HINDUSTAN
INSTITUTE OF TECHNOLOGY & SCIENCE
(DEEMED TO BE UNIVERSITY)

DEPARTMENT OF AUTOMOBILE ENGINEERING

CURRICULUM AND SYLLABUS

Under CBCS

M.Tech. Automotive Technology

DEPARTMENT OF AUTOMOBILE ENGINEERING

SCHOOL OF MECHANICAL SCIENCES

HINDUSTAN INSTITUTE OF TECHNOLOGY & SCIENCE
VISION AND MISSION

MOTTO

"TO MAKE EVERY MAN A SUCCESS AND NO MAN A FAILURE"

VISION OF THE INSTITUTION

To be an International Institute of Excellence, providing a conducive environment for education with a strong emphasis on innovation, quality, research and strategic partnership blended with values and commitment to society.

MISSION OF THE INSTITUTION

- To create an ecosystem that promotes learning and world class research.
- To nurture creativity and innovation.
- To instill highest ethical standards and values.
- To pursue activities for the development of the Society.
- To develop national and international collaborations with institutes and industries of eminence.
- To enable graduates to become future leaders and innovators.

VALUE STATEMENT

Integrity, Innovation, Internationalization

DEPARTMENT OF AUTOMOBILE ENGINEERING
VISION AND MISSION

VISION OF THE DEPARTMENT

To enable the graduates to be successful in their career as an Automobile Engineer.

MISSION OF THE DEPARTMENT

M1 : To inculcate knowledge in Automobile Engineering

M2 : To impart skills and training on the advancements in Automobile Engineering such as Automotive Electronics, Autonomous Vehicles, etc.

M3 : To instill the highest ethical standards to be a Professional Automobile Engineer for social development.

M.Tech. Automotive Technology

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO 1 : Expertise in analyzing and providing solutions which are technically feasible and economically affordable and socially sustainable to real life problems in various Automobile Engineering systems.

PEO 2 : To enable the graduates to exhibit leadership skills and enhance their abilities through lifelong learning.

PEO 3 **:** Motivate the students to undertake research activities and to adapt to the latest trends in technology for sustainable development in Automobile Engineering field.

PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

PO1 **Scholarship of knowledge** Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with a synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.

PO2 **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.

PO3 **Problem Solving** Think laterally and originally, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

PO4 **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.

PO5 **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.

PO6 **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.

PO7 **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 economical and financial factors.

PO8 **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.

PO9 **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.

PO10 **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.

PO11 **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.

Program Specific Outcomes: (PSOs)

PSO1 : Design, Analysis, Fabrication and Testing of vehicles, which enable the students to compete globally.

PSO2 : Carry out research in fuel economy, emission reductions, alternate fuels and solar vehicle for the benefit of the society and environment.

HINDUSTAN INSTITUTE OF TECHNOLOGY AND SCIENCE
DEPARTMENT OF AUTOMOBILE ENGINEERING
M.TECH. AUTOMOTIVE TECHNOLOGY
SEMESTER WISE COURSE DISTRIBUTION WITH CREDITS

SEMESTER – I

Sl. No	Course Category	Course Code	Course Title	L	T	P	C	TCH
THEORY								
1	BS	MAA4701	Applied Engineering Mathematics	3	0	0	3	3
2	PC	AUA4701	Automotive Engine Technology	2	0	2	3	4
3	PC	AUA4702	Automotive Chassis and Drive Line Systems	2	0	2	3	4
4	DE		Department Elective – I	3	0	0	3	3
5	DE		Department Elective – II	3	0	0	3	3
6	CC	ZZZ4715	Research Methodology & IPR	2	0	0	2	2
PRACTICAL								
7	PC	AUA4791	Modelling and Simulation Laboratory	0	0	4	2	4
8	PC	AUA4781	Mini-Project	0	0	4	2	4
						Total Credits	**21**	

- Research Methodology & IPR is a compulsory Course.

SEMESTER II

Sl. No	Course Category	Course Code	Course Title	L	T	P	C	TCH
THEORY								
1	PC	AUA4703	Vehicle Dynamics	3	0	0	3	3
2	PC	AUA4704	Finite Element Methods	3	0	0	3	3
3	PC	AUA4705	Automotive Systems Components Design	3	0	0	3	3
4	DE		Department Elective – III	3	0	0	3	3
5	NE		Open Elective	3	0	0	3	3
PRACTICAL								
7	PC	AUA4792	Vehicle Dynamics Laboratory	0	0	4	2	4
8	CC	AUA4796	Seminar	0	0	4	2	4
						Total Credits	**19**	

- One of the core course shall be a MOOC. (same course to all students)

SEMESTER III

Sl. No	Course Category	Course Code	Course Title	L	T	P	C	TCH
THEORY								
1	DE		Department Elective – IV	3	0	0	3	3
PRACTICAL								
2	CC	AUA4897	Internship *	0	0	0	2	0
3	PC	AUA4898	Project Phase –I	0	0	24	8	24
						Total Credits	**13**	

*Internship to be undergone during vacation between 2nd and 3rd semesters

SEMESTER IV

Sl. No	Course Category	Course Code	Course Title	L	T	P	C	TCH
PRACTICAL								
1	PC	AUA4899	Project Phase –II	0	0	35	12	35
						Total Credits	**12**	

TOTAL CREDITS: (21+19+13+12) = 65

LIST OF COURSES FOR DEPARTMENT ELECTIVES

Sl. No	Course Category	Course Code	Course Title	L	T	P	C	TCH
List of Courses for Elective - I								
1	DE	AUA4721	Automotive Transmission	3	0	0	3	3
2	DE	AUA4722	Vehicle Body Engineering	3	0	0	3	3
3	DE	AUA4723	Automotive Materials	3	0	0	3	3
4	DE	AUA4724	Automotive Electrical and Electronics	3	0	0	3	3
5	DE	AUA4725	Advanced Manufacturing Technology for Automotive Components	3	0	0	3	3
6	DE	AUA4726	Automotive safety	3	0	0	3	3
List of Courses for Elective - II								
1	DE	AUA4727	Advanced Internal Combustion Engines	3	0	0	3	3
2	DE	AUA4728	Hybrid and Electric vehicles	3	0	0	3	3
3	DE	AUA4729	Fuel cell technology	3	0	0	3	3
4	DE	AUA4730	Vehicular Maintenance and Diagnostics	3	0	0	3	3
5	DE	AUA4731	Autotronics and Vehicle Intelligence	3	0	0	3	3
6	DE	AUA4732	Automotive Instrumentation and Embedded System	3	0	0	3	3

List of Courses for Elective - III								
1	DE	AUA4733	Electronic Engine Management System	3	0	0	3	3
2	DE	AUA4734	Vibration and Noise Control	3	0	0	3	3
3	DE	AUA4735	Engine Exhaust System Development	3	0	0	3	3
4	DE	AUA4736	Computational Fluid Dynamics	3	0	0	3	3
5	DE	AUA4737	Automotive Air Conditioning	3	0	0	3	3
6	DE	AUA4738	Rubber Technology for Automobiles	3	0	0	3	3
List of Courses for Elective - IV								
1	DE	AUA4739	Automotive Aerodynamics	3	0	0	3	3
2	DE	AUA4740	Alternative fuels and Energy Systems	3	0	0	3	3
3	DE	AUA4741	Off-Highway Mobility	3	0	0	3	3
4	DE	AUA4741	Electronic Control Unit (ECU) development in Automotive systems	3	0	0	3	3
5	DE	AUA4743	Surface Coating Techniques and Applications	3	0	0	3	3
6	DE	AUA4744	Robotics and Industrial Automation	3	0	0	3	3

COURSE TITLE	APPLIED ENGINEERING MATHEMATICS			CREDITS	3
COURSE CODE	MAA4701	COURSE CATEGORY	BS	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	PO
1	The mathematical methods of differential and integral calculus and of some simple solution methods for various types of differential equation.	
2	Select and apply appropriate mathematical methods to solve abstract and real-world problems.	
3	Show confidence in manipulating mathematical expressions, setting up and solving equations and constructing simple proofs and apply problem solving techniques to familiar and unfamiliar problems	

MODULE I	CALCULUS OF VARIATIONS	(9L)

Concept of variation and its properties- Euler's Equation-Functional dependent on first and higher order derivatives - Functional dependent on functions of several independent variables- Isoperimetric problems - Direct methods-Ritz and Kantrovich methods

MODULE II	TRANSFORM METHODS	(9L)

Laplace transform methods for one dimensional wave equation - Displacements in a long string - Longitudinal vibration of an elastic bar - Fourier Transform methods for one dimensional heat conduction problems in infinite and semi-infinite rod

MODULE III	ELLIPTIC EQUATIONS	(9L)

Laplace equation - Properties of Harmonic functions - Solutions of Laplace equation by means of Fourier transform in a half plane in an infinite strip and in a semi-infinite strip

MODULE IV	NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS	(9L)

Solution of Laplace and Poisson equation on a rectangular region by Lieebmann's method - Diffusion equation by the explicit and Crank Nicolson - Implicit methods - Solution of wave equations by explicit scheme Cubic spline interpolation

MODULE V	CONFORMAL MAPPING AND APPLICATIONS	(9L)

The Schwarz - Christoffel transformation - Transformation of boundaries in parametric form - Physical applications - Application to fluid and heat flow

TEXT BOOKS

1. Gupta, A.S. - Calculus of Variations with Applications, Prentice Hall of India(P) Ltd., New Delhi, 6th print, 2006
2. Sankar Rao, .K. - Introduction to Partial Differential Equations, Prentice Hall of India(P) Ltd., New Delhi, 5th print, 2004
3. Jain.R.K, Iyengar.S.R.K. - Advanced Engineering Mathematics, Narosa publications 2nd Edition, 2006
4. Grewal, B.S - Numerical Methods in Science and Engineering, Kanna Publications, New Delhi, 2008

REFERENCE BOOKS

1. Kandasamy.P, Thilagavathy. K and Gunavathy, K - Numerical Methods, S Chand and Co., Ltd., New Delhi, 5th Edition, 2007
2. Spiegel , M. R - Theory and problems of Complex Variables with an Introduction to Conformal Mapping and Its applications, Schaum's outline series, Mc Graw Hill Book Co.,2007.

COURSE TITLE	AUTOMOTIVE ENGINE TECHNOLOGY			CREDITS	3
COURSE CODE	AUA4701	COURSE CATEGORY	PC	L-T-P-S	2-0-2-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	PO
1	The students should be able to: Understand SI and CI engine construction and operation & grasp the basic engine terminologies.	
2	Understand the fuel system, Ignition system, combustion and combustion chambers in SI engines.	
3	Understand the fuel system, air motions, stages of combustion and combustion chambers in CI engines.	
4	Acquire the knowledge on various emissions, emission control techniques	
5	Get knowledge on performance characteristics of both SI and CI engines.	

MODULE I	CONSTRUCTION AND OPERATION	(8L + 4P)

Constructional details of spark ignition (SI) and compression ignition (CI) engines. Working principles. Two stroke SI and CI engines. Comparison of SI and CI engines and four stroke and two stroke engines. Engine classification, firing order. Otto, diesel and dual cycles. Introduction to Lean burn engine technologies.

MODULE II	SI ENGINES	(8L + 4P)

Air fuel ratio requirements - Carburetion - Throttle body injection, Multi point injection. Function of Components, Spark plug, Ignition System - battery coil, magneto coil, Electronic. Combustion in SI Engines - Combustion Chambers, Stages of Combustion - factors affecting flame propagation, Knock in SI engines, variables affecting knocking. Pollution from SI engines.

MODULE III	CI ENGINES	(8L + 4P)

Diesel fuel injection system, Function of Components, Jerk type pump, Distributor pump, Mechanical and pneumatic Governor, Fuel Injector, Types of nozzles, importance of Swirl, Squish, Turbulence air motion, Combustion in CI Engines - Combustion Chambers, Stages of Combustion, Factors affecting Ignition Delay, Knock in CI engines. Pollution from CI engines.

MODULE IV	EMISSION CONTROL TECHNIQUES	(8L + 4P)

Design of engine, optimum selection of operating variables for control of emissions, EGR, charge stratification, SCR, DPF, Lean NOX catalyst technology. Thermal reactors, secondary air injection, catalytic converters, catalysts, fuel modifications, fuel cells, Two stroke engine pollution and control.

