES WITH GRADUATE ATTRIBUTES:

PEO	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11
PEO1	2	1	1	1	-	-	2	1	1	1	-
PEO2	2	2	2	3	2	2	1	1	1	1	1
PEO3	2	3	2	3	2	2	1	1	1	1	1
PEO4	1	1	1	2	1	2	2	3	1	1	1
PEO5	1	1	2	1	1	-	1	1	1	1	1

1: Slightly 2: Moderately 3: Substantially

PROGRAM OUTCOMES:

Program Outcomes: as per NBA, are narrower statements that describe what the students are expected to know and be able to do upon the graduation. These relate to the knowledge, skills and behavior the students acquire through the program. The Program Outcomes (PO) are specific to the program and should be consistent with the Graduate Attributes and facilitate the attainment of PEOs.

At the end of the program the student will be able to:

PO1	Understand the basic layout of an automobile with an emphasis on prime mover.
PO2	Understand the principles and operation of modern automotive transmission system.
PO3	Develop emission control strategies to comply with national/international norms
PO4	Analyze stability of vehicle under dynamic conditions.
PO5	Evaluate vehicle performance as per driving cycles and emission norms.
PO6	Design automotive components and body panels.
PO7	Identify and apply sensors and actuators for better control of automobiles.
PO8	Apply computational techniques for optimal design of automotive components.
PO9	Translate competencies to support team efforts
PO10	Engage in lifelong learning for career and professional growth with ethical concern fo society and the environment.

MAPPING OF PROGRAM OUTCOMES WITH PROGRAM EDUCATIONAL OBJECTIVES

	PE01	PE02	PE03	PE04	PE05
PO1	3	1	1	1	1
PO2	3	3	2	-	1
PO3	2	1	1	1	2
PO4	1	2	3	1	1
PO5	1	1	3	-	2
PO6	2	3	2	1	1
PO7	1	2	1	-	1
PO8	1	3	3	-	1
PO9	-	1	-	3	2
PO10	1	1	1	2	3

1: Slightly 2: Moderately 3: Substantially

SCHEME OF INSTRUCTION

M.TECH (AUTOMOBILE ENGINEERING) COURSE STRUCTURE

I - Year I – Semester

S. No	Course Code.	Course Title	L	T	P	Credits	Cat. Code
1	ME5501	Automotive Engineering	4	0	0	4	PCC
2	ME5502	Prime Movers for Automobiles	4	0	0	4	PCC
3	ME5403	Advanced Mechanical Vibrations	4	0	0	4	PCC
4	ME5404	Advanced CAD	4	0	0	4	PCC
5		Elective – 1	3	0	0	3	DEC
6		Elective – 2	3	0	0	3	DEC
7	ME5406	CAD Laboratory	0	0	3	2	PCC
8	ME5503	Computational Laboratory	0	0	3	2	PCC
Total			**22**	**0**	**6**	**26**	

I - Year II – Semester

S. No.	Course Code.	Course Title	L	T	P	Credits	Cat. Code
1	ME5551	Automotive Body Structures	4	0	0	4	PCC
2	ME5452	Finite Element Analysis in Design	4	0	0	4	PCC
3	ME5456	Vehicle Dynamics	4	0	0	4	PCC
4		Elective – 3	3	0	0	3	DEC
5		Elective – 4	3	0	0	3	DEC
6		Elective – 5	3	0	0	3	DEC
7	ME5553	Automotive Engines Laboratory	0	0	3	2	PCC
8	ME5554	Simulation Laboratory	0	0	3	2	PCC
9	ME5591	Seminar	0	0	3	2	PCC
Total			**21**	**0**	**9**	**27**	

II - Year I – Semester

S. No.	Course Code.	Course Title	Credits	Cat. Code
1	ME6542	Comprehensive Viva – Voce	4	PCC
2	ME6549	Dissertation - Part A	8	PCC
Total			**12**	

II - Year II - Semester

S. No.	Course Code.	Course Title	Credits	Cat. Code
1	ME6599	Dissertation - Part B	18	PCC
Total			**18**	

LIST OF ELECTIVES

I Semester

ME5511	Alternative Fuels and Emissions
ME5316	Manufacturing Management
ME5411	Mechanical Behavior of Materials
ME5412	Optimization Methods for Engineering
ME5415	Condition Monitoring
ME5416	Robust Design

II Semester

ME5561	Vehicle Testing and Instrumentation
ME5563	Automotive Electronics
ME5564	Advanced Materials and Sensors for Automobiles
ME5169	Computational Fluid Dynamics
ME5361	Supply Chain Management
ME5371	Mechatronics
ME5463	Tribology in Design
ME5466	Reliability Engineering
ME5469	Automotive Component Design

DETAILED SYLLABUS

ME5501	AUTOMOTIVE ENGINEERING	PCC	4 - 0 - 0	4 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Understand the types of vehicle layout, engine cooling, lubrication and ignition systems.
CO2	Outline the functions and components of clutch.
CO3	Describe working of fluid couplings and torque converters.
CO4	Explain the working of gear box and its types.
CO5	Explain the requirements of axles, final drive, differential, steering systems and suspension systems.
CO6	Outline the design features of brakes, tires, lighting and accessories.

CO-PO MAPPING:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3		1		2	1	1	1	
CO2	1	3			1	2		3		2
CO3			2	1		2				
CO4		3				1			2	
CO5		2		3	2	2			1	1
CO6	2	3		2		1			1	1

DETAILED SYLLABUS:

Introduction: Overview of the course, Examination and Evaluation patterns, History of Automobiles, Classification of Automobiles.

Power Plant: Classification, Engine Terminology, Types of Cycles, working principle of an IC engine, advanced classification of Engines- Multi cylinder engines, Engine balance, firing order.

Fuel System and Ignition System and Electrical system: spark Ignition engines-Fuel tank, fuel filter, fuel pump, air cleaner/filter, carburettor, direct injection of petrol engines. Compression Ignition engines, Fuel Injection System- air & solid injection system, Pressure charging of engines, super charging and turbo charging, Components of Ignition systems, battery ignition system, magneto ignition system, electronic ignition and ignition timing. Main electrical circuits, generating & stating circuit, lighting system, indicating devices, warning lights, speedometer.

Lubricating system and cooling systems: Functions & properties of lubricants, methods of lubrication-splash type, pressure type, dry sump, and wet sump & mist lubrication. Oil filters, oil pumps, oil coolers. Characteristics of an effective cooling system, types of cooling system, radiator, thermostat, air cooling & water cooling.

Transmission, axles, clutches, propeller shafts and differential: Types of gear boxes, automatic transmission, electronic transmission control, functions and types of front and rear axles, types and functions, components of the clutches, fluid couplings, design considerations of Hotchkiss drive torque tube drive, function and parts of differential and traction control.

Steering System: functions of steering mechanism, steering gear box types, wheel geometry.

Breaking and suspension system: functions and types of brakes, operation and principle of brakes, constructional and operational classification and parking brake. Types of springs shock observers, objectivesand types of suspension system, rear axles suspension, electronic control and proactive suspension system.

Wheels and tyres: Wheel quality, assembly, types of wheels, wheel rims. Construction of tyres and tyre specifications.

READING:

1. Srinivasan.S, Automotive Mechanics, 2nd Edition, Tata McGraw-Hill, 2003
2. Crouse and Anglin, Automotive Mechanism, 9th Edition. Tata McGraw-Hill, 2003.
3. Jack Erjavec, A Systems Approach to Automotive Technology, Cengage Learning Pub., 2009
4. Kirpal Singh, Automobile Engineering, Vol.1 and 2, Standard Publishers, New Delhi, 2003.

ME5502	PRIME MOVERS FOR AUTOMOBILES	PCC	4 - 0 - 0	4 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Understand the importance of IC engine as a prime mover and compare its performance on the basis of thermodynamic cycles and combustion process.
CO2	Estimate engine performance and emission parameters.
CO3	Identify harmful IC engine emissions and use viable alternate fuels in engines.
CO4	Classify electric vehicles based on batteries, electric motors and alternate power sources.
CO5	Analyze batteries and electric motors commonly used in electric/hybrid vehicles.

CO - PO MAPPING:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	3		3		2	1		2
CO2	3		2	2	3		1		3	2
CO3	3	1	3	3	3		2	2	2	2
CO4	3	3	3	2	3	2	3	2	3	
CO5	3		2	2	3	2	2		2	

DETAILED SYLLABUS:

Introduction to IC engines: Overview of the course, Examination and Evaluation patterns-Classification of Prime Movers; IC Engines as Prime Movers; Historical Perspective-Contribution of IC Engines for Global Warming. Concept of charge, Differences between EC Engines and IC Engines-Classification, Mechanical cycle and Thermodynamic cycle, Air standard cycles-Diesel, Otto, Dual and Miller cycles.Classification of 2-s cycle engines based on scavenging, Differences between 2-s and 4-s cycle engines, Differences between SI and CI engines.

