Vel Tech
Rangarajan Dr. Sagunthala
R&D Institute of Science and Technology
(Deemed to be University Estd. u/s 3 of UGC Act, 1956)

B.Tech. Automobile Engineering

Curriculum and Syllabus

VTU R15

DEPARTMENT OF AUTOMOBILE ENGINEERING

Department Vision

To be a centre of excellence in the field of automobile engineering by imparting knowledge and skill, enhancing research and development activities with social, ethical and environmental responsibilities to meet domestic and global challenges

Department Mission

- To produce effective and responsible automobile engineering graduates with respect to global requirements by imparting quality education.
- To constantly improve the pedagogical methods to deliver the academic programs with industry-oriented knowledge.
- To focus on learning through the state-of-the-art laboratories that possess a standard set-up to carry out research based education.
- To motivate students to pursue higher education and successfully take-up competitive examinations to reach a better position in their professional career

The Programme Educational Objectives (PEOs)

B.Tech -Automobile Engineering

- A strong foundation in mathematics, basic science and engineering fundamentals to successfully compete for entry level positions and pursue graduate studies in Automobile Engineering and related fields.
- Contemporary professional and lifelong learning skills including hands-on experience, familiarity with CAD/CAE software packages, technical expertise on engineering materials, vehicle dynamics, automobile structures, propulsion, FEA systems, hybrid vehicles, alternative fuels and automobile manufacturing methods to successfully compete in the national and global engineering market.
- Strong communication and interpersonal skills, broad knowledge, and an understanding of multicultural and global perspectives to work effectively in multidisciplinary teams, both as team members and as leaders.
- Understand societal related issues such as ethical choices, environmental protection, health and safety, and appropriate business skills.

Program Outcomes (POs)

Engineering Graduates will be able to

1. **Engineering Knowledge**: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems
2. **Problem Analysis**: Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.
4. **Conduct investigations of complex problems** using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.
5. **Modern Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The Engineer and Society**: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
7. **Environment and Sustainability**: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.
11. **Life-long Learning**: Recognize the need for and have the preparation and ability to engage in independent and life- long learning in the broadest context of technological change.
12. **Project Management and Finance**: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Programme Specific Outcomes (PSOs)

- **Automotive System Analysis and Testing:** Identify, formulate and solve Automobile Engineering problems and to work in research laboratory and multidisciplinary tasks in Automobile Engineering.
- **Automotive Design and Development:** Analyze, design, conduct experiments, and interpret data of an automobile system to meet the requirements of an automobile industry and to solve problems related to Automobile Engineering by using modern engineering tools and software

VEL TECH RANGARAJAN DR SAGUNTHALA R & D INSTITUTE OF SCIENCE AND TECHNOLOGY

SCHOOL OF MECHANICAL AND CONSTRUCTION

DEPARTMENT OF AUTOMOBILE ENGINEERING

B.TECH - AUTOMOBILE ENGINEERING (VTU R15)

Foundation Courses

COURSE CODE	COURSE NAME	L	T	P	C
1150EN201	Technical English	2	0	2	3
1150MA202	Engineering Mathematics-I	2	2	2	4
1150PH101	Engineering Physics	3	0	0	3
1150ME101	Basic Mechanical Engineering	2	0	0	2
1150CE101	Basic Civil Engineering	2	0	0	2
1150ME202	Engineering Graphics	1	2	4	4
1150GE101	Biology for Engineers	2	0	0	2
1150GE103	Introduction to Engineering	2	0	0	2
1150PH302	Engineering Physics Laboratory	0	0	2	1
1150ME304	Engineering Practice Laboratory	0	0	2	1
1150EN102	Technical Communication	3	0	0	3
1150MA103	Engineering Mathematics-II	3	2	0	4
1150CH101	Engineering Chemistry	3	0	0	3
1150EE101	Basic Electrical Engineering	2	0	0	2
1150EC101	Basic Electronics Engineering	2	0	0	2
1150CS201	Problem Solving using C	1	2	2	3
1150ME103	Engineering Materials	2	0	0	2
1150GE102	Design Thinking	3	0	0	3
1150CH302	Engineering Chemistry Laboratory	0	0	2	1
1150EE302	Basic Electrical and Electronics Engineering Laboratory	0	0	2	1
1150MA104	Transform and Partial Differential Equation	2	2	0	3
1150MA201	Applied Statistics	2	0	2	3
1150MG101	Project Management and Finance	3	0	0	3
1150CH103	Environmental Studies	3	0	0	3
TOTAL CREDITS					**60**

Program Core

COURSE CODE	COURSE NAME	L	T	P	C
THEORY COURSES					
1151AU101	Engineering Mechanics	2	2	0	3
1151AU102	Basic Engineering Thermodynamics	2	2	0	3
1151AU103	Strength of Materials	2	2	0	3
1151AU104	Manufacturing Technology	3	0	0	3
1151AU105	Mechanics of Machines	2	2	0	3
1151AU106	Engineering Metrology and Measurements	3	0	0	3
1151AU107	IC Engines	3	0	0	3
1151AU108	Automotive Transmission	3	0	0	3
1151AU109	Vehicle Design and Data Characteristics	3	0	0	3
1151AU110	Engine design and development	2	2	0	3
1151AU111	Vehicle Dynamics	2	2	0	3
1151AU112	CAD &Applied FEA	2	2	0	3
INTERGRATED COURSES					
1151AU213	Fluid Mechanics and Machinery	3	0	2	4
1151AU214	Automotive Chassis	3	0	2	4
1151AU215	Automotive Electrical and Electronics	3	0	2	4
1151AU216	Automotive Fuels, Lubricants and Coolants	3	0	2	4
1151AU217	Vehicle Evaluation and Maintenance	3	0	2	4
LABORATORY COURSES					
1151AU318	Engine Performance and Emission Testing Lab	0	0	2	1
1151AU319	CAD &Applied FEA Lab	0	0	2	1
1151AU320	Strength of Materials Lab	0	0	2	1
1151AU321	Manufacturing Technology Lab	0	0	2	1
TOTAL CREDITS					**60**

Program Elective

Course Code	Course Name	Domain	L	T	P	C
1152AU101	Combustion & Heat Transfer in Engines	IC Engines	3	0	0	3
1152AU102	Automotive Emission and Control		3	0	0	3
1152AU103	Fuel conservation & Alternate fuels		3	0	0	3
1152AU104	Engine Testing and Certification		3	0	0	3
1152AU105	Advanced Theory of I.C.Engines		3	0	0	3
1152AU125	Super Charging & Turbo Charging		3	0	0	3
1152AU126	Engine Tribology		3	0	0	3
1152AU106	Two and Three Wheeler	Design	3	0	0	3
1152AU107	Computational Fluid Dynamics		3	0	0	3
1152AU108	Vehicle Body Engineering		3	0	0	3
1152AU109	Off Highway Vehicles		3	0	0	3
1152AU110	Automotive Aerodynamics		3	0	0	3
1152AU127	CAD/CAM Technology In Automotive Engineering		3	0	0	3
1152AU128	Quality Control and Reliability Engineering		3	0	0	3
1152AU132	Advanced 3D Modelling		2	0	2	3
1152AU111	Modern Vehicle Technology	Autotronics	3	0	0	3
1152AU112	Microprocessor and Microcontroller		3	0	0	3
1152AU113	Engine Electronics and Management Systems		3	0	0	3
1152AU114	Automotive Safety		3	0	0	3
1152AU115	Electric and Hybrid Vehicles		3	0	0	3
1152AU124	Automotive ECU Design and Wiring Harness		3	0	0	3
1152AU129	Micro Electro Mechanical Systems		3	0	0	3
1152AU116	Transport Management	Automotive Materials and Management	3	0	0	3
1152AU117	Integrated Product Development		3	0	0	3
1152AU118	Total Quality Management		3	0	0	3
1152AU119	Automotive Materials		3	0	0	3
1152AU120	Automotive Components Manufacturing		3	0	0	3
1152AU130	Regulatory Mechanism for Transportation Systems		3	0	0	3
1152AU131	Transport Economics & Business Management		3	0	0	3
1152AU121	Automotive HVAC	Advance topics	3	0	0	3
1152AU122	Automotive Testing and Certification		3	0	0	3

1152AU123	Automotive Noise Vibration And Harshness		3	0	0	3
1152AU133	Hydrogen Engines		3	0	0	3
Course Code	**Course Name**	**Domain**	**L**	**T**	**P**	**C**
1152AU134	Homogeneous Charge Compression Ignition Engine	**Advance topics**	3	0	0	3
1152AU135	Optimization in Gear Train Design		3	0	0	3
1152AU136	Sustainable Fuel for Non-Conventional Engine		3	0	0	3
TOTAL CREDITS (Students should choose minimum six courses)						**18**

Allied Elective

Course Code	Course Name	L	T	P	C
1153AU101	IC Engines	3	0	0	3
1153AU102	Automotive Transmission	3	0	0	3
1153AU103	Automotive Electrical and Electronics	3	0	0	3
1153AU104	Engine Electronics and Management System	3	0	0	3
1153AU105	Advanced Theory of I.C.Engines	3	0	0	3
1153AU106	Automobile Engineering	3	0	0	3
1153AU107	Vehicle Dynamics	3	0	0	3
1153AU108	Automotive Emission and Control	3	0	0	3
1153AU109	Fuel conservation & Alternate fuels	3	0	0	3
1153AU110	Electric and Hybrid Vehicles	3	0	0	3
1153AU201	Electric Two Wheeler Technology	3	0	6	6
TOTAL CREDITS (Students should choose minimum two courses)					**6**

Institute Elective

Course Code	Course Name	L	T	P	C
1154AU101	Automotive Safety	3	0	0	3
1154AU102	Automotive Electrical and Electronics	3	0	0	3
1154AU103	Automotive ECU Design and Wiring Harness	3	0	0	3
1154AU104	Automobile Engineering	3	0	0	3
1154AU105	Automotive Emission and Control	3	0	0	3
1154AU301	Two Wheeler Maintenance Laboratory	0	0	2	1
1154AU302	Engine Components Laboratory	0	0	2	1
1154AU303	Fuel Testing Laboratory	0	0	2	1
MAXIMUM CREDITS					**10**

Program Core

COURSE CODE	COURSE NAME	L	T	P	C
THEORY COURSES					
1151AU101	Engineering Mechanics	2	2	0	3
1151AU102	Basic Engineering Thermodynamics	2	2	0	3
1151AU103	Strength of Materials	2	2	0	3
1151AU104	Manufacturing Technology	3	0	0	3
1151AU105	Mechanics of Machines	2	2	0	3
1151AU106	Engineering Metrology and Measurements	3	0	0	3
1151AU107	IC Engines	3	0	0	3
1151AU108	Automotive Transmission	3	0	0	3
1151AU109	Vehicle Design and Data Characteristics	3	0	0	3
1151AU110	Engine design and development	2	2	0	3
1151AU111	Vehicle Dynamics	2	2	0	3
1151AU112	CAD and Applied FEA	2	2	0	3
INTERGRATED COURSES					
1151AU213	Fluid Mechanics and Machinery	3	0	2	4
1151AU214	Automotive Chassis	3	0	2	4
1151AU215	Automotive Electrical and Electronics	3	0	2	4
1151AU216	Automotive Fuels, Lubricants and Coolants	3	0	2	4
1151AU217	Vehicle Evaluation and Maintenance	3	0	2	4
LABORATORY COURSES					
1151AU318	Engine Performance and Emission Testing Lab	0	0	2	1
1151AU319	CAD and Applied FEA Lab	0	0	2	1
1151AU320	Strength of Materials Lab	0	0	2	1
1151AU321	Manufacturing Technology Lab	0	0	2	1
TOTAL CREDITS					**60**

1151AU101 **ENGINEERING MECHANICS**

L	T	P	C
2	2	0	3

1. Preamble

This course provides an introduction to the basic concepts of forces, inertias, centroid, and moments of area and techniques of finding their effects on motion. It introduces the phenomenon of friction and its effects. It introduces students to cognitive learning in applied mechanics and develops problem solving skills with both theoretical and engineering oriented problems.

