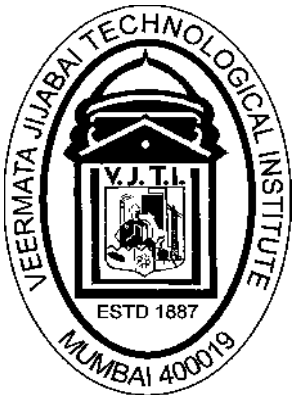
VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE

(VJTI)

MATUNGA, MUMBAI 400 019

(Autonomous Institute affiliated to University of Mumbai)



Curriculum

(Scheme of Instruction & Evaluation and Course contents)

For

Two Year Postgraduate Programme Leading to

Master of Technology (M.Tech.) Degree in

Mechanical Engineering with specialization in Automobile Engineering

Implemented from the batch admitted in Academic Year 2014-15

PROGRAMME EDUCATIONAL OBJECTIVES

1. To achieve competency in the subject domain of chassis body, vehicle dynamics, Engines, Vibration, Reliability; required for Mechanical Engineering problems.

2. To implement analytical and computational skills to formulate and solve problems related to thrust areas in Automobile Engineering.

3. To carry out research and development activity and recognize the need for lifelong learning with ethical and professional responsibility

The students should have –

PO1 Gain knowledge of the concepts of Automobile.

PO 2 Ability to apply knowledge to solve complex problems in Automobile.

PO 3 Capability to analyse / design / optimize of automobile systems

PO 4 Development of selfcritical thinking in evaluating technical solutions.

PO 5 Ability to communicate effectively and develop leadership skills to function in multidisciplinary teams.

PO 6 Inculcate desire and ability to do research work.

PO 7 Ability to use and update the techniques, skills, and modern engineering tools necessary for engineering practice.

PO 8 Ability to understand professional and ethical responsibility.

MECHANICAL ENGINEERING DEPARTMENT

PROPOSED SCHEME M. TECH. AUTOMOBILE ENGINEERING

Draft Scheme for M.Tech Automobile to be implemented from AY 2014-15

Semester-I

Scheme of Instruction				Scheme of Evaluation				
Sr. No.	**Course Code**	**Course Title**	**L-T-P (Hr/Week)**	**Credits**	**TA**	**IST**	**ESE**	**ESE Hour**
1	ME5011S	Computational Methods	3-1-0 =4	4	20	20	60	3
2	ME5012S	Chassis and Body Engineering	3-1-0 = 4	4	20	20	60	3
3	ME5013T	Advanced Internal Combustion Engines	3-0-0 = 3	3	20	20	60	3
	ME5013P	Advanced Internal Combustion Engine Lab	0-0-2 = 2	1	100% CIE			3
4	ME5014T	Machine Dynamics & Vibration	3-0-0 = 3	3	20	20	60	3
	ME5014P	Machine Dynamics & Vibration Lab	0-0-2 = 2	1	100% CIE			
5		Program Elective Course1	3-1-0 = 4	4	20	20	60	3
6		Program Elective Course2	3 -0 -0 = 3	3	20	20	60	3
		Program Elective Course2 Lab	0-0-2 = 2	1	100% CIE			
		Total Hours	27	24				

Abbreviations: **L**: Lecture, **T**: Tutorial, **P**: Practical, **TA**: Teacher Assessment / Term work Assessment, **IST**: In Semester Tests (comprise of average of two In Semester Tests), **ESE**: End Semester Written Examination, **CIE**: Continuous In-semester Evaluation

Semester-II

Scheme of Instruction				Scheme of Evaluation				
Sr. No.	**Course Code**	**Course Title**	**L-T-P (Hr/Week)**	**Credits**	**TA**	**IST**	**ESE**	**ESE Hour**
1	ME5015S	Research Methodologies	3-1-0 =4	4	20	20	60	3
2	ME5016S	Design of Suspension Systems	3-1-0 = 4	4	20	20	60	3
3	ME5017T	Vehicle Dynamics	3-0-0 = 3	3	20	20	60	3
	ME5017P	Vehicle Dynamics Lab	0-0-2 = 2	1	100% CIE			3
4	ME5018T	Design of Automobile Transmission Systems	3-0-0 = 3	3	20	20	60	3
	ME5018P	Design of Automobile Transmission SystemLab	0-0-2 = 2	1	100% CIE			
5		Program Elective Course 3	3-0-0 = 3	3	20	20	60	3
6		Program Elective Course 4	3 -0 -0 = 3	3	20	20	60	3
		Program Elective Course 4 Lab	0-0-2 = 2	1	100% CIE			
7	ME5801D	Technical Seminar	0-0-4 = 4	2	100% CIE			
		Total Hours	30	25				

Abbreviations: **L**: Lecture, **T**: Tutorial, **P**: Practical, **TA**: Teacher Assessment / Term work Assessment, **IST**: In Semester Tests (comprise of average of two In Semester Tests), **ESE**: End Semester Written Examination, **CIE**: Continuous In-semester Evaluation

Semester III & IV – Project Work

Sr. No	Course Category	Course Title	Credits	Evaluation pattern	Semester
1.	ME6901D	Stage –I Presentation	4	Graded evaluation by a committee of at least two examiners including supervisor (guide)	III (As per Academic calendar)
2.	ME6902D	Stage –II Presentation	4	Graded evaluation by a committee of at least two examiners including supervisor (guide)	III (As per Academic calendar)
3	ME6903D	Stage –III Presentation	4	Graded evaluation by a committee of at least two examiners including guide (guide)	IV (As per Academic calendar)
4.	ME6904D	Presentation and Final Viva Voce	12	Graded evaluation by a committee of at least two examiners including supervisor (guide) and an external examiner	IV (As per Academic calendar)

List of Electives1:

Sr. No.	Course code	Course Title
1.	ME5118S	System Modeling & Analysis
2.	ME5119S	Energy Conservation &Management
3.	ME5120S	Reliability Engineering

List of Electives 2:

Sr. No.	Course code	Course Title
1	ME5111T	Vehicle Performance
	ME5111P	Vehicle Performance Lab
2	ME5147T	Finite Element Methods
	ME5147P	Finite Element Methods Lab

List of Electives 3:

Sr. No.	Course code	Course Title
1.	ME5112S	Automotive Materials
2.	ME5113S	Condition Monitoring

List of Electives 4:

Sr. No.	Course code	Course Title
1	ME5114T	Computational Fluid Dynamics
	ME5114P	Computational Fluid Dynamics Lab
2	ME5115T	Automotive Electronics
	ME5115P	Automotive Electronics Lab
3	ME5116T	Robotics
	ME5116P	Robotics Lab

Programme Name:		M. Tech. (Mechanical) Automobile Engineering					SEMESTER –I
Course Code:		ME5011S					
Course Title:		Computational Methods					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	1	-	4	20	20	60	100
Outcomes		The students should be able to 1. Solve algebraic equations and Eigen value problems 2. Analyse data using interpolation and regression methods. 3. Apply concepts of vector spaces & different transformation techniques for problem solving. 4. Apply optimization, numerical methods , statistical methods to solve engineering problems					