MODULE V	MEASUREMENT TECHNIQUES, EMISSION STANDARDS AND TEST PROCEDURES	(8L + 4P)

NDIR, FID, Chemiluminescent analyzers, Gas Chromatograph, smoke meters, emission standards, driving cycles - USA, Japan, Euro and India. Test procedures - ECE, FTP Tests. SHED Test - Chassis dynamometers, dilution tunnels.

LAB EXPERIMENTS

1. Dismantling, study and Assembling of multi cylinder petrol engine.
2. Dismantling, study and Assembling of multi cylinder diesel engine.
3. Study of Engine Auxiliary systems.
4. Engine combustion, performance testing and emission measurement.

TEXT BOOKS

1	V. Ganesan, Internal Combustion Engines, 2012, Tata Mc Graw Hil

2	Ramalingam K.K., "Internal Combustion Engines", Sci-Tech Publications, 2015.
3	B.P.Pundir, “Engine Emissions” 2012, Alpha science.
REFERENCE BOOKS	
1	Heisler, Advanced Engine Technology, SAE Publication, 2010
2	John B. Heywood, "Fundamentals of Internal Combustion Engines", Tata McGraw - Hill Education,2012
3	Mathur and Sharma, Internal Combustion Engines, Dhanpat Rai and Sons 2012

COURSE TITLE	**AUTOMOTIVE CHASSIS AND DRIVE LINE SYSTEMS**			**CREDITS**	**3**
COURSE CODE	**AUA4702**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**2-0-2-0**
CIA	**50%**			**ESE**	**50%**
LEARNING LEVEL				**BTL-3**	

CO	**COURSE OUTCOMES**	**PO**
1	Acquire the knowledge of different types of chassis.	
2	Attain the concept of various front axles and steering systems	
3	Gain the knowledge of various Drive line systems	
4	Obtain the knowledge in Suspension system	
5	Develop the knowledge of Braking systems	

MODULE I	**INTRODUCTION**	**(8L + 4P)**
Types of chassis layout with reference to drives, vehicle frames, various types of frames, Monocoque structure, constructional details, materials, testing of vehicle frames, unitized frame body construction.		
MODULE II	**FRONT AXLE AND STEERING SYSTEM**	**(8L + 4P)**
Types of front axles, construction details, materials, front wheel geometry: castor, camber, king pin inclination, toe-in. conditions for true rolling motion of wheels during steering, steering geometry, Ackermann steering system, constructional details of steering linkages, slip angle, cornering force, different types of steering gear boxes, steering linkages and layouts, turning radius, wheel wobble, power assisted steering, steering of crawler tractors and Electronic Steering System.		
MODULE III	**DRIVE LINE**	**(8L + 4P)**
Effect of driving thrust and torque reactions, Hotchkiss drive, torque tube drive and radius rods, propeller shaft, universal joints, front wheel drive, different types of final drive, double reduction and twin speed final drives, differential principle, construction details of differential unit, non-slip differential, differential locks, differential housings, construction of rear axles, types of loads acting on rear axles, fully floating, three quarter floating and semi floating rear axles, rear axle housing, construction of different types of axle housings, multi axle vehicles, Differential for Tandem drive.		
MODULE IV	**SUSPENSION SYSTEM**	**(8L + 4P)**
Need of suspension system, types of suspension, suspension springs, constructional details and characteristics of leaf, coil and torsion bar springs, independent suspension, rubber suspension, pneumatic suspension, shock absorbers, semi-active and active suspension system. Compensated suspension system, hydro-gas suspension system, wheels and tyres		
MODULE V	**BRAKING SYSTEM**	**(8L + 4P)**
Braking Efficiency and stopping distance, Reaction time, Braking time, Classification of brakes, drum brakes and disc brakes, constructional details, theory of braking, concept of dual brake system, parking brake, material, hydraulic system, vacuum assisted system, air brake system, antilock braking, retarded engine brakes, eddy retarders and electronic braking system.		

LAB EXPERIMENTS
Study and measurement of critical dimensions of 1. Heavy duty vehicle chassis frame 2. Light duty vehicle chassis frame 3. Front axle and Steering Systems 4. Brakes and Braking Systems 5. Gear boxes and Transfer case 6. Suspension systems

TEXT BOOKS	
1	Kirpal singh, Automobile Engineering, Volume I, standard publishers distributors, 2014
2	Rajput, A text book of Automobile Engineering, Firewall media, 2010
REFERENCE BOOKS	
1	K.K.Ramalingam - "Automobile Engineering" - Scitech Publication, Chennai - 2010
2	James E Duffy, Modern Automotive Technology, 2010

COURSE TITLE	RESEARCH METHODOLOGY & IPR			CREDITS	2
COURSE CODE	ZZZ4715	COURSE CATEGORY	CC	L-T-P-S	2-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-4	

CO	COURSE OUTCOMES	PO
1	Understand research problem formulation.	
2	Analyze research related information	
3	Follow research ethics	
4	Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.	
5	Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.	
6	Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.	

MODULE I	RESEARCH PROBLEM FORMULATION	(5L)
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations		
MODULE II	**RESEARCH WRITINGS**	**(5L)**
Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.		
MODULE III	**DATA ANALYSIS AND INTERPRETATION**	**(8L)**
Classification of Data, Methods of Data Collection, Sampling, Sampling techniques procedure and methods, Ethical considerations in research Data analysis, Statistical techniques and choosing an appropriate statistical technique, Hypothesis, Hypothesis testing, Data processing software (e.g. SPSS		

etc.), statistical inference, Interpretation of results.		
MODULE IV	**NATURE OF INTELLECTUAL PROPERTY**	**(4L)**
Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.		
MODULE V	**PATENT RIGHTS**	**(4L)**
Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.		
MODULE VI	**NEW DEVELOPMENTS IN IPR**	**(4L)**
Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.		

TEXT BOOKS	
1	Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students
2	Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”
3	Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners”
4	Kothari C.R., Research Methodology – Methods and Techniques, New Age International (P) Ltd, New Delhi, 2003.
5	Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd, 2007.
6	T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008
REFERENCE BOOKS	
1	Mayall , “Industrial Design”, McGraw Hill, 2002.
2	Niebel , “Product Design”, McGraw Hill, 2004.
3	Asimov, “Introduction to Design”, Prentice Hall, 2006.
4	Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016.
5	Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition Creswell, John W. Research design: Qualitative, quantitative, and mixed methods, approaches. Sage publications, 2013.

COURSE TITLE	MODELING AND SIMULATION LABORATORY			CREDITS	2
COURSE CODE	AUA4791	COURSE CATEGORY	PC	L-T-P-S	0-0-4-0
CIA	80%			ESE	20%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	PO
1	Acquire knowledge on Design, analysis of piston, piston pin and piston rings	
2	Get knowledge on Design, analysis of Connecting Rod, Crankshaft and camshaft.	
3	Familiarize on Design, analysis of Inlet, Exhaust Valves.	
4	Acquire knowledge on Heavy duty vehicle frame and Light duty vehicle frame	

LIST OF EXPERIMENTS

1. Modeling and analysis of Piston
2. Modeling and analysis of Piston Pin and Piston Rings
3. Modeling and analysis of Connecting Rod
4. Modeling and analysis of Crankshaft
5. Modeling and analysis of Camshaft
6. Modeling and analysis of Inlet and Exhaust Valves
7. Modeling and analysis of Heavy duty vehicle frame
8. Modeling and analysis of Light duty vehicle frame

COURSE TITLE	MINI PROJECT			CREDITS	2
COURSE CODE	AUA4781	COURSE CATEGORY	PC	L-T-P-S	0-0-4-0
CIA	80%			ESE	20%
LEARNING LEVEL				BTL-4	

CO	COURSE OUTCOMES	PO
1	Students will be able to model, analyze and animate /fabricate a functional model of any component, sub system or a mechanism used in Automobiles.	

DESCRIPTION

Students should model, analyze and animate /fabricate a functional model of any component, sub system or a mechanism used in automobile. They should prepare a mini project report and submit it. The assessment will be done on a continuous basis as follows:

Assessment Model: LE	
Review / Exam	**Weightage**
First Review	20%
Second Review	20%
Third Review	20%
Report	20%
Final Viva- Voce	20%
TOTAL	**100%**

SEMESTER II

COURSE TITLE	**VEHICLE DYNAMICS**			**CREDITS**	**3**
COURSE CODE	**AUA4703**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-0**
CIA	**50%**			**ESE**	**50%**
LEARNING LEVEL				**BTL-4**	

CO	**COURSE OUTCOMES**	**PO**
1	To Understand vibrating systems and its analysis, modeling and simulation and modal analysis	
2	To Understand various Suspension systems, selection of springs and dampers	
3	To Understand the stability of vehicles on curved track and slope, gyroscopic effects and cross wind handling	
4	To Know about tyres, ride characteristics and effect of camber, camber thrust	
5	To Learn about vehicle handling under different steering conditions and directional stability of vehicles	

MODULE I	**INTRODUCTION**	**(9)**

Classification of vibration, definitions, mechanical vibrating systems, mechanical vibration and human comfort. Modelling and simulation studies. Model of an automobile, one degree of freedom, two degree of freedom systems, free, forced and damped vibrations - Random vibration - Magnification and Transmissibility. Vibration absorber. Multidegree of Freedom Systems-Closed and far coupled system, Orthogonally of modal shapes, Modal analysis.

MODULE II	**SUSPENSION**	**(9)**

Requirements. Spring mass frequency. Wheel hop, wheel wobble, wheel shimmy, Choice of suspension spring rate. Calculation of effective spring rate. Vehicle suspension in fore and aft directions. Hydraulic dampers and choice of damper characteristics. Independent, compensated, rubber and air suspension systems. Roll axis and vehicle under the action of side forces.

MODULE III	**STABILITY OF VEHICLES**	**(9)**

Load distribution. Stability on a curved track and on a slope. Gyroscopic effects, weight transfer during acceleration and braking, overturning and sliding. Rigid vehicle – stability and equations of motion. Cross wind handling.

MODULE IV	**TYRES**	**(9)**

Types. Relative merits and demerits. Ride characteristics. Behavior while cornering, slip angle, cornering force, power consumed by a tyre. Effect of camber, camber thrust.

MODULE V	**VEHICLE HANDLING**	**(9)**

Over steer, under steer, steady state cornering. Effect of braking, driving torques on steering. Effect of camber, transient effects in cornering. Directional stability of vehicles.

TEXT BOOKS

1	Thomas D.Gillespie, “Fundamentals of vehicle dynamics” Premiere Series Books,2012
2	J. Y. Wong, ‘Theory of Ground Vehicles’, John Wiley and Sons Inc., New York, 2013

REFERENCE BOOKS

1	Hans Pacejka, Tire and Vehicle Dynamics, Elsevier, 2012.
2	Jazar**,** Reza N, Vehicle Dynamics, Theory and Application, Springer, 2015

COURSE TITLE	FINITE ELEMENT METHODS			CREDITS	3
COURSE CODE	AUA4704	COURSE CATEGORY	PC	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	PO
1	Understand the basics of Engineering problems, Mathematical modeling of FEA	
2	Understand the finite element formulations of Boundary Value problems	
3	Understand ONE dimensional FEA	
4	Understand TWO dimensional FEA	
5	Understand Dynamic Analysis using FEM	

MODULE I	INTRODUCTION TO FINITE ELEMENT FORMULATION OF BOUNDARY VALUE PROOBLEM	(9L)

Weighted residual methods -General weighted residual statement - Weak formulation of the weighted residual statement -Comparisons - Piecewise continuous trial functions - Example of a bar finite element - Functional and differential forms - Principle of stationary total potential - Rayleigh Ritz method – Galerkin's method - Piecewise continuous trial functions - Finite element method- Choice of the elements - Application to bar element.

MODULE II	ONE DIMENSIONAL FINITE ELEMENT ANALYSIS	(9L)

General form of total potential for 1-D applications - Generic form of finite element equations - Linear bar element - Quadratic element -Nodal approximation - Development of shape functions - Element matrices and vectors - Example problems - Extension to plane truss- Development of element equations - Assembly - Element connectivity - Global equations - Solution methods - Beam element - Nodal approximation - Shape functions - Element matrices and vectors - Assembly - Solution - Example problems.