2. Pre Requisite

1150PH101 Engineering Physics

3. Links to other courses

- Mechanics of Machines
- Strength of Materials

4. Course Educational Objectives

Students undergoing this course are expected to

- Develop the basic knowledge in mechanics in the areas of applied engineering.
- Develop the skills in the areas of forces and their effects and in the concept of free body diagram.

5. Course Outcomes:

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand engineering problems using the principles of statics of particles	K2
CO2	Establish the magnitude of forces and moments acting on rigid bodies	K2
CO 3	Apply properties and theories related to surfaces and solids	K3
CO4	Solve engineering problems using the principles of dynamics of particles	K3
CO5	Describe the principles of various types of friction	K2

6. Correlation of COs with Programme Outcomes :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	H	H	M		M	M					L	L	H	H
CO 2	L	H	M		M	M					L	L	M	H
CO 3	M	H	M		M	M					L	L	M	H

CO 4	L	H	M		M	M					L	L	M	M
CO 5	L	H	M		M	M					L	L	M	M

H- High; M-Medium; L-Low

7. Course Content

UNIT – I: BASICS & STATICS OF PARTICLES L-6 T-6

Introduction – Units and Dimensions – Laws of Mechanics – Lami's Theorem- Parallelogram and Triangular Law of Forces – Vectors – Vectorial representation of forces and couples – Vector operations: additions, subtraction, dot product, cross product – Coplanar Forces – Resolution and Composition of forces – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility – Single equivalent force.

UNIT – II: EQUILIBRIUM OF RIGID BODIES L-6 T-6

Free Body Diagram – Types of supports and their reactions – requirements of stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis –Scalar components of a moment – Varignon's theorem – Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions – Examples

UNIT – III: PROPERTIES OF SURFACES AND SOLIDS L-6 T-6

Determination of Areas and Volumes – First moment of area and the Centroid of sections –Second and product moments of plane area – Parallel axis theorem and perpendicular axis theorem – Polar moment of inertia – Principal moments of inertia of plane areas – Principal axes of inertia – introduction to Mass moment of inertia

UNIT – IV: DYNAMICS OF PARTICLES L-6 T-6

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion – Newton's law – Work Energy Equation of particles – Impulse and Momentum – Impact of elastic bodies.

UNIT – V: FRICTION L-6 T-6

Frictional force – Laws of Coulomb friction – simple contact friction – Belt friction – Roller friction. Translation and Rotation of Rigid Bodies – General Plane motion

TOTAL: 60 Periods

8. Text Books:

1. Hibbeller, R.C., Engineering Mechanics, Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., 2015.
2. S.Timoshenko, D.H.Young, J.V.Rao, SukumarPati, Engineering Mechanics, McGraw Hill Education (India) Private Limited., 2013.

9. References:

1. Palanichamy, M. S., and Nagan, S., Engineering Mechanics (Statics and Dynamics),Tata McGraw Hill, New Delhi 2012.
2. Kumar, K. L., Engineering Mechanics, Tata McGraw- Hill, New Delhi, 2011.

3. Shames, I. H., and Krishna Mohana Rao, G., Engineering Mechanics (Statics and Dynamics), Dorling Kindersley India) Pvt. Ltd. (Pearson Education), 2011.
4. Beer, F. P., and Johnston, E. R., Vector Mechanics for Engineers – Dynamics and Statics, Tata McGraw-Hill, New Delhi, 2011.
5. Natarajan, K.V., Engineering Mechanics, Dhanalakshmi Publishers, 2011.
6. Rajasekaran,S. and Sankarasubramanian,G., Engineering Mechanics, Vikas Publishing House Pvt Ltd, 2011.

10. Revised Bloom's based Assessment Pattern :

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20			15
Understand	80	80	30	30	25
Apply			70	70	60
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	80	80
Analyse	20	20
Evaluate		
Create		

11. Lecture plan

S.No	Topics to be covered	No. of periods	Content delivery method
	UNIT –I	**L6 T6**	
1	Introduction, Units and Dimensions, Laws of Mechanics	2	Lecture with Discussion /Assignment/ Tutorial/
2	Lami's theorem, Parallelogram and triangular Law of forces	2	
3	Vectors – Vectorial representation of forces and couples.	1	
4	Vector operations: additions, subtraction, dot product, cross product.	1	
5	Coplanar Forces, Resolution and Composition of forces.	1	

S.No	Topics to be covered	No. of periods	Content delivery method
6	Equilibrium of a particle.	1	
7	Forces in space, Equilibrium of a particle in space.	1	
8	Equivalent systems of forces.	2	
9	Principle of transmissibility, Single equivalent force.	1	
	Unit Test-I (CO1)		
	UNIT –II	**L6 T6**	
10	Free body diagram, Types of supports and their reactions	2	Lecture with Discussion/ Assignment/ Tutorial
11	requirements of stable equilibrium, Moments and Couples	2	
12	Moment of a force about a point and about an axis	1	
13	Scalar components of a moment	2	
14	Varignon's theorem	1	
15	Equilibrium of Rigid bodies in two dimensions	2	
16	Equilibrium of Rigid bodies in three dimensions, Examples	2	
	Mid Term Test-I (CO1 & CO2)		
	UNIT-III	**L6 T6**	
17	Determination of Areas and Volumes	1	Lecture with Discussion/ Assignment/ Tutorial
18	First moment of area and the Centroid of sections	2	
19	Second and product moments of plane area	1	
20	Parallel axis theorem and perpendicular axis theorem	2	
21	Polar moment of inertia	2	
22	Principal moments of inertia of plane areas	2	
23	Principal axes of inertia	1	
24	Mass moment of inertia	1	
	Unit Test-II (CO3)		
	UNIT IV	**L6 T6**	
25	Displacements, Velocity and acceleration, their relationship	2	Lecture with Discussion/ Tutorial
26	Relative motion	2	
27	Curvilinear motion	2	
28	Newton's law, Work Energy Equation of particles	2	
29	Impulse and Momentum	2	
30	Impact of elastic bodies	2	
	UNIT V	**L6 T6**	
31	Frictional force, Laws of Coulomb friction	2	Lecture with Discussion/ Tutorial
32	Simple contact friction	2	
33	Belt friction	2	
34	Roller friction.	2	
35	Translation and Rotation of Rigid Bodies	2	
36	General Plane motion.	2	
Mid Term Test II (CO3, CO4, CO5)			
Total		**60**	

1151AU102	BASIC ENGINEERING THERMODYNAMICS	L	T	P	C
		2	2	0	3

1. Preamble

This course provides an introduction to the basic concepts in thermodynamics, First law of thermodynamics and Energy, second law, Entropy and energy, Ideal and real gases and non-reactive ideal gas mixtures and general thermodynamic property relations. Develop the problem solving skills with both theoretical and engineering oriented problems in basic thermodynamics.

2. Prerequisite

1150MA202 Engineering Mathematics-I

3. Links to other courses

- Combustion and heat transfer in engines
- Automotive HVAC

4. Course Educational Objectives

Students undergoing this course are expected to

- To understand the basic laws of thermodynamics and their application to the non-flow and flow processes.
- To understand the thermodynamic properties of ideal and real gases, gaseous mixtures.

5. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the fundamentals of Thermodynamics concepts	K2
CO2	Apply first law of thermodynamics to solve problems.	K3
CO3	Apply second law of thermodynamics to solve problems.	K3
CO4	Describe the working principles of ideal and real gases and mixtures.	K2
CO5	Apply general thermodynamic property relations and standards to solve problems	K3

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	L	M	M			L		L		H	M
CO2	H	H	H	L	M	M			L		L		H	H
CO3	H	H	H	L	M	M			L		L		H	H
CO4	H	H	H	L	M	M			L		L		H	H
CO5	H	H	H	L	M	M			L		L		H	H

H- High; M-Medium; L-Low

7. Course Content :

UNIT – I: BASIC CONCEPTS L-6 T-6

Basic Concepts, Concept of Continuum, Microscopic and Macroscopic Approach, Thermodynamic Systems (Closed, Open, Isolated), Control Volume, Property, Point and Path Functions, Thermodynamic Equilibrium, State, Path and Process, Reversible and Quasi-Static Process, Work, Modes of Work, Zeroth Law, Concept of Temperature and Heat.

UNIT – II: FIRST LAW AND ENERGY L-6 T-6

First Law, Application to Closed and Open Systems, Internal Energy, Enthalpy, Specific Heat Capacities (C_p&C_v), Steady Flow Process With Reference to Various Engineering Devices.

UNIT – III: SECOND LAW, ENTROPY AND EXERGY L-6 T-6

Second Law – Kelvin Planck and Clausius Statements, Heat Engine, P-V, P-T, T-V, T-S and H-S Diagrams, PVT Surfaces, Refrigerator and Heat Pump, Efficiency and COP, Carnot Cycle, Clausius Inequality, Concept of Entropy, Entropy of Ideal Gases, Principle of Increase of Entropy, Quality of Energy, Exergy (Availability).

UNIT – IV: IDEAL & REAL GASES AND NON-REACTIVE IDEAL GAS MIXTURES L-6 T-6

Properties of Ideal and Real Gases, Avogadro's Hypothesis and Gas Laws, Vander Walls and Other Equations of State, Non-Reactive Ideal Gas Mixtures, Mass and Mole Fractions, Dalton's Law of Additive Pressures, Amagat's Law of Additive Volumes, Properties of Ideal Gas Mixtures.

UNIT – V: GENERAL THERMODYNAMIC PROPERTY RELATIONS L-6 T-6

Partial Derivatives and Associated Relations, Differential Relations For U, H, G And A, Maxwell's Relations, Clausius Clapeyron Equation, Joule Thomson Coefficient, Air and Gas Tables

TOTAL: 60 Periods

8. Text Books

1. Yunus A Cengel / Michael A Boles, "Thermodynamics - An Engineering Approach", (SI Units), Tata McGraw Hill India, 7e, Special Indian Edition 2011.
2. P K Nag, "Engineering Thermodynamics", Tata McGraw Hill, New Delhi, 6th Edition, 2008.