CONTENTS:

1	**Algebraic Equations**
	Formulation and solution of linear system of equations, Gauss elimination, LU, QR decomposition, iteration methods (Gauss-Seidal), convergence of iteration methods. Eigen Value problems
2	**Interpolation & Regression Methods**
	Newton's divided difference, interpolation polynomials, Lagrange interpolation polynomials, Linear and non-linear regression, multiple linear regression, general linear least squares
3	**Transform Techniques**
	Vector spaces, Basis vectors, Orthogonal/Unitary transform, Fourier transform, Laplace transform
4	**Optimization Techniques for Engineers**
	Local and global minima, Line searches, Steepest descent method, Conjugate gradient method, Quasi Newton method, Penalty function
5	**Numerical Methods**
	Trapezoidal rule,Simpson's $1/3^{rd}$ and $3/8^{th}$ rule. Newton Ralphson Method, Numerical differentiation & integration.
6	**Statistical Methods**
	Uncertainty analysis for data reduction ,Data Sampling

Tutorials:
Two tutorials on each module covering relevant engineering applications

Text Books:

1. Steven C. Chapra and Raymond P. Canale, "Numerical Methods for Engineers'', McGraw Hill, 1st Edition, 1999.
2. Hines and Montrogmery, John Willey, "Probability and Statistics in Engineering and Management Studies",2nd Edition,1993.
3. Santosh Gupta, "Numerical Methods for Engineers", New age international publishers2nd Edition, 1992.

Programme Name:		M. Tech. (Mechanical) Automobile Engineering					SEMESTER –I
Course Code:		ME5012S					
Course Title:		Chassis and Body Engineering					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	1	-	4	20	20	60	100
Outcomes		The student should be able to – 1. Evaluate various analytical techniques for vehicle body engineering. 2. Design different frames types, to minimize the deformation in the body. 3. Analyze the effects of vibration, noise and ergonomics of the vehicle. 4. Evaluate various methods in vehicle body manufacturing.					

Contents:	
1	**Introduction to vehicle body engineering and various systems mounted on frames:** Vehicle body type and layouts, load distribution, dynamic loading, Aerodynamic drag on cars and commercial vehicle, drag reduction chassis frames for commercial vehicles, analysis of frame structure and application to chassis frames.
2	**Body Types and constructions:** Integral construction for cars, structural analysis integral chassis, application of theory of plates, shell to body components, principles of thin walled beams. Shear centers.
3	**Noise control:** Noise and vibration sources, Effects of vibration on various components of vehicle and comfort of passengers. Engine, body panel, tyre and vibration damping and absorption.
4	**Safety consideration:** impact protecting desirable crash characteristics. CMV(Central Govt. Motor Vehicle acts) rules and regulations.
5	**Vehicle Ergonomics:** driver visibility and passenger seating and controlling arrangements for more safety.

Text Books:

1 Reimpell J.,"The automotive chassis: Engineering principle", 2nd Edition, 1983.

Programme Name	:	M. Tech. (Mechanical) Automobile Engineering	SEMESTER –I
Course Code	:	ME 5013 T	
Course Title	:	Advanced Internal Combustion Engines	

L	T	P	Credits	TA	IST	ESE	Total
3	-	-	3	20	20	60	100

Outcome	The student should be able – 1.Examine the effect of engine variables on the combustion process in S.I. and C.I. engines. 2.Analyze the performance of naturally aspirated and supercharged internal combustion engines. 3.Compare the performance of various sub systems employed in the engines. 4.Evaluate the data of engine emissions and suggest solutions.

Content:

1	**Introduction and Classification of I.C. Engines:** Comparative study of two stroke and Four stroke engines. Classification based on other parameters. Applications.
2	**Cycle Analysis of I.C. Engines:** Air standard cycles, Fuel air cycles, Actual cycles of operation, Valve timing diagrams.
3	**S.I. Engines:** Induction system- Air intake, volumetric efficiency, factors influencing the volumetric efficiency. Carburetion - Theory of Carburetion. Simple carburetor, various systems of actual Carburetor. Types of Carburetors (refer mfg. Manuals of present day vehicles) Petrol Injection- Advantages of injection, MPFI systems Ignition System – Battery and Magneto Ignition Systems, Electronic Ignition Systems Combustion in S.I. Engines- Pressure - crank angle diagram, Stages of combustion, Ignition Delay, Flame Propagation, Afterburning. Abnormal Combustion – Auto ignition, Effects of auto ignition factors affecting combustion & auto ignition/detonation,. Control of abnormal combustion Principles involved in combustion chamber design, Types of combustion chambers used in S.I. engines.
4	**C.I. Engines:** Intake of air, volumetric efficiency, factors influencing the volumetric efficiency. Fuel Injection Systems - Types of fuel injection systems, viz. Common rail, individual

	pump, and distributor and unit injector systems. High pressure fuel injection pumps. Type of Nozzles. Necessity of Governor in Diesel engines. Combustion in C.I.Engines- Pressure–Crank angle diagram, combustion phenomenon in C.I. Engines, Stages of combustion, importance of delay period. Abnormal combustion, Knocking, Factors affecting combustion and knocking. Types of combustion chambers used in C.I. engines
5	**Supercharging/Turbo charging:** Objectives of Supercharging /Turbo charging, Effect of Supercharging / Turbo charging on power output & efficiency of engine. Methods of Supercharging / Turbo charging, Types of Superchargers/Turbochargers. Limits of Supercharging / Turbo charging.
6	**Performance Characteristics of S.I. & C.I. Engines:** Heat transfer in an engine, Losses, Unit air charge/ volumetric efficiency, Indicated efficiency, Mechanical efficiency, Brake thermal efficiency, Effect of load and speed on indicated, mechanical, brake thermal & volumetric efficiencies. Torque, Mean Effective Pressure, Specific Fuel consumption (Indicated and Brake parameters for all of these)Heat balance for an engine. Methods of determining indicated power of the engine.
7	**Air Pollution due to I.C. Engines:** Air/Fuel Ratio with the help of exhaust gas analysis, various pollutants and sources of pollution in the engine. Pollution control devices, EURO standards/ Bharat Standards.
8	**Alternate fuels and engines:** Alternate fuels for I.C. Engines, CNG, LPG, Stratified Charge and Wankel engines.
12	**Recent Developments in I.C. Engines.**

Text Books:

- E.E.Obert, “Internal Combustion Engines”, Harper and Row Publishers, Based on Third Edition.
- V.Ganesan, “Internal Combustion Engines”, Tata McGraw Hill 2003 Edition.

Reference Books :

- C.F.Taylor, “Internal Combustion Engines”, Vol. I and II, MIT Press, 1985 Revised Edition.
- Richard Stone, “Internal Combustion Engines”, Palgrave publications 1999 Third Edition.

- John Heywood, “Internal Combustion Engines”, McGraw Hill company 2011 Indian Edition.
- C.R.Ferguson, A.T.Kirkpatrick, “Internal Combustion Engines”, John Wiley& Sons(Asia), Second Edition.