MODULE III	TWO DIMENSIONAL FINITE ELEMENT ANALYSIS	(9L)

Introduction - Approximation of geometry and field variable - 3 nodded triangular elements - Four nodded rectangular elements - Higher order elements - Generalized coordinates approach to nodal approximations - Difficulties - Natural coordinates and coordinate transformations - Triangular and quadrilateral elements - ISO-parametric elements - Structural mechanics applications in 2-dimensions - Elasticity equations - Stress strain relations - Plane problems of elasticity - Element equations - Assembly - Need for quadrature formula - Transformations to natural coordinates - Gaussian quadrature. - Example problems in plane stress, plane strain and axisymmetric applications.

MODULE IV	DYNAMIC ANALYSIS USING FINITE ELEMENT METHOD	(9L)

Introduction - Vibrational problems - Equations of motion based on weak form - Longitudinal vibration of bars - Transverse vibration of beams - Consistent mass matrices - Element equations - Solution of eigenvalue problems - Vector iteration methods - Normal modes - Transient vibrations - Modeling of damping - Mode superposition technique - Direct integration methods.

MODULE V	APPLICATIONS IN HEAT TRANSFER & FLUID MECHANICS	(9L)

One dimensional heat transfer element - Application to one-dimensional heat transfer problems- Scalar variable problems in 2-Dimensions - Applications to heat transfer in 2-Dimension - Application to problems in fluid mechanics in 2-D.

TEXT BOOKS

1	P.Seshu, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2012.
2	David V Hutton, "Fundamentals of Finite Element Analysis", McGraw-Hill Int. Ed. 2012.

3	Chandrupatla T.R., and Belegundu A.D., Introduction to Finite Elements in Engineering, Pearson Education 2012.
REFERENCE BOOKS	
1	J.N.Reddy, "An Introduction to the Finite Element Method", McGraw-Hill International Editions (Engineering Mechanics Series), 2013.
2	Rao S.S., The Finite Element Method in Engineering, Pergammon Press, 2009.
3	Logan D.L., A First course in the Finite Element Method, Third Edition, Thomson Learning, 2012.
4	Robert D.Cook., David.S, Malkucs Michael E Plesha, "Concepts and Applications of Finite Element Analysis", 2013.
5	O.C.Zienkiewicz and R.L.Taylor, The Finite Element Methods, Vol.1. The basic formulation and linear problems, Vol.1, Butterworth Heineman, 5th Edition, 2010.

COURSE TITLE	**AUTOMOTIVE SYSTEMS COMPONENTS DESIGN**			**CREDITS**	**3**
COURSE CODE	**AUA4705**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-0**
CIA	**50%**			**ESE**	**50%**
LEARNING LEVEL				**BTL-4**	

CO	**COURSE OUTCOMES**	**PO**
1	Gain knowledge on design of cylinder, piston, piston pin and piston rings	
2	Acquire knowledge on design of connecting rod and crank shaft	
3	Obtain knowledge on design of valves, valve springs and flywheel	
3	Attain knowledge on design of ladder type chassis frame and suspension components.	
4	Obtain the knowledge on design procedure of front axle and steering systems.	

MODULE I	**DESIGN OF CYLINDER AND PISTON**	**(9)**
Choice of material for cylinder and piston, design of cylinder, piston, piston pin, piston rings.		
MODULE II	**DESIGN OF CONNECTING ROD, CRANKSHAFT**	**(9)**
Material for connecting rod, Connecting rod small end and big end design, shank design, design of big end cap and bolts, design of crankshaft, material for crankshaft.		
MODULE III	**DESIGN OF VALVES AND FLYWHEEL**	**(9)**
Design of inlet and Exhaust valves, valve springs. Materials and design of flywheel.		
MODULE IV	**DESIGN OF CHASSIS FRAME AND SUSPENSION**	**(9)**
Study of loads, moments and stresses on Chassis frame members, design procedure of ladder type chassis frame, design procedure of leaf springs, coil springs and torsion bar springs.		
MODULE V	**DESIGN OF FRONT AXLE AND STEERING SYSTEMS**	**(9)**
Study of loads, moments and stresses on front axle, design procedure of front axle; Condition for true rolling motion, Ackermann steering principles, calculation of turning circle radius.		

TEXT BOOKS	
1	Giri.N.K- "Automobile Mechanics"- Khanna Publisher, New Delhi- 2012
REFERENCE BOOKS	
1	Julian Happian*, An Introduction to Modern Vehicle Design* -Smith. Edition, Publisher, SAE International, 2014.
2	John Fenton*, Handbook of Vehicle Design Analysis*, Published by Society of Automotive Engineers Inc, 2016

COURSE TITLE	VEHICLE DYNAMICS LABORATORY			CREDITS	2
COURSE CODE	AUA4792	COURSE CATEGORY	PC	L-T-P-S	0-0-4-0
CIA	80%			ESE	20%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	PO
1	To find the natural frequency of the given model	
2	To study vibration characteristics of a vehicle using quarter car / half car model	
3	To find displacement, Velocity and acceleration with the use of Mathematical software Using various sensors	
4	To familiarize using MATLAB- SIMULINK software to solve simple mechanical systems.	
5	To familiarize using Multi Body dynamics software to solve simple Car model.	

LIST OF EXPERIMENTS

1. Testing of natural frequency
2. Measurement of displacement, velocity and acceleration
3. Whirling of Shafts
4. Camber angle measurement
5. Introduction to MAT Lab – Simulink, solving simple MCK problems
6. Modal Analysis of given structure
7. Study of LS Dyna / Adams

COURSE TITLE	SEMINAR			CREDITS	2
COURSE CODE	AUA4796	COURSE CATEGORY	CC	L-T-P-S	0-0-4-0
CIA	80%			ESE	20%
LEARNING LEVEL				BTL-4	

CO	COURSE OUTCOMES	PO
1	Students will be able to present a seminar on latest topics in Automobile Engineering	

DESCRIPTION

Each student has to take a topic on latest trends/ developments in Automobile Engineering, present it in the Seminar period through any teaching aids.

The assessment will be done on a basis as follows:

Assessment Model: LE	
Criterion	**Weightage**
Preparatory skill	20%
Presentation skill	20%
Communication skill	20%
Technical Knowledge	20%
Aptitude skill	20%
TOTAL	**100%**

SEMESTER-III

COURSE TITLE	INTERNSHIP			CREDITS	2
COURSE CODE	AUA4897	COURSE CATEGORY	CC	L-T-P-S	0-0-0-0
CIA	-			ESE	100%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOME	PO
1	The students should acquire knowledge from Automobile industries, may be a Manufacturing or Design or Service Industry.	

DESCRIPTION

Students should undergo industrial training in reputed industries for a period of 3 weeks (minimum) during the vacation period at the end of 2nd semester. Assessment will be conducted along with the 3rd semester as a practical subject. Students should prepare a report on Internship and present it during the III semester practical exam.

ASSESSMENT MODEL : LF	
Criterion	**Weightage**
Final Presentation	50%
Internship Report	50%
Total	100%

COURSE TITLE	PROJECT PHASE-I			CREDITS	8
COURSE CODE	AUA4898	COURSE CATEGORY	PC	L-T-P-S	0-0-24-0
CIA	80%			ESE	20%
LEARNING LEVEL				BTL-5	

CO	COURSE OUTCOME	PO
1	Acquire knowledge on selection of a research area, identification of engineering problem by doing literature review, define the problem, and prepare a methodology and action plan for the Phase-II Project.	

Students should start first phase of the final semester project involving theoretical and experimental studies related to the Automobile engineering and will have to submit a phase I project report which comprises of title, objective, Literature review, detailed execution plan for doing some part of research work in phase I, continue the research in phase-II and finish the project. The assessment will be done on a continuous basis as follows:

Assessment Model: LE	
Review / Exam	**Weightage**
First Review	20%
Second Review	20%
Third Review	20%
Report	20%
Final Viva- Voce	20%
TOTAL	**100%**

SEMESTER-IV

COURSE TITLE	PROJECT PHASE-II			CREDITS	12
Course Code	AUA4899	Course Category	PC	L-T-P-S	0-0-35-0
CIA	80%			ESE	20%
LEARNING LEVEL				BTL-5	

CO	COURSE OUTCOME	PO
1	Student should be able to do intensive research on the selected topic, conducting experimentation/Simulation, compiling data, analyzing the collected data, preparing a detailed project report and present it. Also able to write a research paper and publish it in a peer reviewed journals.	

Students should do an intensive research on the selected topic (in phase-I), conducting experimentation/Simulation, compiling data, analyzing the collected data, preparing a detailed project report and present it on final Viva Voce.

In phase-II project, student has to complete the research work fully and present their work in an International Conference or publish their work in a Scopus Indexed Journals.

The assessment will be done on a continuous basis as follows:

Assessment Model: LE	
Review / Exam	**Weightage**
First Review	10%
Second Review	20%
Third Review	20%
Report & Publication	30%
Final Viva- Voce	20%
TOTAL	**100%**

COURSES FOR ELECTIVES I

COURSE TITLE	AUTOMOTIVE TRANSMISSION			CREDITS	3
COURSE CODE	AUA4721	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	PO
1	Familiarize on the automotive clutch and gear boxes	
2	Acquire the concepts Hydrodynamic drive and gear box.	
3	Gain knowledge on the Hydrostatic drive and electric drive	
4	Acquire knowledge about the various application of automatic transmission	
5	Gain knowledge on design of transmission system	

Prerequisites :

MODULE I	CLUTCH AND GEAR BOX	(9L)

Requirement of Transmission system. Different types of clutches: Principle, construction and operation of friction clutches. Objective of gear box. Performance of automobile such as Resistance to motion, Tractive effort and acceleration. Determination of gear ratios. Three speed and four speed gear boxes.

MODULE II	PLANETARY GEAR DRIVE	(9L)

All spur and internal gear type planetary gear boxes, Wilson gear box. Automatic overdrives

MODULE III	HYDRODYNAMIC DRIVE	(9L)

Principles, performance and limitations of fluid coupling- Constructional details of a typical fluid coupling. Principle, construction and advantages of torque converters. Multi-stage Torque converter and poly phase torque converter-

MODULE IV	HYDRO STATIC DRIVE AND ELECTRIC DRIVE	(9L)

Principle of hydrostatic drive systems. Construction and working of typical hydrostatic drives. Advantages and limitations. Janney hydrostatic drive. Principle of electric drive. Ward Leonard Electric drive and control systems.

MODULE V	AUTOMATIC TRANSMISSION AND APPLICATION	(9L)

Automatic transmission; relative merits and demerits when compared to conventional transmission. Chevrolet transmission. Electronic control system- Continuously Variable Transmission (CVT), Latest developments in transmission.

TEXT BOOKS

1. Kirpal singh, Automobile Engineering, Volume 1, Standard Publishers distributor, 2014
2. Heinz Heisler, “Advanced Vehicle Technology”, second edition, New York, 2008.
3. R.B.Gupta, Automobile Engineering, Satyaprakasan publications, 2012

REFERENCE BOOKS

1. Dr. N. K. Giri, “Automobile Mechanics”, Seventh reprint, Khanna Publishers, Delhi, 2015

COURSE TITLE	VEHICLE BODY ENGINEERING			CREDITS	3
COURSE CODE	AUA4722	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	PO
1	To understand the details of car body and safety design aspects	
2	To introduce bus body details and types of metal sections used	
3	To broaden the understanding of vehicle aerodynamics and wind tunnel technology	
4	To introduce commercial vehicle body details and driver's seat design	
5	To underline the importance of bus body loads and stress analysis	

MODULE I	CAR BODY DETAILS	(9L)

Types car bodies – Visibility: regulations, driver's visibility, methods of improving visibility – Safety: Safety design, constructional details of roof, under floor, bonnet, boot, wings etc.

MODULE II	BUS BODY DETAILS	(9L)

Types of bus bodies. Floor height, engine location – Entrance and exit location, Constructional details, frame construction, Double skin construction, Types of metal sections used, regulations, Conventional and integral type construction.

MODULE III	VEHICLE AERODYNAMICS	(9L)

Vehicle resistances and types. Various types of forces and moments. Various body optimization techniques for minimum drag. Principle of wind tunnel technology. Flow visualization techniques. Tests with scale models.

MODULE IV	COMMERCIAL VEHICLE BODY DETAILS	(9L)

Construction of commercial vehicle bodies. Types of bodies – Flat platform, drop side, fixed side, tipper body, tanker body. Dimensions of driver's seat in relation to controls. Drivers cab design.