9. References

1. Yadav R., "Thermodynamics and Heat Engines", Vol 1, Central Publishing House, 2011.
2. Jones J.B and Dugan R.E., "Engineering Thermodynamics", Prentice Hall of India, 2010.
3. Roy Choudry T., "Basic Engineering Thermodynamics", Second Edition, Tata McGraw Hill, 2012.

10. Revised Bloom's based Assessment Pattern :

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	40				10
Understand	60	70	70	70	60
Apply		30	30	30	30
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (Max marks in %)	2 (CO3&CO4) (Max marks in %)
Remember		
Understand		
Apply	70	80
Analyze	30	20
Evaluate		
Create		

11. Lecture plan:

S.No.	Topics to be covered	No. of periods	Content delivery method
	Unit–I	**L6 T6**	
1	Basic concepts, Concept of continuum	1	Lecture with discussion
2	Microscopic and Macroscopic approach	1	
3	Thermodynamic systems (closed, open, isolated)	2	

S.No.	Topics to be covered	No. of periods	Content delivery method
4	control volume, property, point and path functions	1	
5	Thermodynamic equilibrium	1	
6	State, Path and process, Reversible process	2	
7	Quasi-static process, Work, Modes of work	2	
8	Zeroth law, Concept of temperature and heat	2	
	Unit Test I (CO 1)		
	Unit–II	**L6 T6**	
9	First law, Application to closed and open systems	3	
10	Internal energy, Enthalpy	3	Lecture with discussion
11	Specific heat capacities (C_p& $_{Cu}$)	3	
12	Steady flow process with reference to various engineering devices	3	
Midterm Test I (CO1, CO2)			
	Unit-III	**L6 T6**	
13	Second law – Kelvin Planck and Clausius statements	2	
14	Heat engine, P-V, P-T, T-V, T-S and H-S diagrams, PVT surfaces	2	
15	Refrigerator and Heat pump, Efficiency and COP	2	Lecture with discussion
16	Carnot cycle, Clausius Inequality	2	
17	Concept of entropy, Entropy of ideal gases	1	
18	Principle of increase of entropy	1	
19	Quality of energy, Energy (Availability)	2	
	Unit Test II (CO 3)		
	Unit-IV	**L6 T6**	
20	Properties of ideal and real gases	1	
21	Avogadro’s hypothesis and gas laws	2	
22	Vander Walls and other equations of state	2	
23	Non-reactive ideal gas mixtures	1	Lecture with discussion
24	Mass and Mole fractions	2	
25	Dalton’s law of additive pressures	1	
26	Amagat’s law of additive volumes	1	
27	Properties of ideal gas mixtures	2	
	Unit –V	**L6 T6**	
28	Partial derivatives and associated relations	2	
29	Differential relations for U, H, G and A	2	
30	Maxwell’s relations	2	Lecture with discussion
31	Clausius Clapeyron equation	2	
32	Joule Thomson coefficient	2	
33	Air and Gas tables	2	
Midterm Test II (CO3, CO4 & CO5)			
	Total	**60**	

1151AU103	STRENGTH OF MATERIALS	L	T	P	C
		2	2	0	3

1. Preamble

This course provides knowledge of stresses, strains and deformations in components due to various loads. It helps in assessing the stresses and deformations through mathematical models of beams, twisting bars or combinations of both.

2. Prerequisite

1151AU101 Engineering Mechanics

3. Links to other Courses

- Engine Design and Development
- Vehicle Design and Data Characteristics
- Finite Element Analysis

4. Course Educational Objectives

After successful completion of this course, students will be able to

- Understand the basic concepts related tensile, compressive and shear stresses in engineering components.
- Understand the basic principles of torsion in shafts, shear force and bending moment in beams, deflection in springs and beams.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the fundamental concepts of rigid and deformable solids in the perspective of stress, strain and energy.	K2
CO2	Illustrate the theory, principles associated to torsion in solid, hollow, stepped shaft and springs.	K3
CO3	Calculate the loads in beams, forces and moments associated with different sections.	K3

CO4	Derive moment and deflection of various types of beams using different methods	K3
CO5	Apply the principles of bi-axial state of stresses in various problems	K3

6. Correlation of Cos with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H								L	L	H	H
CO2	H	H	H								L	L	H	H
CO3	H	H	H								L	L	H	H
CO4	H	H	H								L	L	H	H
CO5	H	H	H								L	L	H	H

H- High; M-Medium; L-Low

7. Course Content:

UNIT – I: DEFORMATION OF SOLIDS L-6 T-6

Introduction to Rigid and Deformable Bodies – Types of Load, Stress, Strain, Tensile- Stress And Strain, Compressive Stress and Strain - Normal Stress – Hooke's Law, Shear Stress and Strain, Shear Modulus, Bearing Stress, Stress-Strain Diagram, Factor of Safety, Selection of Factor of Safety, Poisson's Ratio, Volumetric Strain-Relation Between Bulk Modulus and Young's Modulus, Relation Between Young's Modulus and Modulus of Rigidity, Impact Stress, Stress in Simple and Composite Bars Under Axial Load – Thermal Stress – Strain Energy

UNIT – II: TORSION L-6 T-6

Theory of Torsion Equation-Torsion of Solid and Hollow Circular Bars – Shear Stress Distribution – Stepped Shaft – Twist And Torsion Stiffness – Compound Shafts – Springs – Types - Helical Springs – Shear Stress And Deflection in Springs.

UNIT – III: BEAMS&COLUMNS L-6 T-6

Types : Beams , Short and Long Beam, Supports and Loads – Shear Force and Bending Moment Diagram – Cantilever, Simply Supported ,Overhanging Beam, Fixed Beam, Continuous Beam – Theory of Simple Bending – Stress, Shear Stress in Beams – Evaluation Of 'I' , 'L' & 'T' Sections - Columns

UNIT – IV: DEFLECTION OF BEAMS L-6 T-6

Introduction –Flexural Formula, Evaluation of Beam Deflection and Slope: Cantilever, Simply Supported Beams- Macaulay Method and Moment-Area Method

UNIT – V: ANALYSIS OF STRESSES IN TWO DIMENSIONS L-6 T-6

Biaxial State of Stresses – Principal Planes And Stresses – Mohr's Circle For Biaxial Stresses – Maximum Shear Stress. Introduction to Theories of Failure-Stresses in Thin Cylindrical and Spherical Shells

Total: 60 periods

8. Text Books

1. Nash W.A, "Theory and problems in Strength of Materials", Schaum Outline Series, McGraw-Hill Book Co, New York, 2014.

2. Timoshenko S.P, "Elements of Strength of Materials", Tata McGraw-Hill, New Delhi 2013.

9. References

1. Popov E.P, "Engineering Mechanics of Solids", Prentice-Hall of India, New Delhi, 2010.
2. Ramamurtham, S, Narayan .R, "Strength of materials", 16th Edition, Dhanpat Rai Publishing Co, 2008.
3. Jindal U.C. "Strength of Materials" Asian Books Pvt Ltd, New Delhi 2007.
4. Bansal, R.K., A Text Book of Strength of Materials, Lakshmi Publications Pvt. Limited, New Delhi, 2012
5. Rajput.R.K. "Strength of Materials",S.Chand& co Ltd. New Delhi 2012.
6. Khurmi R.S, A Text book of strength of materials, S.Chand& co Ltd. New Delhi 2012
7. http://nptel.ac.in/courses/112101095/

11. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	30				10
Understand	70	70	70	70	10
Apply		30	30	30	70
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (Max marks in %)	2 (CO3&CO4) (Max marks in %)
Remember		
Understand		
Apply	70	80
Analyze	30	20
Evaluate		
Create		

11. Lecture plan

S. No.	Topic to be covered	No. of periods	Content delivery methods
	Unit –I	**L6 T6**	
1	Introduction to Rigid and Deformable bodies, Types of Load	1	

S. No.	Topic to be covered	No. of periods	Content delivery methods
2	Stress, Strain, Tensile- Stress and Strain, Compressive Stress and Strain	1	Lecture with discussion, demonstration
3	Normal stress – Hooke's law, Shear Stress and Strain, Shear Modulus, Bearing Stress, Stress-strain Diagram	2	
4	Factor of Safety, Selection of Factor of Safety, Poisson's Ratio, Volumetric Strain	2	
5	Relation Between Bulk Modulus and Young's Modulus	1	Lecture with discussion, PPT
6	Relation Between Young's Modulus and Modulus of Rigidity	1	
7	Impact Stress, stress in simple and composite bars under axial load	2	
8	Thermal stress	1	
9	Strain energy	1	
	Unit Test I (CO 1)		
	Unit –II	**L6 T6**	
10	Theory of torsion equation	1	Lecture with discussion
11	Torsion of Solid and hollow circular bars	2	
12	Shear stress distribution, Stepped shaft	2	
13	Twist and torsion stiffness	1	
14	Compound shafts	2	
15	Springs, types – leaf spring and helical spring	2	
16	Shear stress and deflection in springs	2	
Midterm Test- I (CO1 & CO2)			
	Unit-III	**L6 T6**	
17	Types : Beams, Supports and Loads	1	Lecture with discussion &PPT
18	Shear force and Bending Moment diagram – Cantilever beam	2	
19	Shear force and Bending Moment diagram - Simply supported	2	
20	Shear force and Bending Moment diagram - Overhanging beam	2	
21	Shear force and Bending Moment diagram - Fixed beam	1	
22	Shear force and Bending Moment diagram - Continuous beam	1	
23	Theory of simple bending – Stress, Shear stress in beams	1	
24	Evaluation of 'I' section	1	
25	Evaluation of 'L' & 'T' sections	1	
	Unit Test II (CO 3)		

S. No.	Topic to be covered	No. of periods	Content delivery methods
	Unit IV	**L6 T6**	
26	Introduction	2	Lecture with discussion & PPT
27	Evaluation of beam deflection and slope: Cantilever - Macaulay Method	3	
28	Evaluation of beam deflection and slope: Simply supported beams- Macaulay Method	3	
29	Evaluation of beam deflection and slope: Cantilever - Moment-area Method	2	
30	Evaluation of beam deflection and slope: Simply supported beams- Moment-area Method	2	
	Unit V	**L6 T6**	
31	Biaxial state of stresses	2	Lecture with discussion & PPT
32	Principal planes and stresses	2	
33	Mohr's circle for biaxial stresses	2	
34	Maximum shear stress.	2	
35	Introduction to theories of failure	2	
36	Stresses in thin cylindrical and spherical shells	2	
	Midterm Test- II (CO3, CO4 & CO5)		
	Total hours	**60**	

1151AU104	MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	0	3

1. Preamble

This course provides an introduction to the basic concepts and techniques of metal casting processes, joining & deformation processes, special welding processes and various types of plastic component manufacturing techniques.