Programme Name	**:**	**M. Tech. (Mechanical) Automobile Engineering**			**SEMESTER –I**	
Course Code	**:**	**ME 5013 P**				
Course Title	**:**	**Advanced Internal Combustion Engines Lab.**				
L	**T**	**P**	**Credits**	**ISE**	**ESE**	**Total**
-	-	2	1	50	50	100
Outcome		The student should be able – 1. Evaluate the performance of a naturally aspirated I.C.Engine 2. Evaluate the performance of a Supercharged I.C.Engine 3. Compare the subsystems used in I.C. Engines				

List of Experiments:

- To dissemble an engine and study the internal details and different sub systems.
- To perform a Load Test on a CI engine, and evaluate the brake parameters' variation with respect to load.
- To perform a Heat Balance on a C.I. Engine, and to analyze the heat flow to various systems. To suggest improvements in the performance by reduction of heat losses.
- To perform a Load Test on an S.I.Engine, and evaluate the brake parameters' variation with respect to load.
- To perform a Speed Test on an S.I.Engine and to evaluate its performance with respect to speed.
- To perform a Morse Test on an S.I.Engine to find out the frictional power and indicated parameters of the engine, their variation with respect to load and speed.
- To perform a Load Test on a Turbocharged Engine, to evaluate the performance parameters and to compare all these with the performance of a naturally aspirated engine.

Assignments:

- Numerical problems based on Engine Design.
- Report on recent developments and current thrust areas in the field.

Programme Name	**:**	**M. Tech. (Mechanical) Automobile Engineering SEMESTER – I**
Course Code	**:**	**ME5014T**
Course Title	**:**	**Machine Dynamics and Vibration**
Course Outcomes		Students should be able to 1. Solve real life problems using 3D vector mechanics. 2. Formulate mathematical model of vibratory system under given input conditions. 3. Estimate response of the system. 4. Evaluate response of the system

CONTENTS:-

I.	**Machine Dynamics**
1	Kinematics of Rigid bodies: First and Second time derivatives of a vector fixed in moving reference frame – velocity and acceleration of a point on rigid body – moving on rigid body. Relationship of time derivatives of vector for different reference frames, Coriolisforce .
2	Inertia tensor: Definition of inertia quantities, Translation of coordinate axes, transformation properties of inertia terms, Tensor notations of transformation, Ellipsoid of inertia, Principal moment of inertia.
3	Dynamics of Rigid Bodies: Angular momentum and its time derivative for a particle and system of particles. Euler's Equation of motion, Applications of Euler's equation, Fixed point rotation.
II. Mechanical Vibration	
4	Single degree of freedom: Undamped& Damped vibration, forced vibration. Multi degree of freedom: Free vibration, modes & mode shape, nodes, Exact and approximate solution methods. Lagrange equation for problem formulation. Two degree of freedom system – co-ordinate coupling - solution.
5	Vibration under general force conditions: Response under periodic and Non periodic force, Solution using Laplace and Fourier transform, Numerical Methods.
6	Vibration of continues systems: Transverse vibration of cable, Longitudinal vibration of bar/rod, Lateral vibration of Beam, Torsion vibration of shaft Rayleigh's method; Rayleigh Ritz method.
7	Vibration control: Balancing of reciprocating and rotating masses, controlling natural frequencies, vibration isolation, vibration absorber
8	Vibration Measurement and applications: Vibration measuring instruments, Exciters/shakers, Signal analysis, Experimental modal analysis
9	Introduction to non-linear vibration

Term work:

1. Assignments
2. Seminars/ Case studies

References:

1. S. S. Rao, "Mechanical Vibration", 5th Ed, 2004.
2. I. H. Shames, "Engineering Mechanics Statics &Dynamics", 4th Ed.
3. Srinivasan, "Non-Linear mechanical vibration", 1stEdition, 1996.
4. S. Graham Kelly, "Fundamentals of Mechanical vibration", 3rd Edition,McGraw Hill Book Company.
5. Thomas Kane, "Dynamics – Theory and Applications", 1st Edition, McGraw Hill Book Company.

Programme Name	**:**	**M. Tech. (Mechanical) Automobile Engineering SEMESTER – I**
Course Code	**:**	**ME5014P**
Course Title	**:**	**Machine Dynamics and Vibration Lab**
Course Outcomes		Students should be able to 1. Analyse various mechanism. 2. Perform the Experiments, and interpret the results of various vibratory systems. 3. Use computer codes to solve vibration problems.

CONTENTS:-

1. Complete analysis of any 4 or higher bar Mechanism
2. Experimental analysis of –
   a. unbalanced rotor,
   b. Bent shaft,
   c. faulty bearing,
   d. misalignments

   using Machinery Fault simulator.
3. Solution to the multi degree problems using codes / software
4. Seminar / Case studies

Examination will be conducted at the end of semester.

Programme Name:		M. Tech. (Mechanical) Automobile Engineering				SEMESTER – I	
Course Code:		ME5118S					
Course Title:		System modeling and analysis					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	-	2	3	20	20	60	100
Outcomes		Students should be able to 1. Model Mechanical, electro-mechanical, hydraulic and pneumatic systems. 2. Estimate and evaluate steady state and transient response for various input conditions. 3. Use numerical and state space approach for finding solutions.					

CONTENTS:

Module 1	**Mathematical Modeling Mechanical Elements** Introduction,Inertia, Stiffness and damper and Mathematical modeling of Mechanical System,Vehicles,Articulated Vehicle and other Mechanical System Modeling of Electro-Mechanical System
Module 2	**The Laplace transform** Introduction,Complex Numbers, Complex Variables, and Complex Functions, Laplace Transformation, Inverse Laplace Transformation, Solving Linear, Time-Invariant Differential Equations
Module 2	**Mathematical Modeling Hydraulic Elements and Systems** Pneumatic Element and System, Transfer Function Representation, Block Diagram, Step variable representation, Matrix Equation.
Module 3	**Numerical and other solution Methods of Differential and step variable equation**
Module 4	**Transient Response of First and Second order system** Steady State response, Step response, ramp response, Impulse response, sinusoidal response, Input-Convolution Integral, Stability of System.

TERMWORK:

1. Assignments

2. Seminar

REFERENCE BOOKS:

1. Hung V Vu &R.S.Esfandi, "Dynamic system Modeling and Analysis",2nd Edition,1999.
2. K.Oggata, "System Dynamics", 2nd Edition,1998.
3. I.J.Nagrath&M.Gopal,"Control System Engineering",3rd Edition,2005.
4. William J.Palm III, "System Dynamics",2nd Edition,1998.
5. Ellis, "Vehicle Dynamics",3rd Edition,2001.