Two-stroke engines: Definition of parameters-Scavenging Efficiency, Delivery ratio and trapping Efficiency, Theoretical Scavenging Processes-Practical Scavenging Systems-Kadenacy effect-Numerical problems on 2-stroke cycle engines

Spark Ignition Engines: Flame Propagation- Combustion phenomena (Normal and Abnormal), Factors affecting, Detonation, Ignition quality, HUCR-Carburetion and fuel injection systems for SI Engines

Compression Ignition Engines: Advantages of CI engines-Importance of air motion and Compression Ratio, Mixture Preparation inside the CC. Normal and abnormal combustion - Ignition Quality-Cetane number-Characteristics of a Good Combustion Chamber-Classification of Combustion Chambers(DI and IDI).Description of Fuel injection Systems -Individual, Unit and Common Rail (CRDI),Fuel Injectors-Nozzle types, Electronic Control Unit(ECU)-Numerical problems on fuel injection

Supercharging of IC Engines: Need of Supercharging and advantages, Configurations of Supercharging-Numerical problems on turbocharging.

Pollutant emissions from IC Engines: Introduction to clean air, Pollutants from SI and CI Engines: Carbon monoxide, UBHCs, Oxides of nitrogen(NO-NO_X) and Particulate Matter.Mechanism of formation of pollutants, Factors affecting pollutant formation.Measurement of engine emissions-instrumentation, Pollution Control Strategies, Emission norms-EURO and Bharat stage norms.

Performance of IC Engines: Classification of engine performance parameters-Measurement of brake power, indicated power and friction power.Factors affecting performance, Heat loss, Air-fuel ratio, Pumping loss, Energy Balance: Pi and Sankey diagrams Numerical problems.

Alternate Fuels: Need for Alternate fuels, Desirable Characteristics of good Alternate Fuel-Liquid and Gaseous fuels for SI and CI Engines, Kerosene, LPG, Alcohols, Bio-fuels, Natural gas, Hydrogen and use of these fuels in engines.

Electric vehicles: Introduction: Limitations of IC Engines as prime mover, History of EVs, EV system, components of EV-DC and AC electric machines: Introduction and basic structure-Electric vehicle drive train-advantages and limitations, Permanent magnet and switched reluctance motors-EV motor sizing: Initial acceleration, rated vehicle velocity, Maximum velocity and maximum gradeability

Hybrid vehicle: Configurations of hybrids, advantages and limitations-Hybrid drive trains, sizing of components Initial acceleration, rated vehicle velocity, Maximum velocity and maximum gradeability-Hydrogen: Production-Hydrogen storage systems-reformers

Batteries: Battery: lead-acid battery, cell discharge and charge operation, construction, advantages of lead- acid battery- Battery parameters: battery capacity, discharge rate, state of charge, state of discharge, depth of discharge, Technical characteristics-Ragone plots.

Fuel Cell vehicles: Fuel cells: Introduction-Fuel cell characteristics, Thermodynamics of fuel cells-Fuel cell types: emphasis on PEM fuel cell

READING:

1. J.B. Heywood *Internal Combustion Engine Fundamentals,* McGraw Hill Co.1988
2. W.W.Pulkrabek *Engineering Fundamentals of IC Engine*, PHI Pvt.Ltd 2002
3. Seth Leitman and Bob Brant *Build your own electric vehicle* McGraw Hill Co.2009.
4. F.Barbir *PEM Fuel Cells-Theory and Practice* Elsevier Academic Press-2005.

ME5403	ADVANCED MECHANICAL VIBRATIONS	PCC	4 - 0 - 0	4 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Understand the causes and effects of vibration in mechanical systems and their classification.
CO2	Develop schematic models for physical systems and formulate governing equations o motion.
CO3	Understand the role of damping, stiffness and inertia in mechanical systems
CO4	Analyse rotating and reciprocating systems and design machine supporting structures, vibration isolators and absorbers
CO5	Calculate free and forced vibration responses of multi degree freedom systems using modal analysis
CO6	Analysis and design for the control/ to reduce vibration effects in machinery.

CO - PO MAPPING:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	-	-	-	2	-	-	-	-	-	1
CO2	-	-	-	2	2	-	-	-	-	1
CO3	-	-	-	2	2	-	-	-	-	1
CO4	-	-	-	3	2	-	-	3	-	1
CO5	-	-	-	3	3	-	-	3	-	1
CO6	-	-	-	3	3	-	-	3	-	1

DETAILED SYLLABUS:

Introduction: Causes and effects of vibration, Classification of vibrating system, Discrete and continuous systems, degrees of freedom, Identification of variables and Parameters, Linear and nonlinear systems, linearization of nonlinear systems, Physical models, Schematic models and Mathematical models.

SDF systems: Formulation of equation of motion: Newton –Euler method, De Alembert's method, Energy method,

Free Vibration: Undamped Free vibration response, Damped Free vibration response, Case studies on formulation and response calculation. Forced vibration response of SDF systems: Response to harmonic excitations, solution of differential equation of motion, Vector approach, Complex frequency response, Magnification factor Resonance, Rotating/reciprocating unbalances.

Dynamics of Rotors: Whirling of rotors, Computation of critical speeds, influence of bearings, Critical speeds of Multi rotor systems.

Design case studies: design case studies dealing with Transmissibility of forces and motion Trans, Vehicular suspension, Analysis of Vehicles as single degree of freedom systems - vibration transmitted due to unevenness of the roads, preliminary design of automobile suspension. Design of machine foundations and isolators.

Two degree of freedom systems: Introduction, Formulation of equation of motion: Equilibrium method, Lagrangian method, Case studies on formulation of equations of motion, Free vibration response, Eigen values and Eigen vectors, Normal modes and mode superposition, Coordinate coupling, decoupling of equations of motion, Natural coordinates, Response to initial conditions, coupled pendulum, free vibration response case studies, Forced vibration response, Automobile as a two degree of freedom system –bouncing and pitching modes undamped vibration absorbers, Case studies on identification of system parameters and design of undamped vibration absorbers.Analysis and design of damped vibration absorbers.

Multi degree of freedom systems: Introduction, Formulation of equations of motion, Free vibration response, Natural modes and mode shapes, Orthogonally of model vectors, normalization of model vectors, Decoupling of modes, model analysis, mode superposition technique, Free vibration response through model analysis, Forced vibration analysis through model analysis, Model damping, Rayleigh's damping, Introduction to experimental model analysis.

Continuous systems: Introduction to continuous systems,discretevs continuous systems. Exact and approximate solutions, free vibrations of bars and shafts, Free vibrations of beams, Forced vibrations of continuous systems Case studies, Approximate methods for continuous systems and introduction to Finite element method.
Vibration Control in structures: Introduction, , State space representation of equations of motion, Passive control, active control and semi active control o, Free layer and constrained damping layers, Piezo electric sensors and actuators for active control, semi active control of automotive suspension sytems..

READING:

1. L. Meirovich, Elements of Vibration analysis, 2nd Ed. Tata Mc-Grawhill 2007
2. Singiresu S Rao, Mechanical Vibrations. 4th Ed. , Pearson education 2011
3. W.T., Thompson, Theory of Vibration,. CBS Publishers
4. Clarence W. de Silva , Vibration: Fundamentals and Practice, CRC Press LLC, 2000

ME5404	ADVANCED CAD	PCC	4 - 0 - 0	4 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Understand geometric transformation techniques in CAD.
CO2	Develop mathematical models to represent curves.
CO3	Design surface models for engineering applications.
CO4	Model engineering components using solid modeling techniques.
CO5	Design and analysis of engineering components.

CO-PO MAPPING:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	-	1	-	1	-	2	-	1	-	2
CO2	-	1	-	2	-	2	-	1	-	3
CO3	-	2	-	3	-	3	-	1	-	3
CO4	-	2	-	3	-	3	-	2	-	3
CO5	-	1	-	3	-	3	-	2	-	3

DETAILED SYLLABUS:

Introduction to CAD: Introduction to CAD, CAD input devices, CAD output devices, CAD Software, Display Visualization Aids, and Requirements of Modelling.

2D Transformations of geometry: 2D Translation, 2D Scaling, 2D Reflection, 2D Rotation, Homogeneous representation of transformation, Concatenation of transformations.

3D Transformations of geometry and Projections: 3D Translation, 3D Scaling, 3D Reflection, 3D Rotation, Homogeneous representation of transformation, Concatenation of transformations, Perspective, Axonometric projections, Orthographic and Oblique projections.

Design of Curves: Analytic Curves, PC curve, Ferguson, Composite Ferguson, curve Trimming and Blending, Bezier segments, de Casteljau's algorithm, Bernstein polynomials, Bezier-subdivision, Degree elevation, Composite Bezier, Splines, Polynomial Splines, B-spline basis functions, Properties of basic functions, Knot Vector generation, NURBS.

Design of Surfaces: Differential geometry, Parametric representation, Curves on surface, Classification of points, Curvatures, Developable surfaces, Surfaces of revolution, Intersection of surfaces, Surface modelling, 16-point form, Coons patch, B-spline surfaces.

Design of Solids: Solid entities, Boolean operations, B-rep of Solid Modelling, CSG approach of solid modelling, Advanced modelling methods.