2. Pre-Requisite

1150ME101 Basic Mechanical Engineering

3. Links to Other Courses

- Automotive components manufacturing

4. Course Educational Objectives

- To understand the various manufacturing processes and machining related to casting, forming, joining of metals, molding and extrusion processes of plastic materials.

5. Course Outcomes

The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain various casting process, defects and its applications.	K2
CO2	Illustrate the various fusion welding process and its applications.	K2
CO3	Describe different deformation processes of manufacturing.	K2
CO4	Explain the various special welding processes for industrial applications	K2

CO5	Describe various moulding process for manufacturing plastic components	K2

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		M		L								L	M	H
CO2		H		L								L	M	M
CO3		H		L								L	M	M
CO4		M		L								L	M	M
CO5		M		L								L	M	M

H- High; M-Medium; L-Low

7. Course Content

UNIT – I: METAL CASTING PROCESSES **L-9**

Sand Casting – Sand Moulds - Type of Patterns – Pattern Materials – Pattern Allowances – Types of Moulding Sand – Properties – Core Making – Methods of Sand Testing – Working Principle of Special Casting Processes – Shell– Pressure Die Casting – Centrifugal Casting – CO_2 Process – Sand Casting Defects – Inspection Methods

UNIT – II: JOINING PROCESSES **L-9**

Fusion Welding Processes – Types of Gas Welding – Equipments Used – Flame Characteristics – Filler and Flux Materials - Arc Welding Equipments - Gas Metal Arc Welding – Flux Cored – Submerged Arc Welding – Electro Slag Welding – TIG and MIG Welding Process. Principles Of Resistance Welding – Spot/Butt, Seam Welding – Percussion Welding- Weld Defects

UNIT – III: DEFORMATION **L- 9**

Hot Working and Cold Working of Metals – Forging Processes – Hot Forging and Cold Forging - Open, and Closed Die Forging Process – Typical Forging Operations – Embossing – Engraving - Rolling of Metals – Types of Rolling Mills - Defects in Rolled Parts - Principle of Rod And Wire Drawing - Tube Drawing .

Principles of Extrusion – Types of Extrusion – Hot and Cold Extrusion. Sheet Metal Characteristics - Typical Shearing Operations, Bending and Drawing Operations – Stretch Forming Operations - Metal Spinning

UNIT – IV: SPECIAL WELDING AND MACHINING PROCESS **L- 9**

Principle And Application of Special Welding Processes - Plasma Arc Welding – Thermit Welding – Electron Beam Welding – Friction Welding -Laser Beam Welding.–Ultra Sonic Welding, CNC Machining Process - Case Study.

UNIT – V: MANUFACTURING OF PLASTIC COMPONENTS **L-9**

Types of Plastics - Characteristics of the Forming and Shaping Processes – Moulding of Thermoplastics – Working Principles and Typical Applications - Injection Moulding – Blow Moulding – Rotational Moulding – Film Blowing – Extrusion – Thermoforming. Moulding of Thermosets- Working Principles and Typical Applications - Compression Moulding - Transfer Moulding - Bonding of Thermoplastics.

Total: 45 periods

8. Text Books:

1. Manufacturing Technology: Foundry, Forming and Welding, 4e (Volume 1)2013 by Dr. P.N Rao
2. Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promotors Pvt Ltd., Mumbai, 2011

9. References:

1. "H.M.T. Production Technology – Handbook", Tata McGraw-Hill, 2000.
2. Begman, 'Manufacturing Process", John Wilely & Sons, VIII Edition, 2010.
3. Fundamentals of Modern Manufacturing: Materials, Processes, and Systems By Mikell P. Groover,2010
4. B.S. Magendran Parashar & R.K. Mittal, "Elements of Manufacturing Processes", Prentice Hall of India, 2012.
5. Beddoes.J and Bibby M.J, 'Principles of Metal Manufacturing Processes', Elsevier, 2011.
6. Serope Kalpajian, Steven R.Schmid, "Manufacturing Processes for Engineering Materials", 4/e, Pearson Education, Inc. 2007.
7. R.K.Jain and S.C. Gupta, "Production Technology", Khanna Publishers. 16th Edition, 2001.
8. Roy. A. Linberg, "Process and Materials of Manufacture", PHI, 2000.

9. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	70	30	30	30	30
Understand	30	70	70	70	70
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (Max marks in %)	2 (CO3&CO4) (Max marks in %)
Remember		
Understand		
Apply	70	80
Analyze	30	20
Evaluate		
Create		

11. Lecture plan

Sl No	TOPIC	No of Periods	Content Delivery Methods

	UNIT- I	**9**	
1	Sand casting, Sand moulds	1	Lecture ,Lecture With Discussion, Lecture With Seminar
2	Type of patterns, Pattern materials, Pattern allowances	1	
3	Types of Molding sand, Properties, Core making	1	
4	Methods of Sand testing	1	
5	Working principle of Special casting processes	1	
6	Shell– Pressure die casting	1	
7	Centrifugal casting	1	
8	CO_2 process	1	
9	Sand Casting defects, Inspection methods	1	
	Unit Test I (CO 1)		
	UNIT-II	**9**	
10	Fusion welding processes	1	Lecture ,Lecture With Discussion, Lecture With Seminar
11	Types of Gas welding, Equipments used	1	
12	Flame characteristics, Filler and Flux materials - Arc welding equipments	1	
13	Gas metal arc welding – Flux cored – Submerged arc welding	2	
14	Electro slag welding, TIG and MIG welding process.	2	
15	Principles of Resistance welding, Spot/butt,	1	
16	Seam welding, Percussion welding, Weld defects	1	
	Midterm Test I (CO1, CO2)		
	UNIT - III	**9**	
17	Hot working and cold working of metals	1	Lecture ,Lecture With Discussion, Lecture With Seminar
18	Forging processes – Open, and closed die forging process, Typical forging operations	1	
19	Rolling of metals, Types of Rolling mills	1	
20	Defects in rolled parts	1	
21	Principle of rod and wire drawing - Tube drawing	1	
22	Principles of Extrusion – Types of Extrusion – Hot and Cold extrusion.	1	
23	Sheet metal characteristics	1	
24	Typical shearing operations, bending and drawing operations	1	
25	Stretch forming operations - Metal spinning	1	
	Unit Test II (CO3)		
	UNIT –IV	**9**	
28	Principle and application of special welding processes	2	Lecture ,Lecture With Discussion, Lecture With Seminar
29	Plasma arc welding	2	
30	Thermit welding	1	
31	Electron beam welding	1	
32	Friction welding	1	
33	Laser beam welding	1	
34	Ultra sonic welding	1	
	UNIT – V	**9**	

35	Types of plastics - Characteristics of the forming and shaping processes	1	Lecture ,Lecture With Discussion, Lecture With Seminar
36	Molding of Thermoplastics	1	
37	Working principles and typical applications: Injection molding and Blow molding	1	
38	Working principles and typical applications: Rotational molding	1	
39	Film blow in, Extrusion, Thermoforming.	1	
40	Molding of thermosets	1	
41	Working principles and typical applications: Compression molding	1	
42	Working principles and typical applications: Transfer molding	1	
43	Bonding of Thermoplastics	1	
	Midterm Test II (CO3,CO4 & CO5)		
	Total	**45**	

1151AU105 **MECHANICS OF MACHINES**

L	T	P	C
2	2	0	3

1. Preamble

This course is to provide the Structural analysis knowledge of Friction, Gearing, cams &Vibration and techniques of linkages &their geometry. It introduces students to understand the Structural analysis of various Mechanical components at different load conditions.

2. Pre-requisite

1151AU101 Engineering Mechanics
1150ME202 Engineering Graphics

3. Links to other courses

- Vehicle Design & Data Characteristics
- Engine design and development
- Vehicle dynamics

4. Course Educational Objectives

Students undergoing this course are expected to

- To develop the basic components and layout of linkages in the assembly of system /machine.
- To develop knowledge about the undesirable effects of unbalance in rotors and engines.
- To develop skills of students in the Structural analysis of various Mechanical components.
- To serve as a pre-requisite course for other courses in UG and PG programmes, specialized studies and research.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Describe the concept of kinematic analysis of mechanism & degree of freedom.	**K2**
C02	Estimate the ratio of tensions and power transmission through belt and rope drive.	**K3**
C03	Compute and draw the Gear, Cam profile and its geometry.	**K3**
C04	Discuss the effects of Static and Dynamic balancing.	**K2**
C05	Explain the concept of vibration and its effects	**K2**

6. Correlation with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	M	M			M		M	L	H	H
CO2	H	H	H	M	M	M			M		M	L	H	M
CO3	H	H	H	M	M	M			M		M	L	H	M
CO4	H	H	H	M	M	M			M		M	L	H	H
CO5	H	H	H	M	M	M			M		M	L	M	M

H- Strong; M-Medium; L-Low

7. Course content

UNIT – I: MECHANISMS **L-6 T-6**

Machine Structure – Kinematic Link, Pair and Chain – Grueblers Criteria – Constrained Motion – Degrees of Freedom - Slider Crank and Crank Rocker Mechanisms – Inversions – Applications – Kinematic Analysis of Simple Mechanisms – Determination of Velocity and Acceleration.(Graphical Method)

UNIT – II: FRICTION **L-6 T-6**

Surface Contacts – Sliding and Rolling Friction - Friction in Screw and Nut –Plate Clutch – Belt (Flat And V) and Rope Drives. Ratio of Tensions –Condition for Maximum Power Transmission – Open and Crossed Belt Drive.

UNIT – III: GEARING AND CAMS **L-6 T-6**

Gear Profile and Geometry – Nomenclature of Spur And Helical Gears – Gear Trains: Simple, Compound Gear Trains and Epicyclic Gear Trains - Determination of Speed and Torque - Cams – Types of Cams – Design of Profiles – Knife Edged and Roller Ended Followers With and Without Offsets for Various Types of Follower Motions

UNIT – IV: BALANCING **L-6 T-6**

Static and Dynamic Balancing – Single and Several Masses in Different Planes –Balancing of Reciprocating Masses- Primary Balancing and Concepts of Secondary Balancing – Single and Multi Cylinder Engines (Inline) – Balancing of Radial V Engine – Direct and Reverse Crank Method

UNIT – V: VIBRATION **L-6 T-6**

Free, Forced and Damped Vibrations of Single Degree of Freedom Systems – Force Transmitted to Supports – Vibration Isolation – Vibration Absorption – Torsional Vibration of Shaft – Single and Multi-Rotor Systems – Geared Shafts – Critical Speed of Shaft.