Programme Name:		M. Tech. (Mechanical) Automobile Engineering					SEMESTER –I
Course Code:		ME5119S					
Course Title:		Energy Conservation and Management.					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	1	-	3	20	20	60	100
Outcomes		Students should be able to 1. Recognize the concepts of basic measurement, instruments for measuring various parameters in energy systems and energy auditing. 2. Apply Energy Planning and forecasting techniques for performing energy analysis. 3. Illustrate the current energy scenario, challenge of climate change & peak oil, importance of energy conservation and need for alternative energy resources. **4.** Integrate energy economics and relevance of sound energy policies for sustainable development					

CONTENTS:

1	**Introduction** Energy Scenario -world and India. Energy Resources Availability in India. Energy consumption pattern. Energy conservation potential in various Industries and commercial establishments. Energy intensive industries - an overview. Peak oil. Energy conservation and energy efficiency – needs and advantages.
2	**Pollution from energy generation** Coal and Nuclear based Power Plants – Fly Ash generation and environment impact, Fly ash utilization and disposal, nuclear fuel cycle, radioactive wastes – treatment and disposal- Environmental pollution limits guidelines for thermal power plant pollution control- Environmental emissions from extraction, conversion, transport and utilization of fossil fuels- Greenhouse effect- Global warming.

3	**Energy auditing and forecasting** **Energy auditing** - Definition, need, types of energy audit methodologies, barriers. Role, Duties and responsibilities of energy managers and auditors. – Energy audit questionnaire - Energy Conservation Act 2003. **Energy forecasting techniques -** Energy demand – supply balancing, Energy models, Simulation and forecasting of future energy demand consistent with macroeconomic parameters in India. Basic concept of Econometrics (OLS) and statistical analysis (Multiple Regression), Econometrics techniques used for energy analysis and forecasting with case studies from India.
4	**Energy conservation and management** Energy management (audit) approach: Understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies for – (a) Thermal utilities: operation and energy conservation (i)Boilers (ii) Thermic Fluid Heaters (iii)Furnaces (iv)Waste Heat Recovery Systems (v) Thermal Storage, A.C. & refrigeration systems; and (b) thermal energy transmission / protection systems such as Steam traps– refractories – optimum insulation thickness– insulation – piping design , optimizing the input energy requirements; Fuel & energy substitution.
5	**Energy economics** Investment - need, appraisal and criteria, financial analysis techniques - break even analysis-simple payback period, return on investment, net present value, internal rate of return, cash flows, DSCR, financing options, ESCO concept.
6	**Energy policies** National energy policy in the last plan periods, Energy use and Energy supply, Overview of renewable energy policy and the Five Year Plan programmers, Basic concept of Input-Output analysis, Concept of energy multiplier and implication of energy multiplier for analysis of regional and national energy policy- Carbon Trading- Renewable Energy Certification – CDM. The Sustainable Energy Utility (SEU) Model.

Recommended Reading

1. Bent Sorensen, "Renewable Energy: Physics, Engineering, Environmental Impacts, Economics and Planning", Fourth Edition, Academic Press, Elsevier Publication, 2011.
2. Laponche B., Jamet B., Colombier M, Attali S., "Energy Efficiency for a Sustainable World", First Edition, International Council for Energy Publication, Paris, France, 1997.
3. Y. P. Abbi, Shashank Jain, "Handbook on Energy Audit and Environment Management" First Edition, TERI Publications, 2006.

4. Hamies, Energy Auditing and Conservation; Methods Measurements, Management and Case study, Hemisphere, Washington, 1980.
5. YP Abbi and Shashank Jain. "Handbook on Energy Audit and EnvironmentManagement", TERI Publications, 2006.
6. Steve Doty, Wayne C. Tur ENERGY FORECASTING TECHNIQUES.
7. Guide book for National Certification Examination for Energy Managers and Energy Auditors (Could be downloaded from www.energymanagertraining.com)
8. R Loulou, P R Shukla and A Kanudia, "Energy and Environment Policies for a sustainable Future", Allied Publishers Ltd, New Delhi, 1997.
9. http://ceep.udel.edu/wp-content/uploads/2013/08/2009_es_BSTS_SEU_model_DE_Wash-DC_Houck_Rickerson_2.pdf.

Programme Name:		M. Tech. (Mechanical) Automobile Engineering					SEMESTER –I
Course Code:		ME5111T					
Course Title:		Vehicle Performance					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	-	-	3	20	20	60	100
Outcomes		Students should be able to 1 Compute different performance parameters associated with vehicle systems. 2 Apply the knowledge of vehicle dynamics for solving the problems. 3 Analyze and interpret the results of various vehicle systems. 4 Use modern tools and techniques to solve vehicle performance problems.					

CONTENTS:

1.	Introduction to vehicle system: Morphology of vehicles, General layout of passenger cars and commercial vehicle, Type of power units, Arrangement of power train, Vehicle controls
2.	Friction and rolling resistance of pneumatic tyres: Aerodynamics forces and moments, Relationship between tractive effort and longitudinal slip of tyres, cornering properties of tyres, Equation of motion and maximum tractive effort.
3.	Vehicle performance estimation and prediction: power plant characteristic and transmission related requirements, Vehicle acceleration, and max. Speed, Gradability Drive systems comparison.
4.	Vehicle transmissions: characteristics and features friction clutches, mechanical geared transmission lay shaft and epicyclic gearbox, Synchronizers, Fluid coupling and torque converters.
5.	Drive lines, two wheel drive, four wheel drive, braking arrangement, safety in braking, weight transfer steering, and cornering power of tyres.
6.	Handling characteristics of vehicles. Steering geometry, steady state handling characteristics, steady state response to steering input. Directional stability of vehicle. Effect of shock and vibration on human being, comfort criteria.

TERM WORK:

1. Assignments
2. Seminar

TEXTBOOK:

1. Rao J.S. and Gupta. K.,"Theory and Practice of Mechanical Vibrations", Wiley Eastern Ltd., 2nd Edition,2002.

2. J.Y. Wong, "Theory of ground vehicle", John Wiley and Sons Inc., New York,1st Edition, 1978.

3. Dr. N. K. Giri, "Automobile Mechanics", Seventh reprint, Khanna Publishers, Delhi, 3rd Edition,2005

Reference:

1. W.Steeds, "Mechanics of road vehicle", Illiffe Books Ltd, London3rd Edition, 1992.
2. J.G.Giles, "Steering, Suspension tyres", Illife Books Lid London1st Edition, 1975.
3. P.M .Heldt, "Automotive chassis", Chilton Co ,New York, 1st Edition,1982.
4. J. R. Ellis, "Vehicle Dynamics", Business Books, London, 2nd Edition,1969.

Programme Name	**:**	**M. Tech. (Mechanical) Automobile Engineering**				**SEMESTER –II**	
Course Code	**:**	**ME5026P**					
Course Title	**:**	**Finite Element Analysis lab**					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
-	-	2	1	50	-	50	100

Course Outcome:	Upon completing this course, the students will be able to: • Use commercial FEA software, to solve problems related to mechanical engineering.