MODULE V	BODY LOADS AND STRESS ANALYSIS	(9L)

Scaled structure – Shear panel method – Symmetric and Asymmetrical vertical loads in a car – Longitudinal loads – Different loading situations – Load distribution on vehicle structure – Stress analysis of bus body structure under bending and torsion – Stress analysis in integral bus body. Analysis of shock and impulse force on vehicle bodies.

TEXT BOOKS

1	Powloski, J., 'Vehicle Body Engineering', Business Books Ltd., 2002
2	John Fenton, 'Vehicle Body Layout and Analysis', Mechanical Engineering Publication Ltd., London, 2013

REFERENCE BOOKS

1	David Crolla , "Automotive Engineering: Powertrain, Chassis System and Vehicle Body" 2013

COURSE TITLE	AUTOMOTIVE MATERIALS			CREDITS	3
COURSE CODE	AUA4723	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	PO
1	Understand the mechanical and chemical behaviour of materials	
2	Acquire knowledge on different class of materials and their selection criterion	
3	Get knowledge on engineering alloys.	
4	Gain knowledge on application of various surface treatments of metals.	
5	Gain knowledge on modern materials and alloys	

MODULE I	REVIEW OF MECHANICAL AND CHEMICAL BEHAVIOUR OF MATERIALS	(9L)

Structure of crystalline solids, imperfections in solids, Plastic deformation -Strengthening mechanisms - Griffith's theory of failure modes –Damping properties of materials - fracture toughness - Initiation and propagation of fatigue cracks -Creep mechanisms environmentally induced degradation and preventive solutions.

MODULE II	AUTOMOTIVE COMPONENTS & MATERIAL SELECTION	(9L)

Organized process of Selection of Materials for different components. Materials for Power train components like cylinder block, head & liner, piston &piston rings, gudgeon pin, connecting rod, bearings, crankshaft, flywheel, camshaft, valves, valves seats, springs, gear train, chain & belt drives. Materials for Automobile components like body –in –white, crash worthiness, suspension systems, cabin interiors.

MODULE III	ENGINEERING ALLOYS	(9L)

Cast iron, steels, alloy steels - significance of iron – iron carbon diagram in design of steels and cast irons, stainless steels, types, specific applications, heat treatment, effect of alloying elements Aluminium, Magnesium and wrought and cast alloys used in automotive applications –Types, specifications, heat treatment.

MODULE IV	SURFACE MODIFICATION OF MATERIALS AND NON METALLIC MATERIALS	(9L)

Mechanical surface treatment and coating - Case hardening and hard facing - thermal spraying – vapour Deposition- iron implantation - Diffusion coating - Electroplating and Electro-less - Conversion coating -Ceramic and organic coatings – laser based surface modification - Diamond coating. Elastomers and Engineering Plastics, FRP Composite materials, ceramics, laminated & heat treated glass, adhesive bonding, An over view of Manufacturing processing, their characteristics features, types and applications.

MODULE V	MODERN MATERIALS AND ALLOYS	(9L)

Lightweight materials & implications on vehicle design, Micro alloyed, high strength low alloy steel – High strength Steels (HSS), Advanced High Strength Steels (AHSS), Ultra high strength Steels (UHSS), developments in Aluminium and Magnesium alloys, carbon fiber composites, Natural fibers, refractory metals, SMART Materials - shape memory alloys (SMA), Piezo-electric materials, MEMS, Metallic glass-Quasi crystal and Nano crystalline materials.

TEXT BOOKS

1. Callister W.D,"Material Science and Engineering- An introduction", Wiley –Eastern, 2016
2. Kenneth G.Budinski and Michael K.Budinski “Engineering Materials” Prentice-Hall of India Private Limited, 9th Edition 2012.

REFERENCE BOOKS

1	Hiroshi Yamagata “The Science and Technology of Materials in Automotive Engines”, 2009
2	Thomas H. Courtney, “Mechanical Behaviour of Materials”, McGraw Hill, 2008
3	Flinn R. A. and Trojan P. K.,”Engineering Materials and their Applications”, Jaico Publications, 2012
4	Avner S.H., “Introduction to physical metallurgy” –Tata McGraw Hill, 2015

COURSE TITLE	**AUTOMOTIVE ELECTRICAL AND ELECTRONICS**			**CREDITS**	**3**
COURSE CODE	**AUA4724**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
CIA	**50%**			**ESE**	**50%**
LEARNING LEVEL				**BTL-3**	

CO	**COURSE OUTCOMES**	
1	Familiarize with lead acid battery and accessories.	
2	Acquire the knowledge of starting system.	
3	Develop the knowledge on charging system.	
4	Gain knowledge on automotive electronics.	
5	Gain the information about sensors and activators.	

MODULE I	**BATTERIES AND ACCESSORIES**	**(9L)**

Principle and construction of lead acid battery, characteristics of battery, rating capacity and efficiency of batteries, various tests on batteries, maintenance and charging. Lighting system: insulated and earth return system, details of head light and side light, LED lighting system, headlight dazzling and preventive methods - Horn, wiper system and trafficator.

MODULE II	**STARTING SYSTEM**	**(9L)**

Condition at starting, behavior of starter during starting, series motor and its characteristics, principle and construction of starter motor, working of different starter drive units, care and maintenances of starter motor, starter switches.

MODULE III	**CHARGING SYSTEM**	**(9L)**

Generation of direct current, shunt generator characteristics, armature reaction, third brush regulation, cutout, Voltage and current regulators, compensated voltage regulator, alternators principle and constructional aspects and bridge rectifiers, new developments.

MODULE IV	**FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS**	**(9L)**

Current trends in automotive electronic engine management system, electromagnetic interference suppression, electromagnetic compatibility, electronic dashboard instruments, onboard diagnostic system, security and warning system.

MODULE V	**SENSORS AND ACTUATORS**	**(9L)**

Types of sensors: sensor for speed, throttle position, exhaust oxygen level, manifold pressure, crankshaft position, coolant temperature, exhaust temperature, air mass flow for engine application. Solenoids, stepper motors, relay.

TEXT BOOKS

1	Young A.P. & Griffiths. L. "Automotive Electrical Equipment", ELBS & New Press- reprint 2010.
2	Crouse, W.H "Automobile Electrical Equipment", McGraw-Hill Book Co., Inc., New York, 3rd edition, reprint 2010.

REFERENCE BOOKS

1	Kholi.P.L "Automotive Electrical Equipment", Tata McGraw-Hill Co., Ltd., New Delhi, reprint 2011
2	Robert Bosch, "Automotive Hand Book", SAE (5th Edition), 2010.

COURSE TITLE	ADVANCED MANUFACTURING TECHNOLOGY FOR AUTOMOTIVE COMPONENTS			CREDITS	3
COURSE CODE	AUA4725	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	
1	To understand the basic concepts of powder metallurgy	
2	To acquire knowledge about the metal forming processes	
3	To study in detail about the modern casting and machining processes followed in automotive components	
4	To have an in depth study about various processes of gear manufacture	
5	To have an in depth study about recent trends in manufacturing of automotive components	

MODULE I	Power Metallurgy and Processing of Plastics	(9L)

Powder metallurgy process, Process variables, manufacture of friction lining materials for clutch and brakes. Plastics - raw material - automobile components - molding- injection, compression and blow - PV foam molding- machining of plastics.

MODULE II	Forming Process	(9L)

Forging- process flow chart, forging of valves of valves, connecting rod, crank shaft, cam shaft, propeller shaft, transmission gear blanks, steering column. Extrusions: Basic process steps, extrusion of transmission shaft, housing spindle, steering worm blanks, Piston pin and valve tappets. Hydroforming: Process, hydro forming of exhaust manifold and comparison with conventional methods- Hydro forming of tail lamp housing- forming of wheel disc and rims. Stretch forming - Process, stretch forming of auto body panels - Super plastic alloys for auto body panels.

MODULE III	Casting and Machining	(9L)

Sand casting of cylinder block and liners - Centrifugal casting of flywheel, piston rings, bearing bushes, and liners, permanent mould casting of piston, pressure die casting of carburettor other small auto parts. Machining of connecting rods - crank shafts - cam shafts - pistons - piston pins - piston rings - valves - front and rear axle housings - fly wheel - Honing of cylinder bores - Copy turning and profile grinding machines.

MODULE IV	Gear Manufacturing	(9L)

Gear milling, Hobbing and shaping, planning- Bevel gear production - Gear finishing and inspection.

MODULE V	Recent Trends In Manufacturing of Auto Components	(9L)

Powder injection moulding - Production of aluminium MMC liners for engine blocks - Plasma spray coated engine blocks and valves - Recent developments in auto body panel forming - Squeeze casting of pistons – aluminimum composite brake rotors. Sinter diffusion bonded idler sprocket- Gas injection molding of window channel - cast con process for auto parts.

TEXT BOOKS

1. Haslehurst.S.E., " Manufacturing Technology ", ELBS, London, 1990.
2. Rusinoff, “Forging and Forming of metals ", D.B. Taraporevala Son & Co. Pvt Ltd., Mumbai, 1995.

REFERENCE BOOKS

1. Sabroff.A.M. & Others, “Forging Materials & Processes ", Reinhold Book Corporation, New York, 1988.
2. High Velocity " Forming of Metals ", ASTME, prentice Hall of India (P) Ltd., New Delhi, 1990.

COURSE TITLE	AUTOMOTIVE SAFETY			CREDITS	3
COURSE CODE	AUA4726	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	
1	Know about the basics about the vehicle.	
2	Understand the safety aspects in the vehicle	
3	Know and understand the various safety aspects	
4	To get the knowledge in sensors provided in the vehicle to avoid the crash and to detect the defects in the vehicle	
5	To know about the comfort and convenience system	

MODULE I	INTRODUCTION	(9L)

Design of the body for safety, Energy equation, Engine location, Deceleration of vehicle inside passenger compartment, Deceleration on impact with stationary and movable obstacle, Concept of crumble zone, Safety sandwich construction.

MODULE II	SAFETY CONCEPTS	(9L)

Active safety: Driving safety, Conditional safety, Perceptibility safety, Operating safety- Passive safety: Exterior safety, Interior safety, Deformation behaviour of vehicle body, Speed and acceleration characteristics of passenger compartment on impact.

MODULE III	SAFETY EQUIPMENTS	(9L)

Seat belt, Regulations, Automatic seat belt tightener system, Collapsible steering column, Tiltable steering wheel, Air bags, Electronic system for activating air bags, Bumper design for safety, Antiskid braking system, Regenerative Braking System, Cruise Control, Adaptive Cruise Control Devices.

MODULE IV	COLLISION WARNING AND AVOIDANCE	(9L)

Collision warning system, Causes of rear end collision, Frontal object detection, ear vehicle object detection system, Object detection system with braking system interactions, Driver Fitness Detection.

MODULE V	COMFORT AND CONVENIENCE SYSTEM	(9L)

Steering and mirror adjustment, Central locking system , Garage door opening system, Tyre pressure control system, Rain sensor system, Environment information system, Manual and Automated Wiper System, GPS.

TEXT BOOKS

1	Bosch - "Automotive Handbook" - 5th edition - SAE publication - 2000.
2	

REFERENCE BOOKS

1	J.Powloski - "Vehicle Body Engineering" - Business books limited, London - 1969.
2	Ronald.K.Jurgen - "Automotive Electronics Handbook" - Second edition- McGraw-Hill Inc., - 1999.

COURSES FOR ELECTIVES II

COURSE TITLE	ADVANCED INTERNAL COMBUSTION ENGINES			CREDITS	3
COURSE CODE	AUA4727	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	PO
1	Understand the concept of combustion in SI engines.	
2	Gain knowledge about the combustion in CI engines.	
3	Gain insight on combustion modeling	
4	Acquire knowledge on advances in I.C.Engines	
5	Familiarize on electronic engine management system	

MODULE I	COMBUSTION IN SI ENGINES	(9L)

Review of cycles (Otto, Diesel, Dual), Comparison of air standard, Fuel air and actual cycles, Simple problems.

MODULE II	COMBUSTION IN CI ENGINES	(9L)

Combustion reactions and stoichiometry, Heat of reaction, adiabatic flame temperature in constant pressure and constant volume systems, Fuels for internal combustion engines and their properties, Premixed and diffusion combustion as applicable to SI and CI engines, Concepts of burning rate and flame velocity, Fuel spray characteristics and combustion in diesel engines.

MODULE III	COMBUSTION MODELLING	(9L)

Basic concepts of engine simulation, Governing equations, Simulation of various engine processes for SI and CI engines. Adiabatic flame temperature, Heat release calculations. Thermodynamic and Fluid mechanic based models.