Data Exchange Formats and CAD Applications: Data exchange formats, Finite element analysis, reverse engineering, modelling with point cloud data,Rapid prototyping.

READING:

1. Ibrahim Zeid and Sivasubramanian, R., CAD/CAM Theory and Practice, Tata McGraw Hill Publications, New Delhi, 2009.
2. David F. Rogers, J. A. Adams, Mathematical Elements for Computer Graphics, TMH, 2008.

ME5511	ALTERNATE FUELS AND EMISSIONS	DEC	3 - 0 - 0	3 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Identify the need of alternate fuels and list out some prospective alternate fuels
CO2	Categorize, interpret and understand the essential properties of fuels for petrol and diesel engines
CO3	Infer the storage and dispensing facilities requirements
CO4	Analyze the implementation limits with regard to performance, emission and materials compatibility
CO5	Identify and understand possible harmful emissions and the legislation standards

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	-	-	-	-	1	-	-	-	1	1
CO2	1	-	-	-	2	1	-	-	1	1
CO3	-	-	3	-	-	-	1	-	1	1
CO4	1	-	-	-	3	2	-	2	1	1
CO5	-	-	3	-	1	2	1	-	1	1

DETAILED SYLLABUS:

Introduction: Estimation of petroleum reserve – Need for alternate fuels – Availability and properties of alternate fuels, ASTM standards

Alcohols: General Use of Alcohols – Properties as Engine fuel – Gasolene and alcohol blends – Performance in SI Engine – Methanol and Gasolene blend – Combustion Characterstics in engine – emission characterstics

Vegetable oils: Soyabeen Oil, Jatropha, Pongamia, Rice bran, Mahuaetc as alternate fuel and their properties, Esterification of oils

Natural Gas, LPG: Availability of CNG, properties, modification required to use in engines – performance and emission characterstics of CNG using LPG in SI & CI engines.

Hydrogen :hydrogen production, Hydrogen as an alternative fuel, fuel cell

Biogas

Electric and Solar powered vehicles: Layout of an electric vehicle – advantage and limitations-specificatios –system component – electronic control system – High energy and power density batteries – Hybrid vehicle – solar powered vehicles

Automobile emissions & its control: need for emission control -Classification/ categories of emissions -Major pollutants - control of emissions – Evaluating vehicle emissions – EURO I,II,III,IV standards – Indian standards

READING:

1. Alternate Fuels : Emissions, Economics, and performance Authors: Maxwell, Timothy .T, and Jesseco Jones, Publisher: Society of Automotive Engineers, 1995
2. Hydrogen fuel for surface transportation, Authors: Norbeck, Joseph M., Publisher: Society of Automotive Engineers, 1996
3. History of the Electric Automobiles: Hybrid Electric Vehicles, Authors: Wakefield, Earnest Henry
4. Engine Emissions: Pollutant formation and advances in control Technology, Authors: NorbePundir B.R., Publisher: Narosa Publishing House
5. Air Pollution and its Control, Authors: S.C. Bhatia, Publisher: Atlantic Publications, 2007
6. Automotive Fuel and Emission Control system, Authors: James D. Halderman, James Linder, Publisher: Prentice Hall

ME5316	MANUFACTURING MANAGEMENT	DEC	3 - 0 - 0	3 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Identify key decision variable for operation managers and researchers, stating Competitive priorities and strategic emphasis for efficient management and production systems
CO2	Calculate and interpret Demand Forecast.
CO3	Design and Selection of optimum facility layout, product design approaches.
CO4	Analyze inventory and associated problems, interpretation of MRP systems.
CO5	Design a process flow and Production scheduling systems for jobshop/flow shop industries.

CO-PO MAPPING:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	-	-	-	-	-	-	-	-	2	1
CO2	-	-	-	-	-	-	-	-	2	1
CO3	1	-	-	-	-	3	-	-	3	1
CO4	-	-	-	-	-	2	-	-	2	1
CO5	2	-	-	-	-	2	-	1	2	1

DETAILED SYLLABUS:

Competitive priorities and manufacturing strategy: Introduction, Historical perspective of manufacturing management, Competitive priorities and operational strategy, Functional area strategy and Capability, Case Study

Demand Forecasting: Introduction, Quantitative Methods introduction, Time series and moving averages method, Exponential Smoothing method, Regression Analysis Method, Qualitative Methods.

Facility Design: Introduction and History, Product design and process selection, Capacity planning, Plant location and Plant layout.

Inventory control: From EOQ to ROP, Independent Demand Inventory control & Economic Order Quantity (EOQ), Dynamic lot sizing, Statistical inventory control models.

The MRP crusade: History, Need, Evolution, Dependent Demand & Material Requirement Planning (MRP), Structure of MRP system, MRP Calculations

The JIT revolution: Just-in-Time System: origin & goals, Characteristics of JIT Systems, Continuous Improvement, The Kanban System, Strategic Implications of JIT System.
Production Planning and Control: Shop floor control, Production scheduling, Aggregate planning, Aggregate and workforce planning.

READING:

1. Krajewski U and Ritzman LP, Operations Management: Strategy and Analysis, Pearson Education Pvt Ltd., Singapore, 2002.
2. Gaither N and Frazier G, Operations Management, Thomson Asia Pvt. Ltd., Singapore, 2002.
3. Chase RB, Aquilano NJ and Jacobs RF, Operations Management for Competitive Advantage, McGraw-Hill Book Company, NY, 2001

ME5411	MECHANICAL BEHAVIOUR OF MATERIALS	DEC	3 - 0 - (	3 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1:	Understand an overview of mechanical behaviour of materials.
CO2:	Identify the suitable Materials for design of components
CO3:	Understand the basics characterisation of materials
CO4:	Understand the fracture behaviour of ductile and brittle materials
CO5:	Apply the knowledge for material selection based on the mechanical behaviour in mechanical engineering design as per the needs of the society

CO - PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	1	-	-	-	-	1
CO2	3	2	2	2	1	-	-	1	1	1
CO3	2	3	2	1	1	1	-	1	1	1
CO4	2	3	2	1	1	1	1	-	1	1
CO5	3	3	2	1	1	1	1	3	1	1

DETAILED SYLLABUS:

Tensile testing, other tests of plastic behavior, strain hardening of metals, strain rate and temperature dependence, slip, Hardening mechanisms in metals, dynamic strain aging; ductility and fracture, fracture mechanics theories, Creep mechanisms, Fatigue Analysis, cyclic stress-strain behavior, fatigue of polymers, design considerations. Mechanical behavior of ceramics and glasses; polymers, composites, Material characterization using optical microscopy and SEM.

READING:

1. George E. Dieter, Mechanical *Metallurgy*, McGraw Hill, 2nd Ed, 2005.
2. Hellan K, *Introduction to Fracture Mechanics*, McGraw Hill, 2002
3. J.E.Dorn, *Mechanical Behavior of Materials at Elevated Temperatures*, McGraw Hill, 2000.

ME5412	OPTIMIZATION METHODS FOR ENGINEERING	DEC	3 - 0 - 0	3 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Explain an overview of modelling of constrained decision making
CO2	Develop a mathematical model for a given problem
CO3	Solve practical problems using suitable optimization technique
CO4	Analyze the sensitivity of a solution to different variables
CO5	Use and develop optimization simulation software for variety of industrial problems

CO-PO MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	-	-	-	-	-	-	-	1	-	-
CO2	1	1	1	-	-	-	-	1	-	1
CO3	-	-	2	2	-	-	-	3	2	1
CO4	-	-	-	-	-	-	-	3	-	1
CO5	-	-	2	3	-	-	-	3	3	1

DETAILED SYLLABUS:

Introduction to the course, Statement of an Optimization Problem and Classification of Optimization Problems.

Optimization Techniques: Single-Variable Optimization, Multivariable Optimization Without any Constraints, with Equality and Inequality Constraints.

Linear Programming: Simplex Methods, Sensitivity Analysis, Transportation Problem

Integer Programming: Graphical Representation, Integer Polynomial Programming

Geometric Programming: Formulation and Solutions of Unconstrained and Constrained geometric programming problem.
Dynamic Programming: Multistage Decision Processes

One-Dimensional Minimization Methods: Elimination methods: Fibonacci Method, Golden Section Method, Interpolation methods: Quadratic Interpolation Method, Cubic Interpolation Method

Unconstrained Optimization Techniques: Univariate, Conjugate Gradient Method and Variable Metric Method.

Constrained Optimization Techniques: Characteristics of a constrained problem; Direct Method of feasible directions; Indirect Method of interior and exterior penalty functions.

READING:

1. Rao, S. S., Optimization Theory and Applications, Wiley Eastern Ltd., 2nd Edition, 2004.
2. Fox, R. L., Optimization Methods for Engineering Design, Addison Wesley, 2001.

ME5415	CONDITION MONITORING	DEC	3 - 0 - 0	3 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Exemplify and summarize the maintenance scheme, their scope and limitations.
CO2	Summarize principles of vibration measurement and selection of sensors, lubrication oil analysis and assess the condition.
CO3	Apply the principles maintenance strategies to common problems in an automobile.
CO4	Analyze the vehicle condition using the signature/wear analysis and identify the malfunctions in an automobile.
CO5	Develop an appreciation towards the modern technological approaches for vehicl testing to reduce the maintenance cost.