DETAILED PRACTICALS

Assignment No.	Topic
Structural Analysis	
1	1-D Element Problems –Linear Static Analysis. The problem will included basic structural problems like bar and rod and linear analysis for the one dimensional problem and analysis. Solve the problem using ANSYS.
2	2-D Element Problems – Linear Static Analysis The problem will included basic structural problems like plates for the two dimensional problem and analysis.Also study of plane stress and Plane strain condition problems will be solved. Solve the problem using ANSYS.
3	3-D Element Problems – Linear Static Analysis The problem will included basic structural problems like for the three dimensional problem and analysis. Problem like corner plate, pulley like problems will be solved. Solve the problem using ANSYS.
4	Free Vibration Analysis on Beam, Bars ,Plates The problem will included basic vibrational problems like for the one dimensional problem and analysis. Problem like beam, plate, bar like problems will be solved using ANSYS
5	Non-Linear Analysis of 1-D Element Problems Like Beams,Bars The problem will included basic Non Linear problems like for the one dimensional problem and analysis. Problem like beam,bar like problems will be solved using ANSYS

Thermal Analysis(Conduction,Covection and Insulation Boundary Conditions.	
6	1-D Element Problems-Steady state And Transient Analysis 1-D elements problems will be solved for Steady State and Transient analysis will be solved using ANSYS.
7	2-D Element Problems of Homogeneous and Composite Slap in Steady State and Transient Analysis.2-D elements problems will be solved like plates and shell for Steady State and Transient analysis will be solved using ANSYS.
8	3-D Element Problems of Homogeneous and Composite Slap in Steady State and Transient Analysis.3-D elements problems will be solved like plates and shell for Steady State and Transient analysis will be solved using ANSYS.
9	Project-Creating or Importing and Map Meshing of 3-D component /Assembly of practical application and FEA Analysis of Same component /Assembly

NOTE:

Reputed FEA software like Hyper Mesh /Ansys will be used for above mentioned Assignments.

ASSESSMENT:

1. Term workAssessment based on submission (Softcopy & Hard Copy) of the above assignment

2. ESE (PracticalExamination)will be online type based on the Application of above assignment using HyperMesh /AnsysSoftware.

REFERENCE BOOKS:

1. Paleti Shrinivas,Krisha Chaitnay, Sambana, Rajesh Kumar Datti, "Finite Element Analysis using Ansys 11.0".
2. Saeed Moaveni , "Element Analysis Theory and Applications with ANSYS".
3. Y. Nakasone and S. Yoshimoto, "Engineering Analysis with ANSYS Software".
4. Erdogan Madenci, Ibrahim Guven Practicle,"The finite element method And applications in Engineering using ansys".
5. Finite Element Analysis by Nitin Gokhale of M/S Finite to Infinite.
6. Reference Manual of Hypermesh SoftwareOnline
7. Tutorial HyperMesh Software.
8. Tutorial of Ansys Software.

Programme Name:		M. Tech. (Mechanical) Automobile Engineering					SEMESTER –I
Course Code:		ME5147T					
Course Title:		Finite Element Analysis					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	-	-	3	20	20	60	100
Outcomes		The student should be able to– 1. Formulate numerical model for a given system. 2. Obtain numerical Solutions for boundary value problems. 3. Solve mechanical engineering problems using Finite Element Method					

CONTENTS:

Module 1	**Introduction to Finite Element Analysis** Introduction,Basic concept of Finite Element analysis,Discretization of continuum,Stiffness Matrix and Boundary Conditions,Introduction to elasticity ,Plane Stress and Plain strain Problem
Module 2	**Finite Element Formulation Techniques** Virtual Work and variationalprinciple,Variational Formulation of Boundary Value problem, Variational Method such as Ritz and weighted Residual methods. Galerkin Method Potential Energy Approach, Displacement Approach
Module 3	**Element Properties** Natural coordinates, Triangular Elements Rectangular Elements,Lagrange and Serendipity Elements,Solid Elements Isoparametric Formulation Stiffness Matrix for IsoparametricElements,Numerical Integration
Module 4	**Displacement Models** Convergence requirements,Shapefunctions,Element stresses and strains Strain—Displacement Matrix for Bar Element ,Strain Displacement Matrix for CST Element ,Strain Displacement Relation for Beam Element
Module 5	**Analysis of Frame Structure** Stiffness of Truss Members,Analysis of Truss,Stiffness of Beam Members Finite Elements analysis of Beam

Module 6	**FEM for Two Dimensional Solids** Constant and Linear Stain Triangle. Rectangular Elements,Finite Element Formulation for 2D elements. Axisymmetric Elements.Finite Element Formulation of Axisymmetric Elements Heat Transfer by conduction and convection for one dimensional and two dimensional elements,
Module 7	**Dynamic Analysis Using FEA** Introduction,Vibration Problems Equation of motion Based on weak form and Lagrange's Approach,Consistent and Lumped ass Matrices,Properties and Solution of Eigen Value Problems Transient Vibration Analysis ,Thermal transient-Unsteady heat Transfer in a Pin-Fin
Module 8	**Non Linear Analysis** Introduction,Geometric and Material Non Linearity,Stability Problems Elastoplastic analysis by FEM

Term work:

1. Assignments
2. Seminar

REFERENCE BOOKS

1. S.S.Bhavikatti, "Finite Element Analysis", New Age International Publication, 2nd Edition.
2. Desai and Abel, "Introduction to FEM", 2nd Edition.
3. Zienkiewicz & Taylor, "The Finite Element Method for Solid and Structural Mechanics Elsevier Publications",6th Edition,2005.
4. J. N. Reddy, "Finite Element Analysis", McGraw Hill Book Co.6th Edition 2010.
5. S. S. Rao, "Finite Element Method in Engineering",4th Edition, Dec. 2004Pergamon Press.
6. P. Sheshu, "Textbook on Finite Element Analysis",1st edition, Prentise Hall Publications.
7. Bathe and Wilson, "Finite Element Analysis",4th Edition 2010,Prentice Hall Publication.
8. T. *Chandrupatla* and A. D. Belegundu, "Introduction to Finite Element Analysis",3rd Edition, Prentice Hall.
9. Robert D. Cook, "Finite Element Modeling For Stress Analysis", 4th Edition John Wiley & Sons

Programme Name:		M. Tech. (Mechanical) Automobile Engineering					SEMESTER –I
Course Code:		ME5016S					
Course Title:		Design Of Suspension Systems					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	1	-	3	20	20	60	100
Outcomes		The student should be able to– 1. Design suspension systems. 2. Select appropriate material for specific requirements of suspension systems. 3. Analyze causes of failure of suspension systems in service.					