Total: 60 Periods

8. Text Books

1. Rattan.S.S, "Theory of Machines", Tata McGraw–Hill Publishing Co, New Delhi, 2013.
2. Ballaney.P.L, "Theory of Machines",Khanna Publishers, New Delhi, 2014.
3. R.S.Khurmi"Theory of Machines", Eurasia Publishing House, 2012

9. References

1. Rao, J.S and Dukkipati, R.V, "Mechanism and Machine Theory", Second Edition, Wiley Eastern Ltd., 2007.
2. Malhotra, D.R and Gupta, H.C., "The Theory of Machines", SatyaPrakasam, Tech. India Publications, 2009.
3. Gosh, A. and Mallick, A.K., "Theory of Machines and Mechanisms", Affiliated East West Press, 2011.
4. Shigley, J.E. and Uicker, J.J., "Theory of Machines and Mechanisms", McGraw-Hill, 2012.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20			20	20
Understand	80	40	30	70	40
Apply		60	70	10	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	40	50
Analyse	60	50
Evaluate		
Create		

11. Lecture Plan

S.No	Topic	No of Periods	Teaching Methods
	Unit I	**L6 T6**	

1	Introduction To Machine Structure	1	Lecture With Discussion
2	Kinematic Link And Their Pair And Chain	1	
3	Gruebler's Criteria	1	
4	Constrained Motion	1	
5	Degrees Of Freedom	1	
6	Slider Crank And Crank Rocker Mechanisms	2	
7	Inversions And Its Applications	2	
8	Kinematic Analysis Of Simple Mechanisms	1	
9	Determination of Velocity And Acceleration.(Graphical Method)	2	
	UT-I (CO1)		
	Unit II	**L6 T6**	
10	Surface Contacts	1	Lecture With Discussion
11	Sliding And Rolling Friction	1	
12	Friction In Screw And Nut	1	
13	Plate Clutch	2	
14	Belt Drive (Flat And V)	2	
15	Rope Drives	2	
16	Ratio of Tensions	1	
17	Condition For Maximum Power Transmission	1	
18	Open And Crossed Belt Drive.	1	
	MT-I (CO1, CO2)		
	Unit III	**L6 T6**	
19	Gear Profile And Geometry	1	Lecture With Discussion
20	Nomenclature of Spur And Helical Gears	1	
21	Gear Trains: Simple, Compound Gear Trains And Epicylic Gear Trains	2	
22	Determination of Speed And Torque	1	
23	Cams	1	
24	Types Of Cams	1	
25	Design Of Profiles	2	
26	Knife Edged And Roller Ended Followers With And Without Offsets	2	
27	Various Types of Follower Motions	1	
	UT-II (CO2)		
	Unit IV	**L6 T6**	
28	Static And Dynamic Balancing	1	Lecture With Discussion
29	Single And Several Masses In Different Planes	1	
30	Balancing of Reciprocating Masses	2	
31	Primary Balancing	1	
32	Concepts of Secondary Balancing	1	
33	Single And Multi Cylinder Engines (Inline)	2	
34	Balancing of Radial V Engine	2	
35	Direct Crank Method	1	
36	Reverse Crank Method	1	
	Unit V	**L6 T6**	
37	Free, Forced Single Degree of Freedom	2	

38	Force Transmitted To Supports	1	Lecture With Discussion
39	Vibration Isolation	1	
40	Vibration Absorption	1	
41	Torsional Vibration of Shaft	2	
42	Single And Multi Rotor Systems	1	
43	Geared Shafts	2	
44	Critical Speed of Shaft	1	
	MT – II (CO3, CO4, CO5)		
Total		**60**	

1151AU106 ENGINEERING METROLOGY & MEASUREMENT

L	T	P	C
3	0	0	3

1. Preamble

This course imparts knowledge for using mechanical and electronic instruments for measurement of dimensions and geometrical concepts of components manufacturing and temperature, pressure, flow and power for automotive applications.

2. Pre-requisite

1150GE103 Introduction to Engineering

3. Links to other courses

- Automotive Electrical and Electronics

4. Course Educational Objectives

Students undergoing this course are expected to

- Understand the theory of metrology and principles, construction, operation of different mechanical, electronic measuring instruments for measurement of various parameters for automotive applications.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Know the principles and method of measurements for geometry and dimensional aspects of automobile components manufacturing.	K2
C02	Understand the selection of measuring instruments for measurement of Pressure, Acceleration and Vibration	K2
C03	Explain the various measuring instruments for measurement of Flow, Density and Viscosity	K2

C04	Demonstrate the various measuring instruments for measurement of Temperature.	K2
C05	Describe the various measuring instruments for measurement of Force, Torque and Speed in engine	K2

(K2-understand, K3-Apply, K4-Analysis)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H		H					L	L		H	H
CO2	H	H	H		H					L	L		M	H
CO3	H	H	H		H					L	L		M	H
CO4	H	H	H		H					L	L		M	H
CO5	H	H	H		H					L	L		H	H

H- High; M-Medium; L-Low

7. Course Content

UNIT – I LINEAR MEASUREMENT L-9

Units and Standards, Precision, Accuracy and Measurement Errors. Linear Measuring Instruments, Dialgauges, Comparators and Linear Measuring Machines. Angular Measuring Instruments- Sine Bar, Bevel Protractor, Measurement of Straightness, Flatness and Surface Finish - Profilographs.

UNIT – II PRESSURE, ACCELERATION, & VIBRATION MEASUREMENT L-9

Bourdon Tube, Diaphragm, Bellows and Pressure Capsules: Potentiometer, Strain Gauges, LVDT, Capacitive and Variable Reluctance Type Transducers. Dynamic Pressure Measurement Piezo Electric and Piezo Resistive Transducers, Farnboro Engine Indicator, Low Pressure Measurement Mcleod Gauge, Pirani Gauge, Thermal Conductivity Type Pressure Measurement, Accelerometer-LVDT Strain Gauge and Piezo Electric Type. Vibration Measurement- Mechanical-Seismic Instrument, Vibration Pickups

UNIT – III FLOW, DENSITY & VISCOSITY MEASUREMENT L-9

Obstruction Type Flow Meter- Orifice Plate, Venturimeter, Flow Nozzles, Pitot Tube, Rotameter. Positive Displacement Flow Meters – Turbine Flow Meter, Flouted Tube Flowmeter, Anemometer, Ultrasonic Flow Meter, Magnetic Flow Meters. Viscosity Measurement- Saybolt Viscometer, Rotometer Type Viscometer. Density Measurement– Densitometer, Pressure Head Type, Floats Type & Ultrasonic Type

UNIT – IV TEMPERATURE MEASUREMENT L-9

Temperature Scales – Mechanical Temperature Sensors, Liquid in Glass, Vapor Pressure, Bimetal Temperature Gauges. Resistance Type Temperature Sensors, Thermistors, Thermocouples, Laws of Thermocouple, Types of Thermocouples, Construction and Circuits for Thermocouples. High Temperature Measurement Pyrometers.

UNIT – V FORCE, TORQUE AND SPEED MEASUREMENT L-9

Force Measuring Devices- Balances, Platform Scales, Weigh Bridges, Load Cells, Proving Ring. Torque Measurement – Prony Brake, Rope Brake and Fan Type Brakes. Dynamometers – Hydraulic, Electric Cradle and Eddy Current Dynamometers. Transmission Dynamometers.

Chassis Dynamometers. Speed Measurements-Revolution Counter. AC/DC Tachometer-Stroboscopic, Strobotron.

Total: 45 Periods

8. Text Books

1. Jain R.K., Engineering metrology, Khanna publishers, New Delhi
2. Alan S Morris, Measurement & Instrumentation Principles, Third Edition, ISBN: 978-0-7506-5081-6

9. References

1. Patranabis D, Principles of industrial instrumentation, TMH Publishing Co. New Delhi
2. Jain R.K., Mechanical & Industrial measurements , Khanna publishers, New Delhi
3. Doeblin,"Measurement System Application &Design" McGraw Hill ,New Delhi
4. Gaylor F.W and Shotbolt C.R Metrology for engineers, ELBS.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	20	20	20
Understand	80	80	80	80	80
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	50	50
Analyse	50	50
Evaluate		
Create		

11. Lecture plan

S.No	Topic	No. of periods	Content Delivery Method
	Unit –I	9	
1	Introduction	1	Lecture with discussions/
2	Units and standards,	1	
3	Precision, accuracy and measurement errors	1	

S.No	Topic	No. of periods	Content Delivery Method
4	Linear measuring instruments	1	Seminar/ Assignment
5	Dial gauges, comparators	1	
6	Linear measuring machines	1	
7	Angular measuring instruments	1	
8	Measurement of straightness flatness	1	
9	Surface finish. Profilographs	1	
	UT-I (CO1)		
	Unit –II	**9**	
10	Bourdon tube, diaphragm, bellows and pressure capsules	1	Lecture with discussions/ Seminar/ Assignment
11	Transducers used in pressure measurement	1	
12	potentiometer, strain gauges	1	
13	LVDT	1	
14	Capacitive and variable reluctance type transducers.	1	
15	Dynamic pressure measurement piezo electric and piezo resistive transducers	1	
16	Farnboro engine indicator. Low pressure measurement.	1	
17	McLeod gauge, Pirani gauge,	1	
18	Thermal conductivity type pressure measurement.	1	
MT-I (CO1, CO2)			
	Unit-III	**9**	
19	Obstruction type flow meter	1	Lecture with discussions/ Seminar/ Assignment
20	Orifice plate, venturimeter	2	
21	Flow nozzles, pitot tube, rotometer	1	
22	Positive displacement flow meters	1	
23	Turbine flow meter	1	
24	Flouted tube flow meter	1	
25	Anemometer, ultrasonic flow meter	1	
26	Magnetic flow meters	1	
27	Alcock viscous air flow meter.	1	
	UT-II (CO3)		
	Unit IV	**9**	
28	Temperature scales – mechanical temperature sensors	1	Lecture with discussions/ Seminar/ Assignment
29	Liquid in glass, vapour pressure	1	
30	Bimetal temperature gauges	1	
31	Resistance type temperature sensors	1	
32	Thermistors, thermocouples	1	
33	Laws of thermocouple	1	
34	Types of thermocouples	1	
35	Construction and circuits for thermocouples	1	
36	High temperature measurement pyrometers.	1	
	Unit V	**9**	
37	Force measuring devices	1	
38	Balances, platform scales	1	

S.No	Topic	No. of periods	Content Delivery Method
39	Weigh bridges	1	Lecture with discussions/ Seminar/ Assignment
40	Load cells	1	
41	Proving ring. Torque measurement	1	
42	Prony brake, rope brake and fan type brakes.	1	
43	Dynamometers – hydraulic, electric cradle	1	
44	Eddy current dynamometers, Transmission dynamometers	1	
45	Chassis dynamometers	1	
MT 2 (CO3, CO4, CO5)			
Total		**45**	

1151AU107 **I.C.ENGINES**

L	T	P	C
3	0	0	3

1. **Preamble**

This course make the students to understand the basic Construction, working principles of I.C. Engines, fuel systems, design of combustion chambers, supercharging techniques & cooling system

2. **Pre-Requisite**

1150ME101 Basic Mechanical Engineering

3. **Links to other courses**

- Advanced theory of IC engines
- Fuel conservation & Alternate fuels

4. **Course Educational Objective**

Students undergoing this course are expected to

- To create the basic knowledge of I.C. Engine working & how combustion takes places.
- Train knowledge about the fuel system used in I.C engine
- To teach the student about supercharging techniques, cooling systems & lubrication systems and its functions.