CO-PO MAPPING:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	1	3	3	-	-	-	-	-
CO2	3	1	3	1	3	-	1	1	1	-
CO3	1	3	2	3	3	-	-	1	-	1
CO4	1	1	1	3	3	-	-	-	1	2
CO5	-	1	1	1	-	-	-	2	1	1

DETAILED SYLLABUS:

Introduction: Failures – System, component and services failures – classification and its causes, Maintenance Schemes – objectives – types and economic benefits, break down, preventive and predictive monitoring.

Vibration Monitoring – causes and effects of vibration, review of mechanical vibration concepts – free and forced vibrations, vibration signature of active systems – measurement of amplitude, frequency and phase.

Vibration monitoring equipment: vibration sensors (contact and non-contact type) –factors affecting the choice of sensors, signal conditioners, recording and display elements, vibration meter and analyzers, measurement of overall vibration levels.

Special Vibration Measurement Techniques: Change in sound method, Ultrasonic measurement method, shock pulse measurement, Kurtosis, Acoustic Emission mentoring, critical speed analysis, shaft orbit analysis, Cepstrum analysis. Non-destructive techniques, application

Contaminant analysis: Contaminants in used lubricating oils – monitoring techniques (wear debris) – oil degradation analysis presence of abrasive particles – SOAP technique, Ferrography, X-ray spectrometry, Particle classification.

Temperature Monitoring: Various techniques – thermograph, pyrometers, indicating paint, corrosion monitoring – direct observation, conventional chemical and electo-chemical and NDT methods.

Performance trend monitoring: primary and secondary performance parameters – steam turbine performance analysis – Selection of monitoring techniques.

READING:

1. Mechanical Faults Diagnosis by R A Collacott, Chapman and Hall, London.
2. Instrumentation, Measurement and Analysis, Choudary K K, Tata McGraw Hill
3. Hand book of Condition Monitoring by B K N Rao, Elsevior Advanced Technology, Oxford.
4. Introduction to Non-destructive testing by P E Mix, John Wiley & Sons
5. Machinery Malfunction Diagnosis and Correction by Robert C Eisenmann, Prentice Hall PTR New Jersey
6. Vibration Measurements and Analysis J D Smith, Butterworths London

ME5416	ROBUST DESIGN	DEC	3 - 0 - 0	3 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Understand stages in engineering design and concept of robust design.
CO2	Develop quality loss functions and S/N ratios for S, N and L type objective functions.
CO3	Identify control and noise factors for a given product or process.
CO4	Conduct experiments using DOE concepts to decide the optimal setting of parameters
CO5	Apply quality loss function approach for fixing the component tolerances.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	-	-	-	2	-	2	-	1
CO2	-	-	-	-	-	2	-	2	-	1
CO3	-	2	-	2	-	2	-	2	-	1
CO4	-	-	2	2	2	2	-	2	-	1
CO5	-	-	-	-	-	2	-	2	-	1

DETAILED SYLLABUS:

Introduction: Taguchi's quality philosophy, causes of performance variation, concept of robust design, stages in product/process design, need for experimentation, QFD, process flow analysis, cause and effect diagram;

Design of Experiments: Principles of experimentation, Basic concepts of probability and statistics, Comparison of two means and two variances, Comparison of multiple (more than two) means &ANOVA,Factorial designs, fractional factorial designs, orthogonal arrays, standard orthogonal arrays & interaction tables, modifying the orthogonal arrays, selection of suitable orthogonal array design,analysis of experimental data;

Parameter Design: Loss function, average quality loss, S/N ratios, objective functions, selection of control & noise factors and their levels, strategy for systematic sampling of noise, classification of control factors, inner-array and outer-array design, data analysis, selection of optimum levels/values for parameters;

Tolerance Design: Experiments, selection of tolerances to be tightened, fixing the final tolerances.

READING:

1. Taguchi G, Chowdhury S and Taguchi S*, Robust Engineering*, TMH, 2000.
2. Ross PJ, *Taguchi Techniques for Quality Engineering,*TMH, 2005.

ME5406	CAD LABORATORY	PCC	0 - 0 - 3	2 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Draw complex geometries of machine components in sketcher mode.
CO2	Write programs to generate analytical and synthetic curves used in engineering practice.
CO3	Generate freeform shapes in part mode to visualize components.
CO4	Create complex engineering assemblies using appropriate assembly constraints.
CO5	Develop G and M codes for turning and milling components.
CO6	Practice on CAD data exchange formats used in design and fabrication of engineering components.

CO-PO MAPPING:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	-	-	1	-	2	-	1	-	2
CO2	-	-	-	2	-	2	-	2	-	3
CO3	2	2	-	3	-	3	-	2	-	3
CO4	2	2	-	3	-	3	-	3	-	3
CO5	-	-	-	3	-	3	-	3	-	3
CO6	1	2	-	3	-	3	-	3	-	2

DETAILED SYLLABUS:

Week Exercise

1. Introduction and Installation of CAD/CAM/CAE Softwares
2. Introduction to Solid Modelling & Pro/E Package
3. Working with sketch mode of Pro/E
4. Introduction to MATLAB Programming
5. Working with creating features (Extrude & Revolve)
6. Working Datum Planes
7. Working with the tools like Hole, Round, Chamfer and Rib
8. Working with the tools like Pattern, Copy, Rotate, Move and Mirror
9. Working with advanced modeling tools (Sweep, Blend & Swept Blend)
10. Assembly modelling in Pro/E
11. Generating, editing and modifying drawings in Pro/E
12. Exercises on Analytic Curves (Lines, Circles, Ellipses, Parabolas, Hyperbolas, Conics) using MATLAB Programming
13. Exercises on Synthetic Curves (Cubic Spines, Bezier Cures, B-Spine Curves) using MATLAB Programming
14. Working with CAD Data Exchange formats: IGES,ACIS, DXF and STL

ME5503	COMPUTATIONAL LABORATORY	PCC	0 - 0 - 3	2 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Apply many built-in functions in MATLAB to solve numerical problems.
CO2	Develop code for solving problems involving different types of mathematical models and equations (ODE, PDE, Linear and nonlinear equations).
CO3	Solve many simulation problems encountered in theory courses of the semester.
CO4	Perform simulations of spring-mass-damper system using Simulink.
CO5	Execute a medium sized project.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	-	-	-	-	-	2	-	3	-	-
CO2	-	-	-	-	-	2	-	3	-	-
CO3	-	-	-	-	-	2	-	3	-	-
CO4	-	-	-	-	-	2	-	3	-	-
C05	-	-	-	-	-	-	-	3	3	2

DETAILED SYLLABUS:

WEEK	EXERCISE
1	Introduction to MATLAB and practice
2	Practice session on handling basic arithmetic etc
3	Writing codes with control loops, functions and scripts
4	Developing codes for visualization and plotting
5	Solving problems involving linear and nonlinear equations
6	Solving problems involving curve fitting and interpolations
7	Solving problems involving ordinary and partial differential equations
8	Solving problems related to transcendental equations
9	Solving problems involving numerical differentiation and integrations
10	Practice session
11	Introduction to Simulink
12	Case studies and working on projects
13	Case studies and working on projects
14	Case studies and working on projects

ME5551	AUTOMOTIVE BODY STRUCTURES	PCC	4 - 0 - 0	4 Credits

PREREQUISITES: None
COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Classify vehicle body according to body shape and frame structures.
CO2	Enumerate the aerodynamic forces acting on the vehicle body and discuss the methods to them.
CO3	Use the principles of simple structural surface method and explain how vehicle body panels are strengthened by using it.
CO4	Describe the vehicle crash testing methods and occupants safety.
CO5	Identify sources of noise and describe the methods to minimize it.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	3	3	3	-	3	2	3
CO2	1	1	-	3	3	3	1	3	2	2
CO3	-	1	-	2	2	3	-	3	3	3
CO4	1	2	-	3	2	3	3	3	3	3
CO5	-	2	2	3	2	2	3	1	2	2

DETAILED SYLLABUS:
Frame: Introduction, Loads on the Frames, Construction and Cross sections of the frame, Types of Frames
Automotive Body: Vehicle body styles, Aerodynamic considerations in body profiling: Drag reduction, Drag force calculation

Vehicle Structure: Basic requirement of stiffness and strength, Vehicle structure types, Demonstration of Simple Structural Surfaces (SSS)

Body Components: Bumpers, Grilles, Sill covers and side airdams, outer moldings, Weather strips, Glass and Mirrors

Body Interiors: Seat Belt Restraint system-Air-Bag, components of Air- Bag, Dash Board

Vehicle Safety: Introduction, Crash testing, protection of occupants Testing for occupants safety, safety controls,

Noise: Interior noise-Engine noise, Road noise, wind noise, brake noise, Interior noise: Assessment and control

READING:

1. Powloski J, Vehicle Body Engineering, Business Books Ltd, 2000.
2. Lorenzo Morello, Automotive Body, Volume-I (component design), Springer, 2011
3. David A Crolla, Automotive Engineering (Power Train, Chassis system and Vehicle Body), Elsevier collection, 2009.
4. Giles G.J. Body Construction & Design Illiffe Books Butter worth & co., 2000.
5. John Fenton Vehicle Body Layout and Analysis, Mechanical Engineering Publication Ltd., London, 2001.