MODULE IV	ADVANCES IN IC ENGINES	(9L)

LHR engines, Surface ignition concept and multi fuel engines, Stratified charge and lean burn engines, Performance and emission characteristics, Merits and demerits.

MODULE V	ELECTRONIC ENGINE MANAGEMENT	(9L)

Computer control of SI & CI engines for better performance and low emissions, Closed loop control of engine parameters of fuel injection and ignition, Combined ignition and fuel management systems. Digital control techniques - Dwell angle calculation, Ignition timing calculation and Injection duration calculation

TEXT BOOKS

1. John B. Haywood, "Internal Combustion Engine Fundamentals", McGraw-Hill Automotive Technology series, 2012
2. Ganesan .V - "IC Engines" - Tata McGraw-Hill, 2009.

REFERENCE BOOKS

1. Ganesan .V - 'Computer Simulation of Spark Ignition Processes' - Universities Process Ltd, Hyderabad - 2003.
2. Ganesan.V. - Computer Simulation of Compression Ignition engines - Orcent Longman - 2008.

COURSE TITLE	HYBRID AND ELECTRIC VEHICLES			CREDITS	3
COURSE CODE	AUA4728	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	PO
1	Familiarize on concepts of electric vehicle & performance of electric vehicles	
2	Gain knowledge on Electric Propulsion Systems & Generators	
3	Acquire the knowledge on hybrid electric drive train systems	
4	Gain knowledge on motor controllers and control systems & energy storages	
5	Attain the knowledge on Energy Storages -Fuel Cells & Solar Cars and Control Systems	

MODULE I	ELECTRIC VEHICLES	(9L)

Layout of an electric vehicle, performance of electric vehicles – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, advantage and limitations, specifications, system components, electronic control system.

MODULE II	ELECTRIC PROPULSION SYSTEMS & GENERATORS	(9L)

DC motors, AC motors, permanent magnet motors, brushless DC and reluctance motors, characteristics, regenerative braking. DC generators, AC generators, voltage and frequency regulations

MODULE III	HYBRID VEHICLES	(9L)

Concepts of hybrid electric drive train, types, architecture of series and parallel hybrid electric drive train, merits and demerits, series and parallel hybrid electric drive train design.

MODULE IV	MOTOR CONTROLLERS AND CONTROL SYSTEMS & ENERGY STORAGES	(9L)

Control system principles, speed and torque control – DC motors and AC motors. Electromechanical batteries- types of batteries –lead acid batteries, nickel based batteries, lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency, ultra-capacitors.

MODULE V	FUEL CELLS & SOLAR CARS	(9L)

Fuel cell, construction, working, equations, possible fuel sources, fuel reformer, design. Solar cars-photovoltaic cells, tracking, efficiency and cost comparison.

TEXT BOOKS

1. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRS Press, 2014.
2. James Larminie and John Loury, “Electric Vehicle Technology-Explained”, John Wiley & Sons Ltd., 2013.

REFERENCE BOOKS

1. Sandeep Dhameja, “Electric Vehicle Battery Systems”, Butterworth –Heinemann, 2012.
2. Donwhite Consultant Incorporate – Handbook of EMI / EMC – Vol I – 2015
3. Ronald K Jurgen, “Electric and Hybrid – Electric Vehicles”, SAE, 2012
4. Ron Hodkinson and John Fenton, “Light Weight Electric/Hybrid Vehicle Design”, Butterworth-Heinemann, 2011.

COURSE TITLE	FUEL CELL TECHNOLOGY			CREDITS	3
COURSE CODE	AUA4729	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	PO
1	Understand various types of Fuel Cells, its construction & working principles.	
2	Understand the Fuel Cells for automotive applications.	
3	Know about the various fuel cell components & its performance characteristics.	
4	Gain knowledge about the different types of fuels used in Fuel Cells.	
5	Do an analysis & comparative study of fuel cells with other types of alternate fuels	

Prerequisites :

MODULE I	FUEL CELLS TYPES	(9L)

Introduction - working and types of fuel cell - Polymer Electrolyte Membrane (PEM) Fuel Cells Direct Methanol Fuel Cells, Phosphoric Acid Fuel Cells, Molten Carbonate Fuel Cells, Solid Oxide Fuel Cells, Regenerative Fuel Cells Alkaline Fuel Cells - low, medium and high temperature fuel cell, Liquid and methanol types, Proton exchange membrane fuel cell solid oxide, Hydrogen fuel cells - Thermodynamics and electrochemical kinetics of fuel cells.

MODULE II	FUEL CELLS FOR AUTOMOTIVE APPLICATIONS	(9L)

Fuel cells for automotive applications - Technology advances in fuel cell vehicle systems - Onboard hydrogen storage - Liquid hydrogen and compressed hydrogen - Metal hydrides, Fuel cell control system - Alkaline fuel cell - Road map to market.

MODULE III	FUEL CELL COMPONENTS AND THEIR IMPACT ON PERFORMANCE	(9L)

Fuel cell performance characteristics - Current/voltage, Voltage efficiency and power density, ohmic resistance, Kinetic performance, Mass transfer effects - Membrane electrode assembly components, Fuel cell stack, Bi-polar plate, Humidifiers and cooling plates.

MODULE IV	FUELING	(9L)

Hydrogen storage technology - Pressure cylinders, Liquid hydrogen, Metal hydrides, Carbon fibers - Reformer technology - Steam reforming, Partial oxidation, Auto thermal reforming - CO removal, Fuel cell technology based on removal like bio-mass.

MODULE V	FUEL CYCLE ANALYSIS	(9L)

Introduction to fuel cycle analysis - Application to fuel cell and other competing technologies like battery powered vehicles, SI engine fueled by natural gas and hydrogen and hybrid electric vehicle.

TEXT BOOKS

1	Fuel Cells for automotive applications - professional engineering publishing UK. ISBN 1-86058 4233, 2004.

REFERENCE BOOKS

1	Fuel Cell Technology Handbook, SAE International Gregor Hoogers CRC Press ISBN 0-8493-0877-1-2003.

COURSE TITLE	VEHICULAR MAINTENANCE AND DIAGNOSTICS			CREDITS	3
COURSE CODE	AUA4730	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	PO
1	Familiarize on vehicle maintenance procedures	
2	Gain knowledge in maintenance procedures for various engine component systems	
3	Acquire knowledge in maintenance procedures for various chassis component systems	
4	Gain knowledge in maintenance procedures for various Electrical component and accessories.	
5	Get knowledge in maintenance procedures for Engine Auxiliary systems	

MODULE I	MAINTENANCE OF RECORDS AND SCHEDULES	(9)

Importance of maintenance, preventive (scheduled) and breakdown (unscheduled) maintenance, requirements of maintenance, preparation of check lists. Maintenance of records, log sheets and other forms, safety precautions in maintenance.

MODULE II	ENGINE MAINTENANCE - REPAIR AND OVERHAULING	(9)

Dismantling of engine components and cleaning, cleaning methods, visual and dimensional inspections, minor and major reconditioning of various engine components, reconditioning methods, engine assembly, special tools used for maintenance overhauling, engine tune up.

MODULE III	CHASSIS MAINTENANCE - REPAIR AND OVERHAULING	(9)

Automobile clutch and gear box, servicing and maintenance, maintenance and servicing of propeller shaft and differential system. Maintenance and servicing of suspension systems, Brake systems. Steering systems, overhauling and maintenance. Computerized Wheel alignment and wheel balancing.

MODULE IV	ELECTRICAL SYSTEM MAINTENANCE - SERVICING AND REPAIRS	(9)

Testing methods for checking electrical components, checking battery, starter motor, charging systems, DC generator and alternator, ignitions system, lighting systems. Fault diagnosis and maintenance of modern electronic controls, checking and servicing of dash board instruments.

MODULE V	MAINTENANCE OF FUEL SYSTEM, COOLING SYSTEMS, LUBRICATION SYSTEMAND VECHICLE BODY	(9)

Servicing and maintenance of fuel system of different types of vehicles, calibration of FIP. Servicing and maintenance of Cooling systems, water pump, radiator, thermostat, anti-corrosion and antifreeze additives. Lubrication system maintenance, lubricating oil changing, greasing of parts. Vehicle body maintenance, Minor and major repairs. Door locks and window glass actuating system and their maintenance.

TEXT BOOKS

1	Kirpal Singh, Automobile Engineering, Volume 1& 2 , Standard Publishers distributor, 2014
2	R.B.Gupta, Automobile Engineering, Satyaprakasan publications, 2012

REFERENCE BOOKS

1	Service Manuals from Different Vehicle Manufacturers.

COURSE TITLE	AUTOTRONICS AND VEHICLE INTELLIGENCE			CREDITS	3
COURSE CODE	AUA4731	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	
1	To understand the automotive electronics	
2	To understand the sensors and their applications	
3	To study about the electronic fuel injection and ignition control	
4	To introduce the different vehicle systems	
5	To broaden the importance of vehicle intelligence system	

MODULE I	AUTOMOTIVE FUNDAMENTALS	(9L)

The engine-components-Drive train -Starting &charging systems operation- Ignition system-Suspension systems-brakes -ABS - Steering system.

MODULE II	AUTOMOTIVE SENSORS	(9L)

Temperature sensor-gas sensor-knock sensor-pressure sensor - flow sensor-torque sensor-crash sensor-Speed sensor and acceleration sensor-micro sensor-smart sensor-operation, types, characteristics, advantages and their applications.

MODULE III	ELECTRONIC FUEL INJECTION AND IGNITION SYSTEM	(9L)

Introduction -fuel system components-electronic fuel system-fuel injection-types-throttle body versus port injection-electronic control fuel injection-operation-different types-fuel injectors-idle speed control-continuous injection system-high pressure diesel fuel injection -MPFI system - Electronic ignition system-operation-types-Electronic spark timing control.

MODULE IV	ELECTRIC VEHICLES AND HYBRID VEHICLES	(9L)

Introduction-Electric Vehicle development- system layout- basic system components-Electric battery-solar cells-rapid charging system-motor drive system-fuel cell Electric vehicle-hybrid vehicle-series Hybrid Vehicle - parallel Hybrid Vehicle-CNG Electric hybrid vehicle.

MODULE V	VEHICLE INTELLIGENCE	(9L)

Introduction -basic structure-vision based autonomous road vehicles-architecture for dynamic vision system - features-applications- A visual control system using image processing and fuzzy theory-An application of mobile robot vision to a vehicle information system.-object detection, collision warning and Avoidance system low tire pressure warning system.

TEXT BOOKS

1	Willium B. Ribbens,*Understanding Automotive Electronics* -Sixth edition Elsevier Science 2003
2	Ronald K.Jurgen, *Sensors and Transducers* - SAE 2003
3	Jack Erjavec, Robert Scharff, *Automotive Technology* - Delmar publications Inc 1992

REFERENCE BOOKS

1	Ronald K.Jurgen, *Electric and Hybrid-electric vehicles* - SAE 2002
2	Ichiro Masaki, *Vision-based Vehicle Guidance* - Springer Verlag, Newyork 1992
3	Jay Webster, *Class Room Manual For Automotive Service And System* – Delmer Publications Inc 1995

COURSE TITLE	AUTOMOTIVE INSTRUMENTATION AND EMBEDDED SYSTEMS			CREDITS	3
COURSE CODE	AUA4732	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	
1	Understand measurement characteristics.	
2	Understand the working of automotive instruments.	
3	Know about the measurement analysis.	
4	Understand the working of embedded systems.	
5	Understand the working of embedded systems.	

MODULE I	MEASUREMENT CHARACTERSTICS	(9L)

Instrument Classification, Characteristics of Instruments - Static and dynamic, experimental error analysis, Systematic and random errors, Statistical analysis, Uncertainty, Experimental planning and selection of measuring instruments, Reliability of instruments.

MODULE II	AUTOMOTIVE INSTRUMENTATION	(9L)

Modern automotive instrumentation - Computerized instrumentation system, multiplexing, sampling and advantages - Measurements - Fuel quality, coolant temperature, oil pressure vehicles speed. Display devices - LED, LCD, VFD, CRT and types, CAN network, the glass cockpit and information system.

Onboard diagnostics - Fault code displays. Off board diagnostics - Engine data display, expert system occupant protection system - Airbag deployment system security and warning systems.