5. **Course Outcomes**

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)

CO1	Classify the constructional and working principles of 2 stroke, 4 stroke, SI and CI Engines and demonstrate the physical features of components.	K2
CO2	Demonstrate the basics, requirements, construction and working of fuel systems of SI and CI Engines	K2
CO3	Illustrate the stages of combustion and its influence by different combustion chamber parameters	K3
CO4	Explain the concept, methods and various features related to super charging, turbo charging and engine testing	K2
CO5	Describe the concept, methods and various features related to Cooling and Lubrication Systems	K2

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H		H	H					L	L		M	H
CO2	H	H		H	H					L	L		M	H
CO3	H	H		H	H					L	L		M	H
CO4	H	H		H	H					L	L		M	H
CO5	H	H		H	H					L	L		M	H

H- High; M-Medium; L-Low

7. Course Structure

UNIT – I: CONSTRUCTION AND OPERATION L-9

Engine Classification, Constructional Details of Spark Ignition (SI) and Compression Ignition (CI) Engines. Air Standard Cycles- Otto, Diesel and Dual. Working Principle of Two Stroke SI and CI Engines – Construction and Working. Comparison of SI and CI Engines, Four Stroke and Two Stroke Engines –Scavenging Process, Scavenging Pump, Firing Order.

UNIT – II: FUEL SYSTEMS L-9

Air Fuel Ratio Requirements of SI Engines, Air Fuel Ratio and Emissions, Introduction to Carburetor, MPFI, GDI, Fuel Injection Pumps and CRDI.

UNIT – III: COMBUSTION AND COMBUSTION CHAMBERS L-9

Introduction to Combustion in SI and CI Engines, Stages of Combustion, Ignition Systems. Dependence of Ignition Timing on Load and Speed, Knock in SI and CI Engines. Combustion Chamber for SI and CI Engines. Direct and Indirect Injection Combustion Chambers for CI Engines. Importance of Swirl, Squish and Turbulence. Factors Controlling Combustion Chamber Design, Introduction to Heat Release Measurements.

UNIT – IV: INTAKE, EXHAUST & TURBO CHARGING SYSTEMS L-9

Intake System, Exhaust Systems, Supercharging and Turbo Charging, Different Methods of Turbo Charging, Inter Cooling, Turbocharger Controls Including, Waste Gate, Variable Geometry. Dynamometers Indicated Thermal, Brake Thermal And Volumetric Efficiencies. Measurement of Friction Power, Cylinder Pressure Measurement, Engine Performance Maps.

UNIT – V: COOLING AND LUBRICATION SYSTEMS L-9

Need for Cooling, Types of Cooling Systems- Air and Liquid Cooling Systems. Thermo-Syphon And Forced Circulation and Pressurized Cooling Systems -- Thermo Controlled Cooling Fans - Properties of Coolants, Hydrodynamic Lubrication - Requirements of Lubrication Systems -Types of Lubrication -Mist, Pressure Feed, Dry and Wet Sump Systems. Properties of Lubricants.

Total: 45 Periods

8. Text Books

1. Internal Combustion Engines by V. Ganesan, 2007, Tata McGraw Hill
2. Ramalingam K.K., "Internal Combustion Engines", Sci-Tech Publications, 2005.

9. Reference Books

1. Advanced Engine Technology by Heisler, SAE Publication.
2. Edward F. Obert Internal Combustion Engines.
3. H.N. Gupta, Fundamentals of Internal Combustion Engines by, PHI.
4. Mathur and Sharma, Internal Combustion Engines, Dhanpat Rai and Sons, 2002.
5. John B. Heywood, "Fundamentals of Internal Combustion Engines.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	40	10		30	10
Understand	60	80	20	60	60
Apply			80	10	30
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	50	60
Analyse	50	40
Evaluate		
Create		

11. Lecture plan

S.No	Topic	No. of periods	Content Delivery Method
	Unit –I	**9**	
1	Constructional details of spark ignition (SI) and compression ignition (CI) engines	2	Lecture with discussions/ Seminar/ Assignment
2	Working principles. Two stroke SI and CI engines – construction and working	3	
3	Comparison of SI and CI engines	2	
4	Four stroke and two stroke engines. Engine classification, firing order	2	
	UT-I (CO1)		
	Unit –II	**9**	
5	Air fuel ratio requirements of SI engines	2	Lecture with discussions/ Seminar/ Assignment
6	Air fuel ratio and emissions	2	
7	Introduction to Carburetor & fuel injection pump	3	
8	Fuel system of SI and CI engines	2	
MT-I (CO1, CO2)			
	Unit-III	**9**	
9	Introduction to combustion in SI and CI engines	1	Lecture with discussions/ Seminar/ Assignment
10	Stages of combustion, ignition systems	1	
11	Dependence of ignition timing on load and speed	1	
12	Knock in SI and CI engines	1	
13	Combustion chambers for SI and CI engines. Direct and indirect injection combustion chambers for CI engines	2	
14	Importance of Swirl, squish and turbulence-measurements	1	
15	Factors controlling combustion chamber design	1	
16	Introduction to heat release measurements	1	
	UT-II (CO3)		
	Unit IV	**9**	
17	Intake system, Exhaust systems	1	Lecture with discussions/ Seminar/ Assignment
18	Supercharging and Turbo charging, Different methods of turbo charging	2	
19	Inter cooling, Turbocharger controls including, water gate, variable geometry and variable nozzle types	1	
20	Dynamometers Indicated thermal, brake thermal and volumetric efficiencies	2	
21	Measurement of friction	1	
22	Cylinder pressure measurement	1	
23	Engine performance maps, Thermo controlled cooling fans	1	
	Unit V	**9**	
24	Need for cooling, types of cooling systems-air and liquid cooling systems.	2	Lecture with discussions/

11. Lecture plan

S.No	Topic	No. of periods	Content Delivery Method
25	Thermo-syphon and forced circulation and Properties of lubricants	2	Assignment
26	Pressurized cooling systems	1	
27	Properties of coolants.	1	
28	Requirements of lubrication systems. Types-mist lubrication systems	1	
29	Pressure feed, dry and wet sump systems.	2	
MT 2 (CO3, CO4, CO5)			
Total		**45**	

1151AU108 AUTOMOTIVE TRANSMISSION

L	T	P	C
3	0	0	3

1. Preamble

This course provides an introduction to the Transmission like gearbox, clutch, fluid couplings, torque converters and electrical drives.

2. Pre-requisite

1151AU105 Mechanics of Machines

3. Links to other courses

- Vehicle Body Engineering
- Automotive chassis

4. Course Educational Objectives

Students undergoing this course are expected to

- To develop the basic knowledge of the students in mechanics, torque conversion areas.
- To develop the skills of the students in the areas of alternative drives and concepts.
- To serve as a pre-requisite course for other courses in UG and PG programs, specialized studies and research.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Describe the basic principle of clutch and gear box.	K2

C02	Explain the construction and working of different hydrodynamic drive	K2
C03	Understand the basic concepts of Fluid coupling and torque converter and its performance characteristics.	K2
C04	Explain various types of advanced automatic transmission system.	K2
C05	Demonstrate the hydrostatic and electric drive system.	K2

6. Correlation of COs with Programme Outcomes :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H			H	H					L	L		M	H
CO2	H			H	H					L	L		M	H
CO3	H			H	H					L	L		M	H
CO4	H			H	H					L	L		M	H
CO5	H			H	H					L	L		M	H

H- High; M-Medium; L-Low

7. Course Content

UNIT – I: CLUTCH AND GEAR BOX L-9

Different Types of Clutches, Principle, Construction and Torque Capacity. Determination of Gear Ratios for Vehicle. Different Types of Gearboxes such as Sliding Mesh Gearbox, Constant Mesh Gearbox and Synchromesh Gearbox

UNIT – II: HYDRODYNAMIC DRIVE L-9

All Spur and Internal Gear Type, Ford T-Model, Cotal and Wilson Gear Box, Electronically Controlled Automatic Transmission – Case Study - Determination of Gear Ratios, Automatic Overdrives.

UNIT – III: TORQUE CONVERTERS L-9

Fluid Coupling: Advantages and Limitations, Construction Details, Torque Capacity, Slip in Fluid Coupling, Performance Characteristics. Means used to Reduce Drag Torque in Fluid Coupling - Principal of Torque Conversion, Single, Multi Stage and Polyphase Torque Converters, Performance Characteristics, Constructional and Operational Details of Typical Hydraulic Transmission Drives.

UNIT – IV: AUTOMATIC TRANSMISSION L-9

Automatic Transmission: Relative Merits and Demerits when Compared to Conventional Transmission, Automatic Control of Gears, Study of Typical Automatic Transmissions, A/MT and Epicyclic Gear Train, Clutchless Transmission: CVT, Transmission Control System, Dual Clutch Transmission.

UNIT – V: HYDROSTATIC AND ELECTRIC DRIVE L-9

Hydrostatic Drives: Advantages and Disadvantages, Principles of Hydrostatic Drive Systems, Construction and Working of Typical Hydrostatic Drives, Janney Hydrostatic Drive. Electrical Drives: Advantages and Limitations, Principles of Ward Leonard System of Control Modern Electric Drive for Buses and Performance Characteristics, Borgwarner Electric Drive.