ME5452	FINITE ELEMENT ANALYSIS IN DESIGN	PCC	4 - 0 - 0	4 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Understand the concept of finite element method of solving engineering problems
CO2	Formulate physical problems related to 1-D structural members like trusses, beams and frames and solve them manually.
CO3	Develop 2-D FE formulations involving triangular, quadrilateral and higher order elements.
CO4	Apply the knowledge of FEA for plain stress, plain strain, axi-symmetric and vibration problems.
CO5	Solve FE problems by writing their own programs in programming platform like MATLAB

CO-PO MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	-	1	-	-	-	1	-	1	-	-
CO2	-	-	-	-	-	2	-	3	-	-
CO3	-	-	-	-	-	2	-	3	-	-
CO4	-	-	-	-	2	2	-	3	-	1
CO5	-	-	-	-	-	2	-	3	-	-

DETAILED SYLLABUS:

Introduction: Overview of the course, examination and evaluation patterns, history and basic concept of finite element method and direct FEM.

Fundamental concepts: Calculus of variation and solving differential equations, Ritz method, Galerkin method, Least squares, collocation and subdomain methods, Case studies for Ritz and Galerkin methods, Ritz FEM formulation, Galerkin FEM formulation.

One-Dimensional Problems: Finite element formulation for 1-D problems, elimination method, penalty method, computer implementation and case studies.

Trusses: Introduction, fem formulation, plane trusses, three dimensional trusses, frames and case studies.

Two-Dimensional Problems: Finite element formulation for 2-D problems, constant strain triangle, various elements,isoparametric, sub parametric and super parametric elements, interpolation functions, computer implementation and case studies.

Numerical Integration and 2-D problems of Elasticity: Introduction to numerical integration, two dimensional integrals, plane stress, plane strain, axisymmetric, plate bending problems.

Three Dimensional Problems: Finite element formulation for 3-D problems, mesh preparation, hexahedral elements, shell elements and case studies.

Dynamic Analysis: Equation of motion, types of analysis, modal analysis, formulation, element mass matrices and advanced topics

READING:

1. Seshu T, Textbook of Finite Element Analysis, PHI.
2. Reddy, J.N., Finite Element Method in Engineering, Tata McGraw Hill, 2007.
3. Zeincowicz, The Finite Element Method for Solid and Structural Mechanics, 4th Edition, Elsevier 2007.

ME5456	VEHICLE DYNAMICS	PCC	4 - 0 - 0	4 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Summarize the principles underlying the development and design of road vehicles under the influence of dynamic loads.
CO2	Analyze the performance and establish the design specifications for the acceleration and braking conditions.
CO3	Model, simulate and analyze the conventional road vehicles for better ride comfort.
CO4	Develop an appreciation for the need of a modern technological approach to reduce the maintenance.
CO5	To reflect the new developments to serve the changing needs of the educational and professional communities.

CO-PO MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	1	1	-	2	-	-	-	1
CO2	2	1	3	3	2	2	-	1	-	1
CO3	1	1	2	3	2	-	-	2	-	2
CO4	1	2	2	2	1	1	1	1	-	3
CO5	1	2	1	1	-	-	1	-	-	3

DETAILED SYLLABUS:

Introduction: Hypothetical vehicle control loop, Fundamental Approach, Vehicle co-ordinates, motion variables. Forces – Dynamic axle loads, Static loads on level ground, aerodynamic forces on body, hitch forces – problems

Acceleration & Braking Performance – Power limited acceleration, Static loads on level ground, aerodynamic forces on body, Fundamental Expressions, Constant retardation, Wind Resistance, Power, Braking forces, Brakes: disc and drum, front, rear and four wheel braking, Road friction rolling resistance, problems.

Road Loads: Aerodynamic, Mechanics of pressure distribution – Aerodynamic forces: lift & drag, Spoilers, Lift force, side force and roll, pitch and yaw moments, Crosswind sensitivity. Rolling Resistance, Factors affecting pressure, velocity, slip temperature, etc – Total road loads – Fuel Economy Effects.

Ride: Excitation sources – road roughness, wheel assembly, driveline excitation, engine transmission. Vehicle response properties: Suspension isolation, suspension stiffness & damping Wheel Hop Resonance. Road-tyre friction – dynamic response of tires – Rigid body bounce, pitch motion.Perception of ride and other vibration forms, Problems.

Steady – State Cornering: Introduction, Low and high speed turning –Tire cornering forces, governing expressions, understeer gradient, oversteer and nutral conditions. Characteristic speed, critical speed, yaw velocity gain, sideslip angle, static margin. Suspension effects on cornering: roll moment distribution – effect of tractive forces on cornering – Problems

Suspension – Solid axes – Independent suspension, Trail arm, Front – Multi link – Trailing rear suspension – Anti-squat and anti- pitch suspension - Active suspension – Performance.

READING:

1. Hans B Pacejka, Tire and Vehicle Dynamics,3rd Edition, Elsevier Ltd., 2012.
2. Amitosh D, Vehicle Dynamics, Galgotia Book Ltd., 2010.
3. Rao V Dukkipati, Road Vehicle Dynamics,Springer 2008
4. Werner and Karl, Ground Vehicle Dynamics,Springer Berlin Heidelberg, 2008

ME5561	VEHICLE TESTING AND INSTRUMENTATION	DEC	3 - 0 - 0	3 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Understand the importance of testing of vehicle components/systems as per standards.
CO2	Apply the knowledge of error and uncertainty with regards to instruments and equipment used in engine/vehicle testing.
CO3	Classify the dynamometers for testing the engines/vehicles.
CO4	Identify the harmful pollutants and analyze the instruments used for measuring vehicle emissions.
CO5	Identify the methods for quantifying aerodynamic drag of vehicles.

CO-PO MAPPING:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	-	2	3	2	3	2	3	2
CO2	3	-	-	3	3	2	2	3	3	1
CO3	-	2	-	-	3	-	-	3	3	-
CO4	3	-	3	-	2	-	-	3	3	-
CO5	3	2	-	3	3	3	2	3	3	-

DETAILED SYLLABUS:

Introduction: Overview of the course-Need of vehicle testing(engine testing both for performance and emissions in specific)-Requirement of standard instrumentation and equipment, certification and national and international standards, Importance of expertise in testing, certification.

Measurement fundamentals: Definitions associated with measurements-Least count, resolution, Precision, Accuracy, Error / Uncertainty analysis- Data collection and handling-Simple numerical problems.

Engine Testing: Definition and importance of engine in a vehicle- Road load equation-Testing under constant speed and variable speed condition. Classification of engine dynamometers-Characteristic curves of various types of dynamometers-Advantage and limitations of different types engine dynamometers-Discussion on typical engine performance characteristics.

Combustion analysis: Definition of Combustion, Combustion stoichiometry, SI engine combustion and CI engine combustion-Measurement of in-cylinder pressure, temperatures-instrumentation

Fuel injection systems: Fuel injection for SI and CI engines, Types of different systems-Electronic injection systems and Electronic Control Units-Testing of injection systems.

Vehicle Emissions: Types of emissions and pollutant formation mechanisms-Vehicle Driving Cycles, Emission measurement on engine and chassis dynamometer-Measurement of regulated and non-regulated pollutants-Description of emission measuring instrumentation-NDIR ,FID, ChemiluminescenceAnalyzer, Chromatograph, Smoke meters -Emission regulations and legislation- EURO and Bharat Stage norms

Vehicle performance and testing techniques: Schematic layout of typical vehicle-Types of testing for both engine in specific, and whole vehicle body. Description of important components of Vehicle and Engine that require testing. Different types of engines for Vehicles- fossil fuel run engines, hybrid and electric vehicles -Testing procedure for electric vehicles- -Chassis and Rolling road dynamometers-Brief introduction to testing of tires, steering, brakes, wheel alignment-Introduction to on-board diagnostics.

Vehicle Drag & Aerodynamics of Vehicle: Introduction to drag and aerodynamics, Description drag-terms associated; streamlined and bluff bodies-Definition of Ahmed car-adverse effects of drag-Drag measuring techniques-drag reduction strategies

Vehicle certification: Need for Vehicle certification and facilities required, Importance driving cycles-Indian Driving Cycle, MIDC-procedures, Introduction to other country driving cycle-Japan, EUDC

READING:

1. Heinz Heisler, Advance Vehicle Technology, Butterworth-Heinemann, 2002
2. Tom Denton, Advanced Automotive Fault Diagnosis,Elsevier Butterworth-Heinemann,2006
3. Martyr and Plint, Engine testing-theory and Practice, Butterworth-Heinemann, 2002.
4. J.P. Holman, Experimental Methods for Engineers, Tata McGraw Hill Co. 2007.