MODULE III	MEASUREMENT ANALYSIS	(9L)

Chemical, thermal, magnetic and optical gas analysers, measurement of smoke, dust and moisture, gas chromatography, spectrometry, measurement of pH, Review of basic measurement techniques

MODULE IV	INTRODUCTION TO EMBEDDED SYSTEM	(9L)

Introduction to functional building blocks of embedded systems - Register, memory devices, ports, timer, interrupt controllers using circuit block diagram representation for each categories - Devices & buses for devices network - Serial communication using I2C, CAN, USB buses - parallel communication using ISA, PCI - device drivers in a system - Serial port & parallel port.

MODULE V	REAL TIME OPERATING SYSTEM (RTOS)	(9L)

Introduction to basic concepts of RTOS, Basics of real time & embedded system operating systems, RTOS - Interrupt handling, task scheduling; embedded system design issues in system development process - Action plan, use of target system, emulator, use of software tools.

TEXT BOOKS

1	William B.Riddens -Understanding Automotive Electronics, 5th edition- Butter worth Heinemann Woburn- 1998
2	Rajkamal, 'Embedded System - Architecture, Programming, Design', Tata McGraw Hill, 2003.
3	Daniel W. Lewis 'Fundamentals of Embedded Software', Prentice Hall of India, 2004.
4	Holman, J.P., Experimental methods for engineers, McGraw-Hill, 1988
5	Raman, C.S., Sharma, G.R., Mani, V.S.V., Instrumentation Devices and Systems, Tata McGraw Hill, New Delhi, 1983.

REFERENCE BOOKS

1	Bechhold- Understanding Automotive Electronics- SAE- 1998.
2	David E. Simon, 'An Embedded Software Primer', Pearson Education, 2004.
3	Frank Vahid, 'Embedded System Design - A Unified hardware & Software Introduction',John Wiley, 2002.
4	Sriram V. Iyer, Pankaj Gupte, 'Embedded Real Time Systems Programming', Tata McGraw Hill, 2004.
5	Steve Heath, 'Embedded System Design', II edition, Elsevier, 2003.
6	Doeblin, Measurement System Application and Design, McGraw Hill, 1978.

COURSES FOR ELECTIVES III

COURSE TITLE	ELECTRONIC ENGINE MANAGEMENT SYSTEM			CREDITS	3
COURSE CODE	AUA4733	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL – 2	

CO	COURSE OUTCOMES	PO
1	Familiarize with automotive instruments and sensors	
2	Gain knowledge about the measurement of engine parameters by using sensors	
3	Attain knowledge on the working of Electronic Ignition System	
4	Attain the Principles of Digital Control systems and its applications	
5	Familiarize with the concept of Engine mapping	

MODULE I	FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS	(9L)

Microprocessor architecture, open and closed loop control strategies, PID control, Look up tables, introduction to modern control strategies like Fuzzy logic and adaptive control. A/D and D/A controllers.

MODULE II	SENSORS	(9L)

Types – Mass Air flow, Manifold Absolute Pressure, Temperature, Speed, EGO, Knock, and Crankshaft Position-Hall Effect-Principle of operation, construction, material and characteristics.

MODULE III	SI ENGINE MANAGEMENT	(9L)

Mono point, Multi point and Direct injection systems - Principles and Features, Bosch injection systems- L-Jetronic and LH –Jetronic- Layout and working, Open loop control and Lambda loop control in injection.

MODULE IV	CI ENGINE MANAGEMENT	(9L)

Fuel injection system parameters affecting combustion, noise and emissions in CI engines. Inline injection pump, Rotary pump and injector - Construction and principle of operation, Electronically controlled Unit Injection system. Layout of the common rail fuel injection system.

MODULE V	IGNITION SYSTEMS AND ENGINE MAPPING	(9L)

Ignition fundamentals, Types of solid state ignition systems, High energy ignition distributors, Electronic spark timing and control. Combined ignition and fuel management systems. Digital control techniques - Dwell angle, Ignition timing and Injection duration calculation.

TEXT BOOKS

1. Bosch Technical Instruction Booklets.
2. Tom Denton, Automotive Electrical and Electronic Systems, Edward Publications, 2012
3. William B Ribbens “Understanding Automotive Electronics”, SAE Publications, 2015
4. Eric Chowanietz “Automobile Electronics” SAE Publications, 2014

REFERENCE BOOKS

1. Robert Bosch “Diesel Engine Management” SAE Publications, 2012
2. Robert Bosch, “Gasoline Engine Management” SAE Publications, 2013
3. Robert N.Brady, “Automotive Computers and Digital Instrumentation”, Prentice Hall, 2015
4. Heinz Heisler, Advanced Engine Technology. SAE Publications, 2014

COURSE TITLE	VIBRATION AND NOISE CONTROL			CREDITS	3
COURSE CODE	AUA4734	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	PO
1	Understand the various types of vibration with damping and without damping.	
2	Understand the various numerical methods to determine natural frequency.	
3	Understand the various vibration controlling techniques.	
4	Understand the various sources of noise from Automobiles.	
5	Understand the various noise controls of Automobiles.	

MODULE I	INTRODUCTION	(9L)

Single degree of freedom, two degree of freedom, free, forced and damped vibrations, modeling and simulation studies, model of an automobile, magnification factor, transmissibility, vibration absorber. Two degree of freedom system. modal analysis

MODULE II	NUMERICAL METHODS	(9L)

Approximate methods for determining fundamental frequency, Dunkerleys lower bound, Rayleighs upper bound, Holzer method for closed coupled system and branched system.

MODULE III	VIBRATION CONTROL TECHNIQUES	(9L)

Vibration isolation, tuned absorbers, un tuned viscous dampers, damping treatments, dynamic forces generated by IC engines, engine isolation, crank shaft damping, modal analysis of the mass elastic model shock absorbers.

MODULE IV	NOISE SOURCES FROM AUTOMOBILES	(9L)

Noise Characteristics of engines, engine overall noise levels, assessment of combustion noise, assessment of mechanical noise, engine radiator noise, intake and exhaust noise, engine accessory contributed noise, transmission noise, aerodynamic noise, tyre noise, brake noise.

MODULE V	AUTOMOTIVE NOISE CONTROL	(9L)

Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles, sound in enclosures, sound energy absorption, sound transmission through barriers.

TEXT BOOKS

1. S.S.Rao - "Mechanical Vibrations" - Pearson Education, 2014.
2. Kewal Pujara, "Vibrations and Noise for Engineers, Dhanpat Rai & Sons, 2012.

REFERENCE BOOKS

1. J.Srinivas, Text book on Mechanical vibrations, Prentice Hall of India, 2014
2. S.Graham Kelly, Mechanical Vibrations, Theory and Practice, Schaum's Outline series, 2008

COURSE TITLE	ENGINE EXHAUST SYSTEM DEVELOPMENT			CREDITS	3
COURSE CODE	AUA4735	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	PO
1	Gain knowledge in the global environmental of air pollution control bureaus.	
2	Familiarize with emission control systems and noise control devices.	
3	Design and validate full exhaust system for on-road, off-road applications.	
4	Gain knowledge on the advanced technology development on exhaust system for SI and CI engines.	
5	Familiarize with automobile design and computational simulation environments.	

MODULE I	INTRODUCTION TO ENGINE EXHAUST	9

Introduction of exhaust system – Engine Exhaust Technology Evolution – India automotive emission regulation – Noise limits for vehicles at manufacturing stage – Basics of Exhaust System from Engine head face to tail pipe – Components of exhaust system – Exhaust catalytic converter – Silencer (Muffler) – System integration.

MODULE II	EMISSION CONTROL SYSTEMS	9

Understanding of Gasoline and diesel engine out pollutants – Emission Norms – Air to Air – Converter Hot end components – TWC – Manifold – Cone Profiles – Substrate – Types of Substrate – Wash coat – Mat – Types of Mats – Shell – Canning – Types of Canning – Controlled canning – GBD (Gab Bulk Density) – Temperature Sensor – Oxygen Sensor – Thermal Management – Insulators – Heat Shields – (Gasoline / Diesel) – Advancement in substrates – Technology for gasoline engine – Three way converter (TWC) – Gasoline particulate filter (GPF) – Lean NOx Trap (LNT) – Technology for diesel engine – Exhaust gas recirculation (EGR) – Diesel oxidation catalyst (DOC) – Partial flow filter (PFF) – Diesel particulate filter (DPF) – Selective catalytic reduction (SCR) – Selective catalytic reduction filter (SCRF) – Global regulations and testing protocols – System integration. Carbon di oxide (CO2) controls systems.

MODULE III	NOISE CONTROL SYSTEMS	9

Basics of Acoustics – Fundamentals of sound – Terminologies – Noise cancellation – Destructive & Constructive interferences – Engine exhaust noise introduction – Gasoline & Diesel engine operation & exhaust noise characteristics – Vehicle Pass by Noise – Exhaust noise measurement standards – Types of exhaust noises – Pulsation noises – Flow noises – Booming noises – Shell radiation noises – Passive noise reduction techniques – Types of mufflers – Reflective – Absorptive Hybrid mufflers – Muffler design constrains – Muffler internal design – Tri flow muffler – Straight though muffler – Helmholtz resonator – Internal resonators – Baffle plates – Perforations – shells – End Plates – Pipe diameters – Absorptive materials – Development methodologies – Muffler performance parameters – Sound transmission loss – Insertion loss – Noise reduction – Tail pipe noise level – back pressure – Vehicle interior noise levels – Advanced muffler technologies – Cat con integrated muffler – variable flow muffler – Twin mufflers – Active noise cancellation – Sporty sound mufflers – Sound engineering, Off Road – On Road – Non Road muffler applications Examples – Manufacturing Types & Process – Roll & Spot welding – Lock seaming – Double seaming – Web forming – Clinching – Cold metal transfer – Hydro forming – Piercing – Stamping – Muffler examples.

MODULE IV	COMPUTATIONAL ANALYSIS (CFD, FEA)	9
CFD for vehicle exhaust system – Governing equation of fluid flow and heat transfer – Flow Uniformity – Pressure loss through exhaust system – Flow Eccentricity – HEGO Index – Conjugate Heat Transfer Analysis – Introduction to finite element analysis. Present, Past, Future FEA – Introduction to Pre-processing ID, 2D, 3D Elements – Meshing, Processing Techniques – Statics of strength of materials – Types of Analysis – Modal Analysis – Linear Static Analysis – Introduction to Non-linear Analysis – Dynamic Analysis – Thermal Analysis – RLDA & Fatigue Analysis – Post processing techniques of different Analysis – Process Flows and Targets – Case Study 1-2-3.		
MODULE V	**TESTING AND VALIDATION**	**9**
Vehicle noise measurement – Operational vibration analysis – Experimental modal analysis – Air leak test Thermal Shock Tests – Thermal fatigue test – Back pressure measurement test – Hot end system: Hot Vibration Test – Cold vibration test – Flow noise measurement – Shell deformation test – Cold end: Biaxial fatigue test – Uni-axial fatigue test – Salt spray test – Condensate Water Noise Test – Transmission loss measurement – Shell stiffness measurement – Glass wool endurance test – Resonance frequency measurement – Shell radiation noise measurement – Tail pipe noise measurement – Water drainage ability test.		
TEXT BOOKS		
1	Engine Emissions: Pollutant Formation and Advances in Control Technology, Alpha science publisher, 2015	
2	Noise & Vibration Control Engineering (Principles and applications) Istvan L. Ver and Leo L.	
REFERENCE BOOKS		
1	M.L. Munjal, Acoustics of Ducts and Mufflers with Applications to Exhaust and Ventilation System Design,– 2ndEdition, Wiley – Inter Science.	