Total: 45 Periods

8. Text Books

1. Heldt. P. M., Torque converters, Chilton Book Co., 1992

9. References

1. Newton and Steeds, The Motor vehicle, llliffe Publishers, 1985.
2. Judge. A.W., Modern Transmission systems, Chapman and Hall Ltd., 1990.SAE Transactions 900550 & 930910.
3. Crouse. W.H., Anglin. D.L, Automotive Transmission and Power Trains construction, McGraw Hill, 1976.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	10	10	20
Understand	80	80	80	80	80
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	40	40
Analyse	60	60
Evaluate		
Create		

11. Lecture plan:

S.No	Topic	No. of periods	Content Delivery Method
	Unit –I	**9**	
1	Introduction	1	Lecture with discussions/ Seminar/ Assignment
2	Gear Box: method of calculation of gear ratios for vehicles	1	
3	Performance characteristics in different speeds	1	
4	Different types of gear boxes	1	
5	Speed synchronizing devices, gear materials, lubrication.	1	
6	Fluid coupling: advantages and limitations	1	
7	Construction details, torque capacity	1	
8	Slip in fluid coupling	1	
9	Means used to reduce drag torque in fluid coupling.	1	
	UT-I (CO1)		
	Unit –II	**9**	

S.No	Topic	No. of periods	Content Delivery Method
10	All spur calculation	1	Lecture with discussions/ Seminar/ Assignment
11	All spur calculation	1	
12	Internal gear type	1	
13	Planetary gearboxes	1	
14	Ford T-model	1	
15	Cotal and Wilson Gear box	1	
16	Cotal and Wilson Gear box	1	
17	Determination of gear ratios	1	
18	Automatic overdrives	1	
MT-I (CO1, CO2)			
	Unit-III	**9**	
19	Principal of torque conversion	1	Lecture with discussions/ Seminar/ Assignment
20	Single torque converters	2	
21	Multi stage torque converters	1	
22	Polyphase torque converters	1	
23	Performance characteristics	1	
24	And operational details of typical hydraulic transmission drives	1	
25	Leyland torque drives	1	
26	White Hydro torque drives, Case study about drives	1	
	UT-II (CO3)		
	Unit IV	**9**	
27	Introduction Automatic transmission	1	Lecture with discussions/ Seminar/ Assignment
28	Relative merits and demerits	1	
29	Conventional transmission	1	
30	Automatic control of gears	1	
31	Study of typical automatic transmissions	1	
32	Ford drive	1	
33	Chevrolet drive	1	
34	Automatic control of gear box	1	
35	Automatic control of gear box	1	
	Unit V	**9**	
35	Hydrostatic drives	1	Lecture with discussions/ Seminar/ Assignment
36	Advantages and disadvantages	1	
37	Principles of hydrostatic drive systems	1	
38	Construction and working of typical hydrostatic drives	1	
39	Janney Hydrostatic drive	1	
40	Electrical drives	1	
41	Advantages and limitations	1	
42	Principles of Ward Leonard system	1	
43	Ward Leonard system of control Modern electric drive for buses and performance characteristics	1	
MT 2 (CO3, CO4, CO5)			
	Total	**45**	

1151AU109 VEHICLE DESIGN AND DATA CHARACTERISTICS

L	T	P	C
3	0	0	3

1. **Preamble**
   This course imparts knowledge in the designing a vehicle sub systems for the given specifications.
2. **Prerequisite**
   1151AU214 Automotive Chassis

3. **Links to other Courses**
   - Engine Design and Development
   - Vehicle Dynamics

4. **Course Educational Objectives:**
   Students undergoing this course are expected to:
   - Acquire skills in designing frames, suspension, clutch and transmission system for the given specifications.
   - Understand the design procedures of steering, brakes and axles.
   - Latest trends in this course.

5. **Course Outcomes**
   Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Generalize the selection of vehicle specifications on the basis of various forces and resistance.	K2
CO2	Choose a suitable vehicle frames and suspension systems by calculating different type of loads and moment	K3
CO3	Select the suitable clutch and transmission systems for the given vehicle specifications	K3
CO4	Calculate the loads and moment on steering, final drive, front and rear axle systems in a vehicle	K3
CO5	Choose a suitable brake system for the given vehicle specification	K3

6. **Correlation of COs with Programme Outcomes**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	H		M							H	H
CO2	H	H	H	H		M							H	H
CO3	H	H	H	H		M							H	H
CO4	H	H	H	H		M							H	M
CO5	H	H	H	H		M							H	H

H- High; M-Medium; L-Low

7. Course Content

UNIT – I: INTRODUCTION L-9

Study and Selection of Vehicle Specifications - Choice of Cycle, Fuel, Speed, Method of Cooling, Material, Design Variables and Operating Variables Affecting Performance and Emission, Benchmarking. Calculation and Plotting the Curves of Air, Rolling and Gradient Resistances, Driving Force – Engine Power, Speed, Differential Ratio, Rear Axle Ratio, Torque and Mechanical Efficiency at Different Vehicle Speeds. Vehicle Interior and Exterior Design. Ergonomics and Styling.

UNIT – II: DESIGN OF VEHICLE FRAMES, BODY AND SUSPENSION L-9

Design of Frame Members: Longitudinal, Cross and Support Members for Heavy and Light Vehicles. Load, Moment and Stress Calculations. Design of Vehicle Body. Design of Springs: Leaf, Coil and Torsion Bar. Design of Hydraulic, Pneumatic and Rubber Suspension.

UNIT – III: DESIGN OF CLUTCH AND TRANSMISSION L-9

Design of Clutch and its Components; Single Plate, Multi Plate, Cone and Centrifugal Clutch. Energy Dissipated and Torque Capacity Calculations. Design of Roller and Sprag Type Clutches. Surplus Power and Torque Calculations and Acceleration Curves. Gear Ratio Calculations .Acceleration and Gradability - Typical Problems. Design of Gearbox: Constant Mesh, Sliding Mesh and Synchromesh. Design of Automatic Transmission.

UNIT – IV: DESIGN OF STEERING, AXLES AND FINAL DRIVE L-9

Design of Rear Axle Bearing Loads, Axle and Axle Housing: Semi Floating, Three Quarter Floating and Full Floating. Design of Loads, Moments and Stresses Across Front Axle. Design of Front Axle Bearing Loads and Axle. Design of Propeller Shaft, Differential and Final Drive. Choice of Lubrication, Bearing and Materials for Rear Axle, Front Axle and Final Drive.

UNIT – V: DESIGN OF BRAKES L-9

Introduction, Energy Absorbed by a Brake, Heat to be Dissipated During Braking, Materials for Brake Lining, Types of Brakes, Single Block or Shoe Brake, Pivoted Block or Shoe Brake, Double Block or Shoe Brake, Internal Expanding Brake.

8. Text Books

1. R.S.Khurmi J.K. Gupta ‘A Textbook of Machine Design’ Eurasia Publishing House (Pvt.) Ltd, New Delhi- 2005
2. Giri.N.K- “Automobile Mechanics”- Khanna Publisher, New Delhi- 2012.

9. References

1. Heldt.P.M - “Automotive Chassis”- Chilton Co., New York- 1992.
2. Steeds. W -“Mechanics Of Road Vehicles”- Illiffe Books Ltd., London- 1990.
3. Giles.K.G - Steering, Suspension andTires”- Wildlife Books Ltd., London – 1988.
4. Newton Steeds & Garret- “Motor Vehicle”- Wildlife Books Ltd., London – 2001

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	10			10
Understand	80	50	40	40	30
Apply		50	60	60	60
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	40	40
Analyse	60	60
Evaluate		
Create		

11. Lecture plan:

S.No.	Topics to be covered	No. of periods	Content delivery method
	Unit –I	**9**	
1	Study and selection of vehicle specifications	1	Lecture with Discussion/ Lecture with Demonstration/ Assignment
2	Choice of Cycle, fuel, speed, method of cooling, material	1	
3	Design variables and operating variables affecting performance and emission, Benchmarking	2	
4	Calculation and plotting the curves of air, rolling and gradient resistances	2	
5	Driving force – Engine power, speed, differential ratio, rear axle ratio	1	
6	Torque and mechanical efficiency at different vehicle speeds	1	
7	Vehicle interior and exterior design	1	
	UT-I (CO1)		
	Unit–II	**9**	
8	Design of frame members; Longitudinal, cross and support members for heavy vehicles	2	Lecture with Discussion
9	Longitudinal, cross and support members for light vehicles	1	
10	Load, moment and stress calculations	1	

S.No.	Topics to be covered	No. of periods	Content delivery method
11	Design of Vehicle Body	1	
12	Design of springs; Leaf, coil and torsion bar	2	
13	Design of hydraulic, pneumatic and rubber suspension	2	
MT-I (CO1, CO2)			
	Unit-III	**9**	
14	Design of clutch and its components; single plate, multi plate, cone and centrifugal clutch	1	
15	Energy dissipated and torque capacity calculations	1	
16	Design of roller and sprig type clutches	1	
17	Surplus power and torque calculations and acceleration curves	1	Lecture with Discussion/ Assignment
18	Gear ratio calculations	1	
19	Acceleration and gradability - typical problems	1	
20	Design of gearbox; Constant mesh, sliding mesh	1	
21	Design of synchromesh gearbox	1	
22	Design of Automatic Transmission	1	
	UT-II (CO3)		
	Unit IV	9	
23	Design of rear axle bearing loads, axle and axle housing; Semi floating	2	
24	Three quarter floating and full floating	1	
25	Design of loads, moments and stresses across front axle	1	Lecture with Discussion/ Assignment
26	Design of front axle bearing loads and axle	1	
27	Design of propeller shaft and final drive	1	
28	Choice of lubrication, bearing and materials for rear axle, front axle	2	
29	bearing and materials for final drive	1	
	Unit V	**9**	
30	Introduction, Energy Absorbed by a Brake	2	
31	Heat to be Dissipated during Braking	2	
32	Materials for Brake Lining	1	Lecture with Discussion/ Assignment
33	Types of Brakes, Single Block or Shoe Brake, Pivoted Block or Shoe Brake	2	
34	Double Block or Shoe Brake	1	
35	Internal Expanding Brake	1	
MT – II (CO3, CO4, CO5)			
Total		**45**	

1151AU110	ENGINE DESIGN AND DEVELOPMENT	L	T	P	C
		2	2	0	3

1. Preamble

This course enables the students to appreciate the different requirements, design principles and procedures involved in automotive design. It helps the students to speculate and verify different design possibilities to meet the customer requirements. It develops the ability in understanding the technical requirements and feasibilities while designing and manufacturing automotive components.

2. Pre-requisite

1151AU107 I.C Engines

3. Links to other Courses

- Vehicle Design & Data Characteristics

4. Course Educational Objectives

Students undergoing this course are expected to

- Analyze and evaluate the different requirements of the crank train components to meet the functional needs.
- Develop the skill of designing different engine components to meet the requirements in the perspective of material, manufacturing technology.
- Apply the different engineering facts, concepts and procedures in accordance with the engine design requirement.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the various engine performance parameters	K2
CO2	Construct crank train for the given specifications which includes the design of piston, connecting rod, crankshaft and flywheel	K3
CO3	Calculate thermal loads and select a suitable material to design cylinder head and block	K3
CO4	Select and design suitable valve train for the given specifications.	K3
CO5	Describe the design procedure involved in Cooling, Lubrication, Intake, Exhaust and Fuel Injection Systems	K2

6. Correlation with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	L	H							H	H
CO2	H	H	H	M	L	H							M	H
CO3	H	H	H	M	L	H							M	H

CO4	H	H	H	M	L	H							M	H
CO5	H	H	H	M	L	H							M	H

H- Strong; M-Medium; L-Low

7. Course content

UNIT – I: PARAMETERS L-6 T-6

Compression Ratio, Pressure Volume and Pressure Crank Angle Diagram, Frictional Mean Effective Pressure, Engine Capacity, Calculation of Bore And Stroke Length, Velocity and Acceleration, Gas Force, Inertia and Resultant Force at Various Crank Angles – Side Thrust an Cylinder Walls, Optimization Criteria for Improving Thermal, Mechanical and Volumetric Efficiency.