CONTENTS:

1.	Dampers: Damper Configurations, Ride leveling Dampers Position Dependent Dampers, Telescopic damper, Mountings, Operating speeds Strokes, Manufacture.
2.	Damper Characteristics: Basic damper parameters, Mechanical Friction, Static Forces, Linear Valve Analysis, Cavitation, Temperature, Compressibility, Cyclical characteristics, Damper Jacking
3.	Specifying a damper: Introduction, end fittings, length range, F(V) curve, configuration, diameter, oil properties, life, cost; active and passive suspensions
4.	Testing of Dampers: Transient Testing, Electromechanical Testers, Hydraulic Testers, Instrumentation, Data Processing, Sinusoidal Test theory, Test Procedures, Triangular Test, Laboratory tests, On - Road Testing
5.	Modeling of delayed dynamic systems: Mathematical models for dynamic systems with delayed feedback control, dynamic systems with operator's retardation.
6.	Stability analysis of linear delay systems: Delay independent stability of single degree of freedom systems
7.	Stability analysis of an active chassis :Quarter car model of suspension with a delayed sky-hook damper, four wheel steering with a time delay in driver's response.
8.	Stability analysis of an active suspension: Center manifold reduction; computation of the approximated center manifold; stability analysis

TEXT BOOKS:

1. John C Dixon, "The Shock Absorber Handbook", SAE Book Store, 1st Edition,1999.

2. Wolfgang Matschinsky, "Road Vehicle Suspensions", Wiley Publishers,2nd Edition,2003.

REFERENCE BOOKS:

1. Haiyan Hu, Zaihua Wang, "SpringerDynamics of Controlled Mechanical Systems with Delayed Feedback",Verlag Berlin Heidelberg Publication.,2nd Edition, 1982.
2. George Bossis, "Electro-rheological Fluids and Magneto-rheological Suspensions", World Scientific Publishing Co. Ltd., 2nd Edition,1982.

Programme Name:		M. Tech. (Mechanical) Automobile Engineering				SEMESTER –I	
Course Code:		ME5017T					
Course Title:		Vehicle Dynamics					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	-	-	3	20	20	60	100
Outcomes		Students should be able to 1. Interpret various forces in static and dynamic conditions. 2. Select analytical modeling for various vehicle dynamics systems. 3. Study vehicle dynamics, their properties, applications & selection of design parameters. 4. Compute effect ofvarious parameters onperformance of vehicle systems.					

Contents:

1	**Introduction**
	Terminology-vehicle dynamics, driver, vehicle, load ,environment Definition's- reference frame, toe-in, toe-out, wheel camber, design position of wheel axis, steering geometry
2	**Road**
	Modeling Aspect DeterministicProfiles-Bump And Potholes,SineWaves RandomProfiles- StasticalProperties, Classification Of Random Road Profiles, Realizations
3	**Tire**
	Introduction- development, composites, forces and torques, measurement, modeling Contact geometry-basic approach, tire deflection, length contact patch, static contact point, contact point velocity, dynamic rolling radiusForces and torques caused by pressure distribution-wheel load, tipping torque, rolling resistance,Friction forces and torques,First order tire dynamics
4	**Suspension system**
	Purpose and Components, Examples,Steeringsystems,Standard force element,Dynamic force element

5	**Vertical dynamics**
	Goals,Basictuning,Sky hook damper,Non-linear force element
6	**Longitudnal dynamics**
	Dynamic wheel load,Maximumacceleration,Driving and braking,Drive and brake pitch
7	**Lateral dynamics**
	kinematic approach,steady state cornering,simple handling model
8	**Driving behavior of single vehicles**
	Standard driving maneuvers,coach with different loading conditions,different rear axle concept for passenger car

Text Books:

1. J. R. Ellis, "Vehicle Dynamics", Business Books, London, 1st Edition1969
2. Vehicle dynamics-Dr. Georg Rill, 2ND Edition1992.

Programme Name:		M. Tech. (Mechanical) Automobile Engineering					SEMESTER –I
Course Code:		ME5017P					
Course Title:		Vehicle Dynamics Lab					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
-	-	2	1	100% CIE			
Outcomes		Students should be able to 1. Interpret various forces in static and dynamic conditions. 2. Select analytical modeling for various vehicle dynamics systems. 3. Study vehicle dynamics, their properties, applications & selection of design parameters. 4. Compute effect ofvarious parameters on performance of vehicle systems.					

Contents:

1.	Road: Various Road reactions, modeling considering the single degree freedom system
2.	Tire: Various Road reactions, modeling considering the single degree freedom system
3.	Suspension system Various Road reactions, modeling considering the single degree freedom system
4.	Vertical dynamics Various Road reactions, modeling considering the single degree freedom system
5.	Longitudinal dynamics Various Road reactions, modeling considering the single degree freedom system
6.	Lateral dynamics Various Road reactions, modeling considering the single degree freedom system
7.	Driving behavior of single vehicles Various Road reactions, modeling considering the single degree freedom system

Programme Name:		M. Tech. (Mechanical) Automobile Engineering					SEMESTER II
Course Code:		ME5018T					
Course Title:		Design of Automobile Transmission Systems					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	-	-	3	20	20	60	100
Outcomes		Students should be able to 1 Interpret the performance characteristics of various transmission components. 2 Evaluate various requirements of semi automatic transmission systems. 3 Design of various transmission components. 4 Analyze the performance of various lubrication systems.					

CONTENTS:

1	**Basic transmission principles**
	Introduction, Geared Transmissions, Hydraulic Drives, Electric Transmissions, Miscellaneous Mechanical Drives
2	**Design requirement of automatic transmissions**
	Starting Duty, Power Transmission Requirements, Range Of Transmission Ratios, Control Mechanism, Drivers Override,
3	**The development of mechanical gearbox**
	Sliding Gears, Constant Mesh Gears, Synchromesh Gearboxes, Full Torque And Automatic Gear Changes
4	**Semi-automatic transmissions**
	A Simplified Specifications, Automatic Clutches, Simplified Gear Changes
5	**Epicyclic gear trains**
	General Considerations, Advantages, Simple Epicyclic Gear, Automobile Epicyclic Gear, Compound Epicyclic Gear, Epicyclic Transmissions, Epicyclic Gear Ratios
6	**Automatic clutches and couplings**
	Centrifugal Clutch, Saxomat Automatic Clutch, Magnetic Clutch, Magnetic Fluid Clutch, Electromagnet Armature Clutch, Gravina Clutch, Fluid Couplings, Operation And Modification Of Fluid Couplings, Advantages And Types Of Fluid Couplings

7	**The torque convertor**
	Introduction, Terms , Combined Convertor And Coupling Unit, Convertor With Two Turbine Members , Convertor With Three Turbine Members, Convertor With Three Stator Members, Automobile Torque Convertor Arrangements, Blade Angles And Fluid Flow, Simple And Variable Blade Angles, Convertor Fluids, Cooling, Stall Speed, Towing
7	**Hydrodynamic lubrication**
	Design Of Plain Fixed And Tilting Pads, Slider Bearing For Steady And Varying Loads, Full And Partial Journal Bearings ,Design Of Journal Bearing For Steady And Varying Loads, Hydrostatic And Aerostatic Bearing, Thrust And Radial Bearing.
8	**Lubricants**
	Selection For General Application And Special Application Such As High Temperature Low Temperature, Extreme Pressure.

TEXT BOOKS:

1. Andras Z. Szeri, "Fluid film lubrication theory and design",2nd Edition, 1992.
2. J.G. Giles, "Automatic and fluid transmissions",1st Edition1969.
3. Arthur w. Judge, "Modern transmission systems",1st Edition, 1973.