COURSE TITLE	COMPUTATIONAL FLUID DYNAMICS			CREDITS	3
COURSE CODE	AUA4736	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL- 4	

CO	COURSE OUTCOMES	PO
1.	The students should be able to Familiarize on the numerical modeling, governing equations of fluid flow and heat transfer	
2.	The students should be able know the importance of grid generation.	
3.	The students should be able to understand the conduction, convection and diffusion concepts.	
4.	The students will be able to understand the importance of turbulence modeling methods	

MODULE 1 – GOVERNING EQUATIONS AND BOUNDARY CONDITIONS (9)
Basics of computational fluid dynamics - Governing equations of fluid dynamics - Continuity, Momentum and Energy equations - Physical boundary conditions - Time-averaged equations for Turbulent flow Turbulence -Kinetic -Energy Equations
MODULE 2 – GRID GENERATION AND TYPES OF GRID (9)
Grid- Types of grid- Unstructured mesh- polyhedral mesh- tetrahedral mesh, Structured Mesh- prismatic mesh, Grid Independence study, Advantages of Grid generation
MODULE 3– HEAT CONDUCTION (9)

Finite difference and finite volume formulation of steady/transient one-dimensional conduction equation, Source term linearization, Incorporating boundary conditions, Finite volume formulations for two and three dimensional conduction problems
MODULE 4- CONVECTION AND DIFFUSION (9)
Finite volume formulation of steady one-dimensional convection and Diffusion problems, Central, upwind, hybrid and power-law schemes - Discretization equations for two dimensional convection and diffusion.
MODULE 5- TURBULENCE MODELLING (9)
Reynold's averaged Navier-Stokes equations and closure problem- Prandtl's mixing length theory and eddy viscosity- Turbulence models- k-epsilon and k-omega- One equation model- two equation model- LES, DNS

TEXT BOOKS	
1.	Versteeg, H.K, and Malalasekera, W., An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Longman, 2008
2.	Ghoshdastidar, P.S., Computer Simulation of flow and heat transfer, Tata McGraw Hill Publishing Company Ltd., 2010
REFERENCE BOOKS	
1.	Patankar, S.V., Numerical Heat Transfer and Fluid Flow, McGraw-Hill, 2015. Ane - Books Indian Edition.2015.
2.	Muralidhar, K and Sundarajan .T., Computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi,2nd Edition 2008.
3.	Bose, T.K., Numerical Fluid Dynamics, Narosa publishing House, 2016.
4.	Muralidhar, K and Biswas Advanced Engineering Fluid Mechanics, Narosa Publishing House, New Delhi, 2nd Edition, 2016.
5.	Anderson, J.D., Computational fluid dynamics - the basics with applications, 2015.

COURSE TITLE	**AUTOMOTIVE AIR CONDITIONING**			**CREDITS**	**3**
COURSE CODE	**AUA4737**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
CIA	**50%**			**ESE**	**50%**
LEARNING LEVEL				**BTL-3**	

CO	**COURSE OUTCOMES**	
1	To broaden the understanding of air conditioning systems and its components	
2	To introduce air conditioner heating systems and protection of engine	
3	To broaden the understanding of refrigerants and its handling	
4	To introduce air routing and temperature control	
5	To underline the importance of maintenance and service of air conditioning systems.	

MODULE I	**AIR CONDITIONING FUNDAMENTALS**	**(9L)**
Basic air conditioning system – Location of air conditioning components in a car – Schematic layout of a refrigeration system - Transport refrigeration - Compressor Components – Condenser and high pressure Service ports. Thermostatic expansion valve – Expansion valve calibration – Controlling Evaporator Temperature –Evaporator pressure regulator – Evaporator temperature regulator.		

MODULE II	AIR CONDITIONER – HEATING SYSTEMS	(9L)
Automotive heaters – Manually controlled, automatic air controlled air conditioner – Heater Systems – Ford automatic controlled air conditioner and heater systems – Automatic temperature control – Air conditioning protection –Engine protection.		
MODULE III	**REFRIGERANT**	**(9L)**
Containers – Handling refrigerants – Tapping into the refrigerant container – Refrigeration system diagnosis –Diagnostic procedure – Ambient conditions affective system pressures.		
MODULE IV	**AIR ROUTING AND TEMPERATURE CONTROL**	**(9L)**
Objectives – Evaporator care air flow – Through – the Dash Recirculating Unit – Automatic temperature control – Duct system – Controlling flow – Vacuum reserve – Testing the air control and handling systems.		
MODULE V	**AIR CONDITIONING SERVICE**	**(9L)**
Air conditioner maintenance and Service – Servicing heater systems removing and replacing components – Trouble shooting of air conditioning systems – Compressor Service.		
TEXT BOOKS		
1	William.H.Crouse, Donald.L.Anglin, Automotive Air Conditioning, McGraw Hill, 1990.	
2	Tom Birch, Automotive Heating and Air conditioning, Prentice Hall, 2003.	
REFERENCE BOOKS		
1	Mitchel Information Services, Inc., Mitchell Automatic Heating and Air Conditioning Systems, Prentice – Hall, Inc., 1989.	
2	Paul Weisler, Automotive Air Conditioning, Reston Publishing Co., Inc., 1990.	

COURSE TITLE	RUBBER TECHNOLOGY FOR AUTOMOBILES			CREDITS	3
COURSE CODE	AUA4738	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	
1	To Select the rubber component according to the suitable design criteria.	
2	To Grouping of materials according to property of the selection	
3	To Calculate complete design of the rubber components for the vibration isolation	
4	To Use the components to various sealing areas	
5	To Deeper knowledge in manufacturing of rubber components	

MODULE I	INTRODUCTION	(9L)
Identification of plastics / rubber components in automobiles - function - selection criteria.		
MODULE II	**STRUCTURE-PROPERTY RELATIONSHIP OF RUBBER**	**(9L)**
Resilience, creep, hysteresis and damping, stability, set and stress relaxation, behavior in dynamic applications.		
MODULE III	**VIBRATION AND RUBBER SPRING**	**(9L)**
Principle of vibration isolation - rubber mounts - spring design - comparison with metallic springs - shape factor and its effect - forced and free vibrations with damping - typical mounts, compounding and manufacture.		
MODULE IV	**FLUID SEALINGS AND FLEXIBLE COUPLINGS AND HOSES**	**(9L)**
Seals for static and dynamic applications - effect of heat / oil ageing - frictional behavior - fundamental of seal ability.		
MODULE V	**COMPOUNDING AND MANUFACTURE**	**(9L)**
Types of couplings - specification and selection - torque vs deflection relationships - brake fluid / hydraulic hoses, materials and manufacture		

TEXT BOOKS	
1	Freakley,P.K., and Payne,A.R., Theory and Practice of Engineering with Rubber, Applied Science Publishers Ltd.
2	

REFERENCE BOOKS	
1	Hobel,E.F., Rubber Springs Design.
2	Blow,C.M. and Hepburn,C., Rubber Technology and Manufacture.

COURSES FOR ELECTIVES IV

COURSE TITLE	AUTOMOTIVE AERODYNAMICS			CREDITS	3
COURSE CODE	AUA4739	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	PO
1	To understand Fundamentals of Aerodynamics	
2	To familiarize the Stability, Safety and Comfort of ground vehicles	
3	To understand measurement techniques in Wind Tunnels	
4	To familiarize the computational fluid dynamics	
5	To design and develop the simulation methods of ground vehicles	

MODULE I	FUNDAMENTALS OF AERODYNAMICS	9

Scope – Concept of bluff body, Generic shapes, Relevance of these shapes to ground vehicles, Pressure drag & Viscous drag. – Flow phenomena related to vehicles – External and Internal flow problems – Performance of cars and light vans – Resistance to vehicle motion – Flow field around car – Aerodynamic development of cars – Optimization of car bodies for low drag.

MODULE II	STABILITY, SAFETY AND COMFORT	9

The origin of forces and moments – effects – vehicle dynamics under side wind – Force and Moment coefficients – Safety limit Design stage measures, Modifications of other details & their effect, Important factors affecting Aerodynamics - Rear slant, Engine cooling air drag, Crosswinds, Underside flows, Wheel Rotation – dirt accumulation on vehicle - wind noise – Air flow around individual components – High performance vehicles – Very log drag cars – Design alternatives – High efficiency radiator arrangement – Development and simulation methods.

MODULE III	WIND TUNNELS AND TEST TECHNIQUES	9

Principles of wind technology – Limitations of simulation – Simulation based optimization of geometries, Drag reduction Technologies – Surface shaping Scale models – Existing automobile wind tunnels Wind Tunnel Experiments – Measurement of Pressure Coefficient, Measurement of Drag Force .Wind Tunnel limitations & Corrections – Boundary Layer Control, Pressure Gradient, Wind Tunnel Blockages. – Climatic tunnels – Measuring equipment and transducers. Pressure measurement – velocity measurements – Flow visualization techniques – Road testing methods – Wind noise measurements.

MODULE IV	APPLICATION OF CFD	9

Methods to solve Navier–Stokes equation – Forces acting in a fluid element – Compressibility effects in a flow field – Inviscid flow – Governing equations – Irrotational flow field and consequences – Potential flows – Boundary layer methods Important requirements of CFD solver – Geometric / Dynamic similarity, Robust Flow solver / Numerical scheme, Convergence level, Transition prediction, Turbulence models. – Numerical modelling of fluid flow around vehicle body

MODULE V	AERODYNAMIC DESIGN	9

Development and simulation methods –cars, buses, trucks. Surface Motion, Surface permeability, Mass addition, Energizing the external flow

TEXT BOOKS

1. W.H. Hucho, ‘Aerodynamics of Road Vehicles’, Butterworth and Co., 2014.
2. A. Pope, “Wind Tunnel Testing”, 2nd Edition, John Wiley & Sons New York, 2015

REFERENCE BOOKS

1	E.L.Houghton & P.L.Carpenter, "Aerodynamics for Engineering students", Butterworth Heinman(2013)
2	Milliken and Milliken, "Race Car Vehicle Dynamics", 2015

COURSE TITLE	ALTERNATIVE FUELS AND ENERGY SYSTEMS			CREDITS	3
COURSE CODE	AUA4740	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50 %			ESE	50 %
LEARNING LEVEL				BTL- 3	

CO	COURSE OUTCOMES	PO
1.	The students should be able to familiarize on various alternate fuels.	
2.	The students should be able to gain knowledge on the details of methanol and ethanol usage, storage, chemical structure.	
3.	The students should be able to acquire knowledge of natural gas, LPG, hydrogen and biogas.	
4.	The students should be able to attain the performance characteristics of various vegetable oils.	
5.	The students should be able to familiarize with electric and hybrid vehicles.	

MODULE 1 – INTRODUCTION (9L)

Need for alternate fuel- Evolution- Availability and properties of alternate fuels, general use of alcohols, LPG, Hydrogen, Ammonia, CNG and LNG, Vegetable oils, water and biogas, Merits and demerits of various alternate fuels. Government norms and Subsidiary. Introduction to alternate energy sources. Like EV, Hybrid, Semi-Hybrid, Fuel cell, Nuclear Cars and Solar car,

MODULE 2 – ALCOHOLS (9L)

Availability –Source- Types of Alcohols- Properties as engine fuel – Octane Number- Self Ignition Temperature- Calorific Value. Fuel and Engine Modification. Blending with diesel and gasoline- Dual Fuel Operation- Energy share Calculation. Performance in SI engine- Combustion characteristics in CI engines- Emission characteristics. Problems of using alcohols in diesel engine. DME, DEE properties- storage, Performance in SI & CI Engines.

MODULE 3- NATURAL GAS, LPG, HYDROGEN AND BIOGAS (9L)

Availability of CNG, properties, Difficulties of using gaseous fuel in IC engines - Modification required using in engines, Performance and emission characteristics of CNG using LPG in SI & CI engines, Performance and emission of LPG. Hydrogen; Storage and handling, properties – flame speed- flammability. Performance emission and Combustion behavior of hydrogen in CI engine - safety aspects and design of gaseous fuel induction system.

MODULE 4- VEGETABLE OILS (9L)

Design of engine, optimum selection of operating variables for control of emissions, Crankcase and evaporative emission control, Thermal and catalytic reactors, Elements of catalytic reactors, catalysts and substrates, Cold start HC control. EGR, Lean de-NOx catalysts, water injection, NOx traps and SCR. Diesel particulate filters (DPF), DPF regeneration, and Secondary air injection. Fuel modifications. Two stroke engine pollution control.

MODULE 5 - ELECTRIC, HYBRID, FUEL CELL AND SOLAR CARS (9L)

Need of E-Vehicle. Layout of an electric vehicle, Advantage and limitations, Specifications, System components, Electronic control system, High energy and power density batteries, battery design - Charging Station – Cost analysis. Hybrid vehicle – type- advantages and limitations. Fuel cell vehicles, Solar powered vehicles.

TEXT BOOKS	
1.	Richard.L.Bechfold - Alternative Fuels Guide Book - SAE International Warrendale - 2007.
2.	Ganesan, V- "Internal Combustion Engines"- Tata McGraw-Hill Co.- 2013.
REFERENCE BOOKS	
1.	Maheswar Dayal - "Energy today & tomorrow" - I & B Horishr India - 2012.
2.	Nagpal - "Power Plant Engineering" - Khanna Publishers - 2011.