ME5563	AUTOMOTIVE ELECTRONICS	DEC	3 - 0 - 0	3 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Understand the need of safety and use of electronics in automobiles
CO2	Understand the electronic circuit fundamentals and basic test equipment.
CO3	Analyze vehicle circuits and use of digital Storage oscilloscope.
CO4	Understand electronic fundamentals and wiring diagrams.
CO5	Outline the working of batteries, starting systems, charging systems, ignition systems and auxiliaries.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	1	-	-	-	-	-	1	3
CO2	1	3	2	-	-	1	1	-	-	2
CO3	-	-	1	-	2	-	-	-	2	-
CO4	3	2	-	2	-	1	-	-	-	1
CO5	-	3	1	1	-	2	-	-	-	1

DETAILED SYLLABUS:

Introduction: Overview of the course, Examination and Evaluation patterns, History of Automotive electronics.

Safety and Communication: Safe working practices-work cloths, eye protection, fire protection, battery safety. Working as an electricity / electronics technician-your toolbox, access to wiring diagrams and repairs information, communicating with the customer, working around air bags

Circuit fundamentals and basic test equipment:voltage, current**,** resistance, circuits components, series and parallel circuits, purpose of voltmeters, measuring voltage drop, connecting the voltmeter, types of ammeters, current probes, reading and interpreting ohmmeter readings, continuity testing.

Vehicle circuits: circuit components, analyzing series and parallel circuits, control circuits, diagnosing open and short circuits.

Digital Storage Oscilloscope: voltage and time setting, DSO trigger and slope, using a current probe with DSO, using the DSO’s multiple-trace capability.

Electronic fundamentals: solid state devices, electronic control input devices, diagnosing and servicing electronic control input devices, integrated circuits as input devices, diagnosing and servicing ICs, oxygen sensors, diagnosing and servicing oxygen sensors.

Wiring diagrams and Batteries: wiring diagram symbols, using the wiring diagram as aservice tool, automotive batteries, diagnosing batteries, servicing batteries.

Starting and charging systems: starting circuits, solenoid shift starters, diagnosing and servicing solenoid shift starters systems, positive engagement starters, diagnosing and servicing positive engagement starting system, gear-reduction starters, diagnosing gear-reduction starters, charging system overview, field circuits, diagnosing and servicing the charging system.

Ignition systems and accessories: secondary ignition systems, servicing the secondary ignition system, primary ignition system, diagnosing and servicing distributed primary ignition systems, distributorless ignition secondary circuits, diagnosing and servicing the secondary ignition system on a distributorless vehicles, distributorless ignition primary circuits, diagnosing and servicing the primary circuit on a distributorless ignition system. Lighting circuits, diagnosing lighting circuits, defogger, horn, and windshield wiper circuits, diagnosing defogger, horn, and windshield wiper circuits, motor driven accessories, diagnosing motor driven accessories

READING:

1. Al Santini, Automotive Technology, Electricity and Electronics, Cengage Publishers, 2011.
2. William Ribbens, Understanding Automotive Electronics, 6th Edition, Elsevier, 2011.

ME5564	ADVANCED MATERIALS AND SENSORS FOR AUTOMOBILES	DEC	3 - 0 - 0	3 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Formulate the manufacturing techniques to shape metals and alloys for automotive components.
CO2	Develop materials to overcome wear and corrosion
CO3	Identify suitable materials for automotive components
CO4	Utilize sensors to make real time decisions on the performance of automotive components

CO-PO MAPPING:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	-	-	-	-	-	1	1
CO2	3	2	2	2	2	2	2	-	1	1
CO3	3	2	2	2	2	2	2	-	1	1
CO4	3	2	2	-	-	-	-	-	1	1

DETAILED SYLLABUS:

Characteristics and fabrication of plastically deformed bodies-Theory of Plasticity-Load requirement to accomplish metal forming operations – Analysis of rolling, forging and extrusion processes
Cold rolled steel- Properties, manufacturing methods and super plasticity –weldability- Hot rolled vs Cold rolled - Foam materials- Structure, Stabiity and Types – Manufacturing Methods – Applications- Materials for safety-bearing materials-coating techniques for wear- PVD and CVD techniques, Chemical and electrochemical techniques, Spraying, Roll to Roll spraying techniques, heat and environment.
Corrosion phenomenon with special reference to automobile bodies - advanced materials for automobile, Nanostructured steel for automotive body structures; Aluminium sheet for automotive applications; High-pressure die-cast (HPDC) aluminium alloys for automotive applications; Magnesium alloys for lightweight powertrains and automotive bodies; Polymer and composite moulding technologies for automotive applications.
Power sources- Materials for super capacitors and electrolytic cells for automobiles-Supercapacitor types-Electrodes-Electrodes for EDLCs-Electrodes for pseudocapacitors-Electrodes for hybrid capacitors-Basic design Principles -Capacitance distribution-Storage principles-Construction details -Styles-Materials-Electrolytes-Separators- Collectors and housing-Electrical parameters.
Neccessity of Sensors in automobiles , sensors for antilock braking systems, seat belts,automaticlocks,gasguage, air bags, heater, temperature sensor, speedometer, oil guage etc.

READING:

1. Black, J.T., Ronald, A.K. Materials and Processes in Manufacturing, 10th Edition, John Wiley Publication, 2007.
2. George S. Brady, Henry R. Clanser, Materials: Theory Properties and Uses,McGraw-Hill, 2006

ME5169	COMPUTATIONAL FLUID DYNAMICS	DEC	3 - 0 - 0	3 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Explain the differential equations for flow phenomena and numerical methods for their solution
CO2	Analyze mathematical models and computational methods for fluid flow and heat transfer simulations
CO3	Solve computational problems related to fluid flow and heat transfer
CO4	Analyze the accuracy of a numerical solution by comparison to known solutions o simple test problems and by mesh refinement studies
CO5	Evaluate forces in both internal and external flows
CO6	Use flow simulation software and develop code for the most important classes of flows in engineering and science

CO-PO MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	-	1	-	-	-	-	-	-	1	1
CO2	-	-	-	3	-	-	-	-	1	1
CO3	-	-	-	3	3	-	-	3	2	1
CO4	-	-	-	-	-	-	-	2	-	1
CO5	-	-	-	3	-	-	-	-	-	1
CO6	-	-	-	3	3	-	-	3	3	1

DETAILED SYLLABUS:

Introduction: History and Philosophy of computational fluid dynamics, CFD as a design and research tool, Applications of CFD in engineering, Programming fundamentals, MATLAB programming, Numerical Methods

Governing equations of fluid dynamics: Models of the flow, The substantial derivative, Physical meaning of the divergence of velocity, The continuity equation, The momentum equation, The energy equation, Navier-Stokes equations for viscous flow, Euler equations for inviscid flow, Physical boundary conditions, Forms of the governing equations suited for CFD, Conservation form of the equations, shock fitting and shock capturing, Time marching and space marching.

Mathematical behavior of partial differential equations: Classification of quasi-linear partial differential equations, Methods of determining the classification, General behavior of Hyperbolic, Parabolic and Elliptic equations.

Basic aspects of discretization: Introduction to finite differences, Finite difference equations using Taylor series expansion and polynomials, Explicit and implicit approaches, Uniform and unequally spaced grid points.

Grids with appropriate transformation: General transformation of the equations, Metrics and Jacobians, The transformed governing equations of the CFD, Boundary fitted coordinate systems, Algebraic and elliptic grid generation techniques, Adaptive grids.

Parabolic partial differential equations: Finite difference formulations, Explicit methods – FTCS, Richardson and DuFort-Frankel methods, Implicit methods – Laasonen, Crank-Nicolson and Beta formulation methods, Approximate factorization, Fractional step methods, Consistency analysis, Linearization.

Stability analysis: Discrete Perturbation Stability analysis, von Neumann Stability analysis, Error analysis, Modified equations, Artificial dissipation and dispersion.

Elliptic equations: Finite difference formulation, solution algorithms: Jacobi-iteration method, Gauss-Siedel iteration method, point- and line-successive over-relaxation methods, alternative direction implicit methods.

Hyperbolic equations: Explicit and implicit finite difference formulations, splitting methods, multi-step methods, applications to linear and nonlinear problems, linear damping, flux corrected transport, monotone and total variation diminishing schemes, tvd formulations, entropy condition, first-order and second-order tvd schemes.

Scalar representation of navier-stokes equations: Equations of fluid motion, numerical algorithms: ftcs explicit, ftbcs explicit, Dufort-Frankel explicit, Maccormack explicit and implicit, btcs and btbcs implicit algorithms, applications.

Grid generation: Algebraic Grid Generation, Elliptic Grid Generation, Hyperbolic Grid Generation, Parabolic Grid Generation

Finite volume method for unstructured grids: Advantages, Cell Centered and Nodal point Approaches, Solution of Generic Equation with tetra hedral Elements, 2-D Heat conduction with Triangular Elements

Numerical solution of quasi one-dimensional nozzle flow: Subsonic-Supersonic isentropic flow, Governing equations for Quasi 1-D flow, Non-dimensionalizing the equations, MacCormack technique of discretization, Stability condition, Boundary conditions, Solution for shock flows.