REFERENCE BOOKS:

4. Rohner,"Industrial hydraulics",2nd Edition, 1969.
5. John Pippenger,"Industrial hydraulics",1st Edition, 1969.

Programme Name:		M. Tech. (Mechanical) Automobile Engineering					SEMESTER II
Course Code:		ME5018P					
Course Title:		Design of Automobile Transmission Systems lab					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
-	-	2	1	100% CIE			
Outcomes		Students should be able to 1. Interpret the performance characteristics of various transmission components. 2. Analyze the models of various transmission systems**.** 3. Evaluate the performance of various lubrication systems.					

CONTENTS:

1.	Design requirement of automatic transmissions
2.	The development of mechanical gearbox
3.	Semi-automatic transmissions
4.	Epicyclic gear trains
5.	Automatic clutches and couplings
6.	The torque convertor
7.	Hydrodynamic lubrication

TEXT BOOKS:

1. Andras Z. Szeri, "Fluid film lubrication theory and design", 2nd Edition, 1992.
2. J.G. Giles, "Automatic and fluid transmissions", 1st Edition, 1969.
3. Arthur w. Judge, "Modern transmission systems", 1st Edition, 1973.

REFERENCE BOOKS:

1. Rohner, "Industrial hydraulics",2nd Edition, 1969.

2. John Pippenger, "Industrial hydraulics", 1st Edition, 1969.

Programme Name:		M. Tech. (Mechanical) Automobile Engineering					SEMESTER II
Course Code:		**ME5112S**					
Course Title:		Automotive Materials					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	-	-	3	20	20	60	100
Outcomes		Students should be able to 1. Examine various composite, carbon fiber and superalloy & their significance. 2. Select appropriate material for specific requirements. 3. Analyze effect of alloying elements on properties. 4. Identify various defects and failure mechanisms.					

CONTENTS:

1	Introduction: Wrought Aluminium alloys & lightweight magnesium for automotive applications and cast aluminum processes. Technologies: Cast aluminum metallurgy and properties; new lightweight alloys; process technologies; mechanical and physical properties; case studies of applications.
2	Testing automotive materials: Evaluation of materials under realistic loading and environmental conditions; different test methods for evaluation of properties for specific applications.
3	Composite materials for automotive applications: Definition, classification, types of materials & reinforcements, characteristics & selection, fiber composites, laminated composites, particulate composites, prepegs, sandwich construction.
4	Manufacturing composite materials: Lay-up and curing – open and closed mould processing-Hand lay–up techniques–Bag moulding and filament winding. Pultrusion, pulforming, Thermoforming, Injection moulding, Cutting, Machining and joining, tooling, Quality assurance – Introduction, material qualification, types of defects, NDT methods.
5	Metal matrix composites: Reinforcement materials, types, characteristics& selection, base metal, selection, applications in automotive engineering.
6	Micro mechanical analysis of a lamina: Introduction, evaluation of the four elastic modules – Rule of mixture, ultimate strengths of unidirectional lamina.

7	Macro mechanics of a lamina: Hooke's law of different types of materials, number of elastic constants; two – dimensional relationship of compliance & stiffness matrix. Hooke's law for two dimensional angle lamina, engineering constants – angle lamina, invariants, theories of failure.
8	Macro mechanics of laminates: laminates coding, ABD matrices, classical laminates theory, special cases of laminates, strength theories of laminates.
9	Superalloy: Historical development, different superalloys and their classification and their phase
10	Carbon fiber: Classification, manufacturing processes and application

REFERENCES BOOKS:

1. James M Boileau "Developments in Lightweight Alloys for Automotive Applications", 2001-2005, SAE (Product Code PT-130).
2. ThomesRuden, "Lightweight Magnesium Technology-2001 through 2005, SAE (Product code PT-131).
3. Donald H Wright "Testing Automotive Materials & Components" SAE (Product Code R-124).
4. Krishan K. Chawla "Composite material science and Engineering" Springer.

P.C. Mallik Marcel Decker "Fiber reinforced composites.

Programme Name:		M. Tech. (Mechanical) Automobile Engineering					SEMESTER –II
Course Code:		ME5114T					
Course Title:		Computational Fluid Dynamics					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	-	-	3	20	20	60	100
Outcomes		The student should be able – 1. Analyze methodologies used in CFD. 2. Apply finite volume method to heat transfer and fluid flow problems. 3. Develop computer codes for simulation of heat transfer and fluid flow problems.					

1	**Introduction:** Definition and overview of CFD, need, Advantages of CFD, Numerical Vs. Analytical Vs. Experimental, Applications of CFD, CFD methodology, grid independence, Verification and validation
2	**Governing equations of mass, momentum and energy :** Derivation, Discussion of physical meanings and presentation of forms particularly suitable to CFD, Boundary Conditions – Dirichlet, Neuman, Robbins, initial conditions, mathematical behavior of partial differential equations – Elliptic, parabolic & hyperbolic equations, impact on CFD
3	**Discretization methods** – Introduction to Finite Difference Method, Finite Volume Method, Finite Element Method. Concepts of Convergence, consistency, stability. **Finite Difference method** – Introduction to finite differences, difference equation, Solution of discretized equations, Direct methods and iterative methods, Tri Diagonal Matrix Algorithm, iterative convergence
4	**Finite volume method for diffusion problems (Conduction)**: Steady state one dimensional heat conduction with or without heat generation, dealing with Dirichlet, Neumann, and Robins type boundary conditions, Multi-solid heat conduction, Non-linear Heat Conduction, Unsteady heat conduction- Explicit, Crank-Nicolson , implicit schemes, two dimensional steady and unsteady heat conduction. Gauss-Seidal point by point and line by line TDMA methods.
5	**Finite volume method for Advection-diffusion problems (Convection-conduction)**: One dimensional convection-diffusion problem - Advection schemes-Central, first

	order upwind, hybrid, power law, Second order upwind, QUICK etc., Properties of advection schemes – Conservativeness, boundedness, transportiveness, False diffusion, Extension to two dimensional steady and unsteady advection – diffusion
6	**Solution algorithms for pressure velocity coupling in steady flows:** Staggered grids, SIMPLE, SIMPLER, SIMPLEC, PISO algorithms, unsteady flows
7	**Turbulence modeling:**Turbulence, its effect on governing equations,Reynolds averaged Navier-Stokes equations, introduction to turbulence modeling - DNS, LES, . k-ε , k-ω, RSM models
8	**Introduction to Grid Generation**: Structured and Unstructured Grids, General transformations of the equations, body fitted coordinate systems, Algebraic and Elliptic Methods, multi block structured grids, adaptive grids

References

1. S V Patankar, "Numerical Heat Transfer and Fluid Flow", Special Indian Edition, Hemisphere, 1980.
2. H K Versteeg and W. Malalasekera, "An Introduction to Computational Fluid Dynamics-The Finite Volume Method", Second Indian Edition, Pearson Education, 2008
3. John. D. Anderson, Jr., "Computational Fluid Dynamics - The basics with applications", McGraw-Hill International edition, 1995.
4. A.W. Date, "Introduction to Computational Fluid Dynamics", Cambridge, 2005.
5. Ferziger and Peric, "Computational Methods for Fluid Dynamics", 3rd Edition, Springer, 2008.