COURSE TITLE	OFF- HIGHWAY MOBILITY			CREDITS	3
COURSE CODE	AUA4741	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL				BTL-3	

CO	COURSE OUTCOMES	PO
1	The students should be able to Familiarize with the construction and working of various Earth moving equipment	
2	The students should be able to Acquire the knowledge on construction and working of various constructional equipment	
3	The students should be able to Gain knowledge on the construction and working of Farm equipment	
4	The students should be able to Familiarize with the working of Industrial equipment	
5	The students should be able to Develop the knowledge on working of Military equipment	

MODULE I	EARTH MOVING AND MINING EQUIPMENT	(9L)

Construction layout, capacity and applications of earthmovers like dumpers, front-end loaders, bulldozers, backhoe loaders etc. Selection criteria of prime mover for dumpers and front end loaders based on vehicle performance characteristics. Rock drilling machines, Mineral handling Equipment.

MODULE II	CONSTRUCTIONAL AND ROAD EQUIPMENT	(9L)

Layout of Constructional and Road equipment: Tower cranes, hoist, excavators, motor graders, Soil Compactors, Road paving machines, concrete ready mixers for construction of bridges and their working principles.

MODULE III	FARM AND FORESTRY EQUIPMENT	(9L)

Classification of tractors – Main components of tractor. Working attachment of tractors – Auxiliary equipment – Trailers and body tipping mechanism - plowing - paddy plantation machine, harvesting machines, Tree cutting and log handling machines.

Suggested Reading: Tractor hydraulic system

MODULE IV	INDUSTRIAL EQUIPMENT	(9L)

Constructional features, capacity and stability of Overhead cranes, Mobile cranes, jib cranes. Forklifts. Towing vehicles, Container Handing machines.

MODULE V	MILITARY VEHICLES	(9L)

Special features and constructional details of tankers, gun carriers and Military transport vehicles, 360° Surveillance platforms.

TEXT BOOKS	
1	Wong.J.T., " Theory of Ground vehicles ", John Wiley & Sons, New York, 2007

2	Robert L. Peurifoy, William B. Ledbrtter, Clifford J. Schexnayder -Construction planning, Equipment and Methods - McGrawHill, Fifth Edition, 2012
REFERENCE BOOKS	
1	John Schaufelberger, Construction Equipment Management, 2013
2	Abrosimov. K. Bran and Katayer.K., " Road making Machinery, MIR Publishers,2011
3	Rodichev and G.Rodicheva, Tractor and Automobiles, MIR Publishers, 2008

COURSE TITLE	**ELECTRONIC CONTROL UNIT (ECU) DEVELOPMENT IN AUTOMOTIVE SYSTEMS**			**CREDITS**	**3**
COURSE CODE	**AUA4742**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
CIA	**50%**			**ESE**	**50%**
LEARNING LEVEL				**BTL-3**	

CO	**COURSE OUTCOMES**	**PO**
1.	The students should be able to Familiarize on concepts of ECU design for automotive applications.	
2.	The students should be able to Gain knowledge on software modules and hardware modules for ECU design	
3.	The students should be able to Acquire the knowledge to solve complex problems in Model based system design & hardware in-the-loop simulation	
4.	The students should be able to Attain the knowledge on the process of Verification and Validation of HIL test results with real world result Hardware in-the-Loop testing.	

MODULE 1 – ECU DESIGN CONCEPT (9L)

The concepts of ECU design for automotive applications- Need for ECUs- advances in ECUs for automotive- design complexities of ECUs-V-Model for Automotive ECU ‘s Architecture of an advanced microcontroller used in the design of automobile ECUs -analog and digital Interfaces-Controllers for ECUs: Understanding different ECUs in an automobile-challenges and design requirements of ECU design - selection of sensors and interfaces for ECU design.

MODULE 2 – MATHEMATICAL MODELING AND VALIDATION (9L)

Top level blocks diagram development for ECUs- design of software modules and hardware modules for ECU design- mathematical modeling of automotive Applications-Designing-modelling and porting of software models on ECUs-development of test setup for ECU testing- System level testing: Experimental setup for ECU validation-system level optimization for cost- reliability check and endurance check of ECUs- signal integrity check and EMI/EMC analysis- integration of ECUs into automotive

MODULE 3– MODEL BASED SYSTEM DESIGN (9L)

Introduction to Model based system design -hardware in-the-loop simulation- continuous and discrete simulation basics-modeling basics. Connection between Hardware and Simulation-Coupling concepts-simulator coupling and co-simulation, synchronization of co-simulations, basic coupling principles- Event Discrete Simulation-Real Time Workshop-Introduction to basic Simulink blocks, xPC target, Real Time Workshop-State flow and Real Time Embedded coder.

MODULE – 4 MODEL BUILDING WITH SIMULINK (9L)

Model Building with Simulink: Controller programming using model based system design for an automotive application using Simulink-Plant Modelling- Plant modelling using Simulink for the automotive application-PID controller design, analog output, targeting a processor for plant-

Hardware Implementation-Design of ECU for automotive applications, interfacing of sensors and Actuators-System modelling and validation using test setup- Interfacing of software models with hardware design.
MODULE- 5 HARDWARE IN LOOP SIMULATION (9L)
System programming and development of experimental setup for hardware in loop simulation. Hardware in-the-Loop-Testing of plant separately, testing of controller separately and testing of plant and controller in the loop-System Verification and Validation-Comparing the HIL test results with real world result Hardware in-the-Loop testing- Experimental setup for HIL-HIL testing using dSPACE micro autobox, introduction to carmaker, building scenarios and vehicle analysis using carmaker- interfacing dSPACE with carmaker and case studies on micro autobox
TEXT BOOKS
1. Frank Vahid and Tony Givargis, Embedded System Design, 2012
2. John Wiley & Sons Ronald K. Jurgen, A Unified Hardware/Software Introduction, Automotive Electronics Handbook, McGraw-Hill, 2013
3 Hall, Douglas V, Microprocessors and Interfacing: Programming and Hardware, 2nd edition, Tata McGraw Hill, 2014
REFERENCE BOOKS
1. David E. Simon, An Embedded Software Primer, Pearson Education, 2015
2. Ferguson, Colin R, Kirkpatrick, Allan T., Internal Combustion Engine - 2014

COURSE TITLE	**SURFACE COATING TECHNIQUES AND APPLICATIONS**			**CREDITS**	**3**
COURSE CODE	**AUA4743**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-3-0**
CIA	**50%**			**ESE**	**50%**
LEARNING LEVEL				**BTL-3**	

CO	**COURSE OUTCOMES**	**PO**
1	Acquire the knowledge of surface engineering properties for different Coatings based on the application requirement.	
2	Acquire the knowledge about the importance of specific coatings & its applications on specific Engineering components.	
3	Understand the importance & role of surface modifications to achieve several technological properties.	
4	Acquire the knowledge of using Thermal spray coating	
5	Acquire knowledge of surface engineering properties for different Coatings based on the application requirement.	

MODULE I	**SURFACE ENGINEERING**	**(9 Hours)**
Introduction to surface engineering, Scope of surface engineering for different engineering materials, Surface Preparation methods such as Chemical, Electrochemical, Mechanical: Sand Blasting, Shot peening, Shot blasting, Hydro-blasting, Vapor Phase Degreasing etc., Coatings: Classification, Properties and applications of Various Coatings		
MODULE II	**CHEMICAL AND METALLIC COATING**	**(9 Hours)**
Chemical Conversion Coating Chromating, Phosphating, and Anodizing, Thermochemical processes: Methodology used, mechanisms, Process parameters and applications.		

Metallic coating Hot Dipping, Galvanizing, Electrolytic and Electro less plating: Methodology used, mechanisms, Process parameters and applications.		
MODULE III	**VAPOUR AND DIFFUSION COATING**	**(9 Hours)**
Coating from Vapour Phase PVD, and CVD: Various Methods used, mechanisms, Process parameters and applications. **Diffusion Coating** Carburizing, Carbonitriding, Siliconizing, Chromizing, Aluminizing, Boronizing, Boronitriding: Various Methods used, mechanisms, Process parameters and applications.		
MODULE IV	**SURFACE MODIFICATION**	**(9 Hours)**
Surface modification by use of directed energy beams, Plasma, Sputtering & Ion Implantation. Surface modification by Friction stir processing. Surface composites.		
MODULE V	**THERMAL SPRAY COATINGS**	**(9 Hours)**
Processes, Types of spray guns, Comparison of typical thermal spray processes, Surface Preparation, Finishing Treatment, Coating Structures and Properties, Applications.		

TEXT BOOKS	
1	Surface Engineering Hand Book, 12th edition by Keith Austin, London : Kogan Page, 2018
2	J.R. Davis., (2004), "Handbook of Thermal Spray Technology", ASM International. USA.
REFERENCE BOOKS	
1	J. R. Davis-Surface Engineering for Corrosion and Wear Resistance.
2	George J. Rudzki -Surface Finishing Systems. metal and non-metal finishing handbook-guide, Metals Park : ASM, 1983
3	James A. Murphy- Surface Preparation and Finishes for Metal, McGraw-Hill, New York 1971
4	P. G. Sheasby and R. Pinner - Surface treatment and finishing of Aluminium and its alloy,Volume-2, 5th ed., ASM, Metals Park, 1987
5	K. E. Thelning -Steel and its Heat Treatment Bofors Handbook, London : Butterworths, 1975
6	Friction Stir Welding and Processing, Rajiv Sharan Mishra, Partha Sarathi De, Nilesh Kumar, Springer, ISBN: 978-3-319-07042-1 (Print)
7	Friction Stir Welding and Processing, R.S. Mishra and M.W. Mahoney, ASM International, 2007, ISBN: 978-0-87170-840-3
8	Advances in Friction-Stir Welding and Processing, M-K Besharati-Givi and P. Asadi, Elesevier, ISBN: 978-0-85709-454-4

COURSE TITLE	**ROBOTICS AND INDUSTRIAL AUTOMATION**			**CREDITS**	**3**
COURSE CODE	**AUA4744**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
CIA	**50%**			**ESE**	**50%**
LEARNING LEVEL				**BTL-3**	

CO	**COURSE OUTCOMES**	
1	To Select tools for required application	
2	To Configure robots with components and devices	
3	To Solve kinematics problems	
4	To Able to make automation modules based on sensor in put	
5	To Able to design and fabricate small robots for material handling, spray painting, spot welding, assembly, inspection etc	

MODULE I	INTRODUCTION	(9L)
Automation and Robotics, CAD/CAM and Robotics - An over view of Robotics - present and future applications - classification by coordinate system and control system.		
MODULE II	**COMPONENTS OF THE INDUSTRIAL ROBOTICS**	**(9L)**
Function line diagram representation of robot arms, common types of arms. Components, Architecture, number of degrees of freedom -requirements and challenges of end effectors, determination of the end effectors, comparison of Electric, Hydraulic and Pneumatic types of locomotion devices.		
MODULE III	**MOTION ANALYSIS**	**(9L)**
Homogeneous transformations as applicable to rotation and translation - problems. Manipulator Kinematics: Specifications of matrices, D-H notation joint coordinates and world coordinates Forward and inverse kinematics - problems.		
MODULE IV	**ROBOT ACTUATORS AND FEED BACK COMPONENTS**	**(9L)**
Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors. Feedback components: position sensors - potentiometers, resolvers, encoders - Velocity sensors.		
MODULE V	**ROBOT APPLICATION IN MANUFACTURING**	**(9L)**
Material Transfer - Material handling, loading and unloading- Processing - spot and continuous arc welding & spray painting - Assembly and Inspection.		

TEXT BOOKS	
1	Groover M P, Industrial Robotics, Pearson Edu
2	Mittal R K & Nagrath I J, Robotics and Control, TMH.

REFERENCE BOOKS	
1	Robotics, Fu K S, McGraw Hill.
2	An Introduction to Robot Technology, Coiffet and M. Chaironze, Kogam Page Ltd. 1983 London.
3	Robotic Engineering, Richard D. Klafter, Prentice Hall
4	Robot Analysis and Intelligence, Asada and Slow time, Wiley Inter-Science.
5	Introduction to Robotics, John J Craig, Pearson Edu.
6	Robot Dynamics & Control - Mark W. Spong and M. Vidyasagar, John Wiley & Sons (ASIA) Pvt. Ltd.