READING:

1. Anderson, J.D.(Jr), *Computational Fluid Dynamics*, McGraw-Hill Book Company, 1995.
2. Hoffman, K.A., and Chiang, S.T., *Computational Fluid Dynamics*, Vol. I, II and III, Engineering Education System, Kansas, USA, 2000.
3. Chung, T.J., *Computational Fluid Dynamics*, Cambridge University Press, 2003.
4. Anderson, D.A., Tannehill, J.C., and Pletcher, R.H., *Computational Fluid Mechanics and Heat Transfer*, McGraw Hill Book Company, 2002.

ME5361	SUPPLY CHAIN MANAGEMENT	DEC	3 - 0 - 0	3 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Understand the decision phases and apply competitive and supply chain strategies.
CO2	Understand drivers of supply chain performance.
CO3	Analyze factors influencing network design.
CO4	Analyze the role of forecasting in a supply chain
CO5	Understand the role of aggregate planning, inventory, IT and coordination in a supply chain.

CO-PO MAPPING:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	-	-	2	-	-	-	-	-	2	2
CO2	-	-	-	-	-	-	-	-	2	2
CO3	-	-	2	-	-	1	-	-	2	2
CO4	-	-	-	-	-	-	-	-	-	2
CO5	-	-	2	-	-	-	-	-	2	2

DETAILED SYLLABUS:

Strategic Framework: Introduction to Supply Chain Management, Decision phases in a supply chain, Process views of a supply chain: push/pull and cycle views, Achieving Strategic fit, Expanding strategic scope.

Supply Chain Drivers and Metrics: Drivers of supply chain performance, Framework for structuring Drivers, Obstacles to achieving strategic fit.

Designing Supply Chain Network: Factors influencing Distribution Network Design, Design options for a Distribution network, E-Business and Distribution network, Framework for Network Design Decisions, Models for Facility Location and Capacity Allocation.
Forecasting in SC: Role of forecasting in a supply chain, Components of a forecast and forecasting methods, Risk management in forecasting.

Aggregate Planning and Inventories in SC: Aggregate planning problem in SC, Aggregate Planning Strategies, Planning Supply and Demand in a SC, Managing uncertainty in a SC: Safety Inventory.

Coordination in SC: Modes of Transportation and their performance characteristics, Supply Chain IT framework, Coordination in a SC and Bullwhip Effect.

READING:

1. Sunil Chopra and Peter Meindl, Supply Chain Management - Strategy, Planning and Operation, 4th Edition, Pearson Education Asia, 2010.
2. David Simchi-Levi, PhilpKamintry and Edith Simchy Levy, Designing and Managing the Supply Chain - Concepts Strategies and Case Studies, 2nd Edition, Tata-McGraw Hill, 2000.

ME5371	MECHATRONICS	DEC	3 - 0 - 0	3 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Model, analyze and control engineering systems.
CO2	Select appropriate sensors, transducers and actuators to monitor and control the behaviour of a process or product.
CO3	Develop PLC programs for a given task.
CO4	Evaluate the performance of mechatronic systems.

CO-PO MAPPING:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	1	2	2	-	2	2	1	1
CO2	1	2	3	3	-	2	1	1	1
CO3	3	2	1	3	-	3	1	1	1
CO4	2	2	2	3	-	2	1	1	1

DETAILED SYLLABUS:

Introduction: Overview of the course, Examination and Evaluation patterns, History of Mechatronics, Scope and Significance of Mechatronics systems, elements of mechatronic systems, needs and benefits of mechatronics in manufacturing

Sensors: classification of sensors basic working principles, Displacement Sensor - Linear and rotary potentiometers, LVDT and RVDT, incremental and absolute encoders. Strain gauges. Force/Torque – Load cells. Temperature – Thermocouple, Bimetallic Strips, Thermistor, RTD Accelerometers, Velocity sensors – Tachometers, Proximity and Range sensors – Eddy current sensor, ultrasonic sensor, laser interferometer transducer, Hall Effect sensor, inductive proximity switch. Light sensors – Photodiodes, phototransistors, Flow sensors – Ultrasonic sensor, laser Doppler anemometer tactile sensors – PVDF tactile sensor, micro-switch and reed switch Piezoelectric sensors, vision sensor

Actuators: Electrical Actuators : Solenoids, relays, diodes, thyristors, triacs, BJT, FET, DC motor, Servo motor, BLDC Motor, AC Motor, stepper motors. Hydraulic & Pneumatic devices – Power supplies, valves, cylinder sequencing. Design of Hydraulic & Pneumatic circuits. Piezoelectric actuators, Shape memory alloys.

Basic System Models & Analysis: Modelling of one and two degrees of freedom Mechanical, Electrical, Fluid and thermal systems, Block diagram representations for these systems.
Dynamic Responses of System: Transfer function, Modelling Dynamic systems, first order systems, second order systems.

Digital Electronics: Number systems, BCD codes and arithmetic, Gray codes, self-complimenting codes, Error detection and correction principles. Boolean functions using Karnaugh map, Design of combinational circuits, Design of arithmetic circuits. Design of Code converters, Encoders and decoders.

Signal Conditioning: Operational amplifiers, inverting amplifier, differential amplifier, Protection, comparator, filters, Multiplexer, Pulse width Modulation Counters, decoders. Data acquisition – Quantizing theory, Analog to digital conversion, digital to analog conversion.

Controllers: Classification of control systems, Feed back, closed loop and open loop systems, Continuous and discrete processes, control modes, Two step Proportional, Derivative, Integral, PID controllers.

PLC Programming: PLC Principles of operation PLC sizes PLC hardware components I/O section Analog I/O section Analog I/O modules, digital I/O modules CPU Processor memory module Programming. Ladder Programming, ladder diagrams, timers, internal relays and counters, data handling, analogue input and output. Application on real time industrial automation systems.

Case studies of Mechatronics systems: Pick and place robot, Bar code, Engine Management system, Washing machine etc.

READING:

1. W. Bolton, "Mechatronics", 5 th edition, Addison Wesley Longman Ltd, 2010
2. Devdas Shetty & Richard Kolk "Mechatronics System Design", 3rd edition. PWS Publishing, 2009.
3. Alciatore David G &Histand Michael B, "Introduction to Mechatronics and Measurement systems", 4th edition, Tata McGraw Hill, 2006.
4. http://video_demos.colostate.edu/mechatronics
5. http://mechatronics.me.wisc.edu

ME5463		TRIBOLOGY IN DESIGN	DEC	3 - 0 - 0	3 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Understand friction, wear and lubrication
CO2	Analyze properties of lubrication on hydrodynamic, hydrostatic, Elasto hydrodynamic condition
CO3	Develop processes of lubrication in all regimes, Suggest an explanation to the cause of a tribological failure
CO4	Understand the friction phenomena and select a suitable lubricant for a specific application
CO5	Understand and determine wear processes in contacts between metallic and non metallic surfaces

CO-PO MAPPING:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10
CO1	1	2	-	-	-	-	-	-	-	1
CO2	1	1	2	1	-	2	-	-	-	1
CO3	1	-	-	-	-	3	1	-	-	1
CO4	3	1	3	-	1	-	-	-	-	1
CO5	1	1	-	-	-	-	-	1	-	1
CO6	3	1	-	-	-	-	-	-	-	1

DETAILED SYLLABUS:

Introduction: Overview of the course, examination and evaluation patterns, history and basic concept of friction wear and lubrication.

Lubricants and Lubrication modes: Properties of lubricants, modes of lubrication: hydrodynamic, hydrostatic, Elastohydrodynamic lubrication,Reynolds' equation, Applications of hydrodynamic lubrication theory, Hydrodynamic lubrication of roughened surfaces

Bearings: Bearing characteristics, Selection of bearings, Squeeze-film lubrication bearings, Thrust bearings , Journal bearings , air lubricated bearing, bearing vibration measurements.

Wear: Types of wear and their mechanisms: Adhesive wear, Abrasive wear, Wear due to surface fatigue , wear due to chemical reactions,, wear of bearings, wear of metallic and non metallic bearing materials, material combination for better tribological contacts.

READING:

1. Stachowaik, G.W., Batchelor, A.W., *Engineering Tribology*, 3rd Ed., Elsevier, 2010.
2. Neale MJ, *Tribology Hand Book*, CBS Publications, 2012.
3. Williams JA, *Engineering Tribology*, Oxford Univ. Press, 2001.
4. Cameron A, *Basic lubrication theory*, Ellis Horwood Ltd., 2002.

ME5466	RELIABILITY ENGINEERING	DEC	3 - 0 - 0	3 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Understand the concepts of Reliability, Availability and Maintainability
CO2	Develop hazard-rate models to know the behavior of components.
CO3	Build system reliability models for different configurations.
CO4	Assess reliability of components & systems using field & test data.
CO5	Implement strategies for improving reliability of repairable and non-repairable systems.