Programme Name:		M. Tech. (Mechanical) Automobile Engineering					SEMESTER –II
Course Code:		ME51116T					
Course Title:		Robotics					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	-	-	3	20	20	60	100
Outcomes		The student should be able – 1. To analyze and evaluate various types Robots and their applications 2. To develop working knowledge of minimum 5 Axis Robot 3. To justify economics of Robots in the modern manufacturing industry and other miscellaneous applications 4. To apply techniques like Robot Vision, Task Planning, Trajectory To make use of techniques like Robot Vision, Task Planning, Trajectory Planning while performing various types of applications					

CONTENTS:

1	**Introduction to Robotics** : Automation & Robotics, Robotic Systems & Anatomy of Robot, Classification, Future prospectus
2	**Drive Technologies**: Control loops, Basic control system concepts & models, control system analysis Robot activation & feedback components, position & velocity sensors, Actuators, Power transmission systems.
3	**Robot and its Peripherals**: End effectors- types, Mechanical & other grippers, Tool as end effecter, Sensors: Sensors in robotics, Tactile sensors, Proximity and range sensors, Sensor based system, User vision systems-Equipment
4	**Robot Kinematics**: Forward, Reverse &homogeneous transformations, Manipulator path control, Robot Dynamics.
5	**Robot Vision**: Introduction, Low level & high level vision, Sensing &digitizing, Image processing & analysis, Segmentation, Edge detection, Object recognition & description, Interpretation, Application
6	**Robot Intelligence & Task Planning**: Introduction, State space search, Problem solving, Robot learning, Robot task planning.
7	**Programming for Robots**: Methods, Robot program as a path in space, Motion

	interpolation, Level & task level language, Robot Languages, Programming in suitable languages, Characteristics of robot.
8	**Robotic Applications in Manufacturing**: Material transfer, Machine loading & unloading, Processing operations, Assembly &Inspections, Robotic cell design & control.
9	**Future Prospects of Robots:**Discussion of Social issues due to developments of Robots, Economics of Robots, Future Scope of Robots.

Text Books:

1 Saeed B. Niku, "Introduction to Robotics", John Wiley & Sons, 2nd Edition, 2010.

2 James L. Fuller, "Robotics Introduction, Programming and Projects", Macmillan Publishing Company, New York, 1st edition, 1991.

3 T. C. Manjunath, "Fundamentals of Robotics", Nandu Printers & Publishers, Mumbai, 5th edition,2007.

Reference Books :

1 John Craig, "Robotics", Pearson/Prentice Hall, 3rd edition, 2005.

2 R.K. Mittal and I. J. Nagrath, "Robotics & Control", Tata McGraw-Hill, New Delhi,2nd edition, 2003.

3 Robert Joseph Schilling, "Fundamentals of Robotics", Prentice Hall, 1 edition, 1990.

4 Paul R. P. "Robot Manipulators : Mathematics, Programming & Control", MIT Press,2nd edition, 1981.

5 K. Ogata, "Modern Control Engineering", Prentice Hall, 3rd edition, 1994.

7 Groover and Simmers, "Industrial Robotics", Tata McGraw-Hill, New Delhi,2nd edition, 2012.

Programme Name:		M. Tech. (Mechanical) Automobile Engineering					SEMESTER –II
Course Code:		ME5015S					
Course Title:		Research Methodology					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	1	-	3-1-0	20	20	60	100
Outcomes		Students should be able to 1. Apply fundamentals of concepts, construct, and theory. 2. Develop capability to undertake empirical and quantitative research with software using scientific methods. 3. Demonstrate skill of writing technical reports in standard format.					

1. Introduction of Research Methodology:

- Meaning and purpose of research.
- Objective of research.
- Types of research.
- Significance and approaches for research.
- Research Process and criteria.
- Scientific methods
- Problems encountered by researchers in India.

2. Research problem definition and Research Design:

- Meaning of Research problem.
- Identification, selection and formulation of Research Problem.
- Meaning of Research Design.
- Need of Research Design.
- Features of a Good Research Design.
- Different types Research Design.

3. Sampling Design and Measurement Techniques:

- Steps in sample design.
- Characteristics of a Good Sample Design.
- Different types of Sample Design.
- Measurement in Research.
- Measurement scales.

- Sources of Errors in Measurement.

2. Methods of Data Collection:

- Methods of Data collection.
- Difference between Questionnaire and Schedule.
- Selection Method for Data Collection.

3. Sampling Fundamentals:

- Need for sampling.
- Sample Distributions.
    - Mean distribution.
    - Student's T-distribution.
    - F- Distribution.
    - Chi-square distribution.

4. Hypothesis:

- What is Hypothesis?
- Concept and procedure of Hypothesis Testing.
- Flow diagram and test for Hypothesis.

5. ANOVA:

- Basic principle of ANOVA.
- ANOVA Techniques.
- One way- Two-way Method for ANOVA.

6. Technical Paper and Report Writing:

- Basic concept of paper writing and report writing.
- Literature review.
- Concept of Bibliography and References.
- Methods of presentation of report.
- Introduction to Latex.(https://www.sharelatex.com/ or Texmaker)

Reference Books:

1. Research Methodology: Methods and Techniques by C.R. Kothari.
2. Design and Analysis of SyExperiments, by D.C. john Willey.

Programme Name	**:**	**M. Tech. (Mechanical) Automobile Engineering**					**SEMESTER –II**
Course Code	**:**	**ME5114P**					
Course Title	**:**	**Computational Fluid Dynamics Laboratory**					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
-	-	2		100% CIE			100

Outcomes	The student should be able to – 1. Develop computer codes for simulation of heat transfer and fluid flow problems. 2. Implement CFD process by using CFD software. 3. Evaluate data obtained from the numerical solution

List of Experiments

Development of computer codes

1. To develop computer codes for steady state one dimensional heat conduction with or without heat generation, different boundary conditions, Multi-solid heat conduction, Non-linear Heat conduction, Unsteady heat conduction, two dimensional steady and unsteady heat conduction and comparison with analytical solution
2. To develop computer codes for one dimensional convection-diffusion problem to implement various advection schemes like - Central, first order upwind, hybrid, power law, Second order upwind, QUICK etc., two dimensional steady and unsteady convection – diffusion and comparison with analytical solution
3. To develop computer codes for implementation of pressure velocity couplings like SIMPLE for problems like benchmark problems like Lid driven cavity etc. and comparison with analytical/numerical solution.

Exposure to CFD software for solving simple problems like

1. Laminar Pipe Flow
2. Turbulent pipe flow
3. Flow over a flat plate
4. Flow over an aerofoil
5. Laminar Convection
6. Turbulent Convection
7. Channel flow with backward facing step
8. Lid driven cavity