CO-PO MAPPING:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	-	2	2	2	-	2	1	1
CO2	-	2	-	2	2	2	-	2	-	1
CO3	-	2	-	-	2	2	-	2	1	1
CO4	-	-	-	-	2	2	-	2	-	1
CO5	-	-	-	-	2	2	-	2	-	1

DETAILED SYLLABUS:

Introduction: Probabilistic reliability, failures and failure modes, repairable and non-repairable items, pattern of failures with time, reliability economics;

Component Reliability Models: Basics of probability & statistics, hazard rate & failure rate, constant hazard rate model, increasing hazard rate models, decreasing hazard rate model, time-dependent & stress-dependent hazard models, bath-tub curve;

System Reliability Models: Systems with components in series, systems with parallel components, combined series-parallel systems, k-out-of-m systems, standby models, load-sharing models, stress-strength models, reliability block diagram;

Life Testing & Reliability Assessment: Censored and uncensored field data, burn-in testing, acceptance testing, accelerated testing, identifying failure distributions & estimation of parameters, reliability assessment of components and systems;

Reliability Analysis & Allocation: Reliability specification and allocation, failure modes and effects and criticality analysis (FMECA), fault tree analysis, cut sets & tie sets approaches;

Maintainability Analysis: Repair time distribution, MTBF, MTTR, availability, maintainability, preventive maintenance.

READING:

1. Ebeling CE, *An Introduction to Reliability and Maintainability Engineering*, TMH, New Delhi, 2004.
2. O'Connor P and Kleymer A, *Practical Reliability Engineering*, Wiley, 2012.

ME5469	AUTOMOTIVE COMPONENT DESIGN	DEC	3 - 0 - 0	3 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Understand the Principles of Transmission, Suspension, steering and braking systems of an Automobile
CO2	Understand the principles of design of mechanical components under static and dynamic loading conditions.
CO3	Carryout the kinematic design of automotive Transmission, Suspension and Steering systems.
CO4	Establish the design specifications for various components of an automobile.

CO-PO MAPPING:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	-	2	-	3	1	-	-	-
CO2	1	1	-	-	-	3	-	-	-	-
CO3	2	3	-	2	-	3	1	2	-	-
CO4	2	2	-	1	-	3	1	-	-	2

DETAILED SYLLABUS:

Principles of Design: General principles of design, Design considerations for components under static loading, Theories of failure, Consideration under dynamic loads, Fatigue, stress concentration factors, endurance strength, design for finite and infinite life.

Overview of Automotive components: classification of automotive components under static and dynamic loads. Design of simple components like levers, tie rods and transmission elements.

Design of Mechanisms: Kinematic Analysis and synthesis of four bar and slider crank mechanisms and their inversions. Design of windshield wipers, steering mechanisms, Suspension mechanisms, Kinematic design of gear trains, differentials, couplings and joints. Selection and design of gear box and drive lines.

Design of Brakes and Clutches: Specifications for brakes and clutches, calculation of brake power requirements and power transmission requirements of clutches. Design aspects of drum and disk brakes, Principle of Anti-lock braking systems. Design of single and multi-plate clutches, Cone clutch and centrifugal clutch.

Design of Suspension system: Classification of suspension, Analysis of roll centre and roll axis, kinematic and dynamic requirement of suspension systems. Vehicle vibration models, Modelling and analysis Passive, active and semi-active suspension systems.

Body and Frame Design: Principles of body and frame design, Estimation of static and dynamic loads, Finite Element Analysis of critical components.

READING:

1. Wang J.Y., Theory of Ground Vehicles, 2nd Ed. John Wiley, 1993
2. Smith J.H., An Introduction to Modern Vehicle Design, 2nd Ed. Butterworth-Heinmann,2001
3. Jazar R.N., Vehicle Dynamics: Theory and Applications, 2nd Ed., Springer, 2010
4. Limpert R., Brake design and Safety, SAE, 1999
5. Matchinsky W., Road vehicle suspensions., PEP, 2000
6. Norton R.L., Machie Design: An Integrated Approach, 4th Ed. Prentice Hall, 2009

ME5553	AUTOMOTIVE ENGINES LABORATORY	PCC	0 - 0 - 3	2 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Compare the Valve Timing Diagram set by the manufacturer
CO2	Perform tests on SI and CI Engines
CO3	Perform tests on SI and CI Engines to draw the heat balance test
CO4	Point out differences in performance, and emissions of single and multi cylinder engines are fuelled with alternate fuels at constant and variable speeds

CO-PO MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	-	-	1	1	-	1	-	1
CO2	3	2	1	1	3	-	1	2	2	1
CO3	1	2	1	-	1	-	2	2	-	1
CO4	2	3	2	1	3	-	2	2	1	1

DETAILED SYLLABUS:

Week	Exercise
1	Dismantling of the Old vehicle to study the parts
2	Study of Power steering system, Braking System, Gear Box and Clutch assembly
3	Draw the Valve Timing Diagram of a given Engine
4	Performance Test on a Single Cylinder Diesel Engine with DC shunt Dynamometer
5	Performance Test on Dual Fuel Engine with Electrical heater plugs
6	Performance Test on Single Cylinder petrol Engine with Electrical Dynamometer
7	Retardation test on a Single Cylinder Diesel Engine with DC shunt Dynamometer
8	Morse test on a Multi Cylinder Petrol Engine
9	Heat Balance Test on a Single Cylinder Diesel Engine with Water brak Dynamometer
10	Study of Fuel Cell and the fuel cell operated prototype car
11	Heat Balance, Nozzle Test and Performance test on Prototype steam power plant
12	Determination of Fuel properties with the apparatus available in the Laboratory
13	Performance test on a MPFI Engine
14	Conduct of experiment on Computerized single cylinder diesel engine to determin performance, Heat balance, Exhaust emissions and temperatures

ME5554	SIMULATION LABORATORY	PCC	0 - 0 - 3	2 Credits

PREREQUISITES: None

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1	Develop programs in MATLAB to solve typical analysis problems.
CO2	Solve problems involving Trusses, Beams and Frames using the developed code.
CO3	Solve problems involving Triangular element and higher order elements using the developed code.
CO4	Solve many structural problems using Ansys.
CO5	Execute a medium size project.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	-	-	-	-	-	-	-	3	-	-
CO2	-	-	-	-	1	-	-	3	-	-
CO3	-	-	-	-	1	-	-	3	-	-
CO4	-	-	-	-	1	-	-	3	-	-
CO5	-	-	-	-	2	-	-	3	2	2

DETAILED SYLLABUS:

Week	**Exercise**
1	Introduction to developing code for finite element analysis in MATLAB
2	Practice session on handling assembly, boundary conditions etc
3	Solving problems of Trusses
4	Solving problems of Beams and Frames
5	Solving problems involving triangular element etc
6	More practice with case studies
7	Introduction to commercial software, Ansys
8	Solving problems of Trusses using Ansys
9	Solving problems of Beams and Frames using Ansys
10	Solving problems involving triangular element etc using Ansys
11	Crash analysis using LS Dyna
12	Case studies and working on projects
13	Case studies and working on projects
14	Case studies and working on projects

ME5591	SEMINAR	PCC		2 Credits

COURSE OUTCOMES:

CO1	Identify and compare technical and practical issues related to the area of course specialization.
CO2	Outline annotated bibliography of research demonstrating scholarly skills.
CO3	Prepare a well organized report employing elements of technical writing and critical thinking
CO4	Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	2	2	1	1	2	-	1
CO2	1	1	2	2	1	1	2	2	-	1
CO3	-	-	-	1	-	1	1	1	1	1
CO4	-	-	1	2	2	1	2	2	-	1

ME6542	COMPREHENSIVE VIVA - VOCE	PCC	0-0-3	4 Credits

COURSE OUTCOMES:

CO1	Comprehend the knowledge gained in the course work
CO2	Infer principles of working of automotive systems and controls
CO3	Demonstrate the ability in problem solving and to communicate effectively

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	2	2	2	2	2	-	1
CO2	1	2	2	2	3	3	3	2	1	-
CO3	-	-	3	-	3	3	-	-	-	1

ME6549	DISSERTATION PART – A	PCC		8 Credits

COURSE OUTCOMES:

CO1	Identify a topic in advanced areas of Automobile Engineering
CO2	Review literature to identify gaps and define objectives & scope of the work
CO3	Employ the ideas from literature and develop research methodology
CO4	Develop a model, experimental set-up and / or computational techniques necessary to meet the objectives.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	-	1	-	-	2	1	-	1
CO2	1	2	2	2	1	1	1	1	-	1
CO3	2	1	1	2	1	-	2	2	-	1
CO4	-	-	1	2	2	2	1	-	-	-

ME6549	DISSERTATION PART – B	PCC		18 Credits

COURSE OUTCOMES:

CO1	Identify methods and materials to carry out experiments/develop code
CO2	Reorganize the procedures with a concern for society, environment and ethics
CO3	Analyze and discuss the results to draw valid conclusions
CO4	Prepare a report as per the recommended format and defend the work.
CO5	Explore the possibility of publishing papers in peer reviewed journals/conference proceedings.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	1	1	-	1	2	2	-	1
CO2	-	1	2	-	3	-	1	-	-	2
CO3	-	2	2	-	3	2	1	2	1	1
CO4	-	-	-	-	-	-	-	2	-	1
CO5	-	-	-	-	-	-	-	-	-	1