UNIT – II: DESIGN OF CRANK TRAIN L-6 T-6

Design of Piston, Piston Rings, Piston Pin, Design of Connecting Rod; Big End, Small End and Shank. Material and Failures Related to Cylinder, Piston, Connecting Rod, Design of Crankshaft For Light and Heavy Vehicle; Crankshaft, Front End, Rear End, Journals, Crank Pin, Crank Web. Design of Flywheel; Speed Fluctuation and Stress Calculations, Turning Moment Diagram, Design of Hub, Rim and Arms of the Flywheel, Ring Gear Material and Failures Related to Crankshaft and Flywheel.

UNIT – III: DESIGN OF CYLINDER HEAD AND BLOCK L-6 T-6

Functional Requirement, Block Material Like Gray Iron, Aluminum, Compacted Graphite Iron and Magnesium, Cylinder Head Alloys, Design Layout, Basic Block, Bulk Head Design, and Cylinder Liner Design Approach and Thermal Loads. Cylinder Arrangement, Number of Cylinders,

UNIT – IV: DESIGN OF VALVE TRAIN L-6 T-6

Effect of Valve Timing on Engine Performance, Number of Valves, Design of Valves, Valve Seat, Valve Guide and Cotter. Time Selection of Valve, Cam Profile Construction, Design of Valve Spring, Design of Camshaft, Single and Double Overhead Camshaft Design, Design of Valve Gear Train for Variable Valve Timing.

UNIT – V: DESIGN OF COOLING, LUBRICATION, INTAKE, EXHAUST AND FUEL INJECTION SYSTEMS L-6 T-6

Design of Cooling System, Radiator, Water Pump, Thermostat and Fan, Computation Of Air Cooling System Engine Friction and Wear, Selection of Lubricant, Lubricating System, Pump and Filters, Design of Intake and Exhaust System ,Design of Fuel System for CI Engine, Governor Design, Design of Carburetor - Electronic Carburetor**,** Design of MPFI, GDI, CRDI System.

Total: 60 Periods

8. Text Books

1. Kevin L. Hoag, "Vehicular Engine Design",SAE international, 2005.
2. A.Kolchin and V.Demidov, "Design of Automotive Engines", MIR Publishers, Moscow,1984.
3. R.K. Jain, "Machine Design", Khanna Publishers, New Delhi, 1997.

9. Reference Books

1. "Design Data Book", PSG College of Technology, Coimbatore, 2000.
2. Engine Design – Giles J. G., Lliffe Book Ltd.

3. Engine Design – Crouse, Tata McGraw Publication, Delhi

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	10			10
Understand	80	50	40	40	30
Apply		50	60	60	60
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand	40	40
Apply	60	60
Analyse		
Evaluate		
Create		

11. Lecture plan

S.No	Topics to be covered	No. of periods	Content delivery method
	UNIT –I	**L6 T6**	
1	Compression ratio, Pressure volume and pressure crank angle diagram	2	Lecture with Discussion /Assignment/ Seminar
2	Frictional mean effective pressure, engine capacity	2	
3	Calculation of bore and stroke length	2	
4	Velocity and acceleration	2	
5	Gas force, inertia and resultant force at various crank angles	2	
6	Side thrust on cylinder walls	2	
	UT-I (CO1)		
	UNIT –II	**L6 T6**	
7	Design of piston rings, piston pin	1	Lecture with Discussion/ Demonstration/ Assignment
8	Design of connecting rod; big end, small end and shank	1	
9	Material and failures related to Cylinder, piston, connecting rod	2	
10	Design of crankshaft for light and heavy vehicle	1	
11	Crankshaft, front end, rear end, journals, crank arm	2	

S.No	Topics to be covered	No. of periods	Content delivery method
12	Design of flywheel; Speed fluctuation and stress calculations, turning moment diagram	2	
13	Design of hub, rim and arms of the flywheel	2	
14	Material and failures related to Crankshaft and flywheel	1	
	MT-I (CO1, CO2)		
	UNIT-III	**L6 P6**	
15	Functional requirement, Block material like Gray Iron, Aluminum	3	Lecture with Discussion/ Assignment/
16	Compacted Graphite Iron and Magnesium, Cylinder head alloys	3	
17	Design layout, Basic block, Bulk head design	2	
18	Cylinder liner design approach and Thermal loads	2	
19	Cylinder arrangement, number of cylinders	2	
	UT-II (CO3)		
	UNIT IV	**L6 P6**	
20	Effect of valve timing on engine performance	2	Lecture with Discussion/ Demonstration
21	Time selection of valve	2	
22	Cam profile construction	2	
23	Design of valve spring	2	
24	Design of camshaft	2	
25	Design of valve gear train for variable valve opening	2	
	UNIT V	**L6 P6**	
26	Design of cooling system, radiator, water pump and fan	2	Lecture with Discussion/ Assignment
27	Computation of air cooling system Engine friction and wear	1	
28	Selection of lubricant, lubricating system, pump and filters	1	
29	Design of intake and exhaust system	2	
30	Design of fuel system for CI engine, Governor Design	2	
31	Design of carburetor	2	
32	Design of direct cylinder and port injection system for SI engine	2	
MT 2 (CO3, CO4 & CO5)			
Total		**60**	

1151AU111 **VEHICLE DYNAMICS**

L	T	P	C
2	2	0	3

1. Preamble

This course enriches knowledge of the learners in analyzing forces and moments exerted in vehicle under different loads, speed and road conditions in order to improve the comfort for the passengers and life of the various components of the vehicle.

2. Pre-Requisite

1151AU105 Mechanics of Machines

3. Links to Other Courses

- Finite element analysis
- Vehicle Design and Data Characteristics

4. Course Educational Objectives

- To develop the basic knowledge of the students in automotive field in the areas of vehicle vibrations.
- To develop the skills of the students in stability of vehicles and their effects, related with longitudinal, vertical & lateral dynamics.

5. Course Outcomes

On successful completion of this course students will be able to:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the basics of vibration, when the vehicle is at dynamic condition.	K2
CO2	Understand the tyre dynamics with respect to force & moments.	K2
CO3	Derive the effective cornering stiffness when considering the elastic elements in the wheel suspension and be able to analyze effect on the dynamic characteristics of the vehicle	K3
CO4	Understand the aerodynamic forces & moments, load distribution in the various vehicles.	K2
CO5	Test the effective steering geometry, vehicle handling & directional control of vehicle	K3

6. Correlation of COs with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	H	H	L	L						L	H	M
CO2	H	M	H	H	L	L							H	M
CO3	H	M	H	H	L	L				L	L		M	H
CO4	H	M	H	H	L	L							H	M
CO5	H	M	H	H	L	L				H	H		H	H

H- Strong; M-Medium; L-Low

7. Course Content

UNIT – I: CONCEPT OF VIBRATION **L-6 T-6**

Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification Factor, Transmissibility, Vibration Absorber, Vibration Measuring Instruments, Torsional Vibration, Critical Speed.

UNIT – II: TIRE DYNAMICS **L-6 T-6**

Tire Forces and Moments, Tire Structure, Longitudinal and Lateral Force at Various Slip Angles, Rolling Resistance, Tractive and Cornering Property of Tire. Performance of Tire on Wet Surface. Ride Property of Tires. Magic Formulae Tire Model, Estimation of Tire Road Friction. Test on Various Road Surfaces. Tire Vibration.

UNIT – III: VERTICAL DYNAMICS **L-6 T-6**

Human Response to Vibration, Sources of Vibration. Design and Analysis of Passive, Semi-Active and Active Suspension Using Quarter Car, Half Car and Full Car Model. Influence of Suspension Stiffness, Suspension Damping, and Tire Stiffness. Control Law for LQR, H-Infinite, Skyhook Damping. Air Suspension System and Their Properties.

UNIT – IV: LONGITUDINAL DYNAMICS **L-6 T-6**

Aerodynamic Forces and Moments. Equation of Motion. Resistance, Rolling Resistance, Load Distribution for Three Wheeler and Four Wheeler. Calculation of Maximum Acceleration, Reaction Forces for Different Drives. Braking and Driving Torque. Prediction of Vehicle Performance.

UNIT – V: LATERAL DYNAMICS **L-6 T-6**

Steady State Handling Characteristics. Steady State Response to Steering Input. Testing of Handling Characteristics. Transient Response Characteristics, Direction Control Of Vehicles Roll Center, Roll Axis, Vehicle Under Side Forces. Stability of Vehicle Running on Slope, Banked Road and During Turn, Effect of Suspension on Cornering, Latest Trends in Vehicle Dynamic Testing Like Four Poster, Multi Axis Simulator, etc.

TOTAL: 60 Periods

8. Text Books

1. Singiresu S. Rao, "Mechanical Vibrations", 5th Edition, Prentice Hall, 2010
2. Wong. J. Y., "Theory of Ground Vehicles", 3rd Edition, Wiley-Interscience, 2001
3. Rajesh Rajamani, "Vehicle Dynamics and Control", 1st edition, Springer, 2005
4. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", Society of Automotive Engineers Inc, 1992

9. References

1. Dean Karnopp, "Vehicle Stability", 1st edition, Marcel Dekker, 2004
2. Nakhaie Jazar. G., "Vehicle Dynamics: Theory and Application", 1st edition, Springer, 2008 3. Michael Blundell & Damian Harty, "The Multibody Systems Approach to Vehicle Dynamics", Elsevier Limited 2004
3. Hans B Pacejka, "Tire and Vehicle Dynamics", 2nd edition, SAE International, 2005 65
4. John C. Dixon," Tires, Suspension, and Handling", 2nd edition, Society of Automotive Engineers Inc, 1996 6. Jan Zuijdijk, 'Vehicle dynamics and damping", Author House, 2009

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20		20	10
Understand	80	80	10	50	50
Apply			90	30	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	40	50
Analyse	60	50
Evaluate		
Create		

11. Lecture plan:

S.No.	Topic	No. of periods	Content delivery method
	Unit –I	**L6 T6**	Lecture with Discussion/ Assignment/ Seminar
1	Single degree of freedom, two degree of freedom	3	
2	Free, forced and damped vibrations, modelling and simulation studies	3	
3	Model of an automobile, magnification.	3	
4	Factor, transmissibility, vibration absorber	3	
	UT-I (CO1)		
	Unit –II	**L6 T6**	
5	Requirements of suspension system.	2	Lecture with Discussion/ Assignment
6	Spring mass frequency, wheel hop, Wheel wobble, wheel shimmy,	2	
7	Choice of suspension spring rate. Calculation of effective spring rate.	2	
8	Vehicle suspension in fore and aft & roll axis. Human response to vibration, vehicle ride model.	2	
9	Tire forces and moments, rolling resistance of tires, relationship between tractive effort and longitudinal slip of tyres	2	

S.No.	Topic	No. of periods	Content delivery method
10	Cornering properties of tyres, ride properties of tyre	2	
	MT-I (CO1, CO2)		
	Unit-III	**L6 T6**	
11	Load distribution, and, and reactions for different drives.	4	Lecture with Discussion
12	stability on a curved track slope	4	
13	banked road calculation of tractive effort	4	
	UT-II (CO3)		
	Unit IV	**L6 T6**	
14	Equation of motion and maximum tractive effort. Aerodynamics forces and moments	2	Lecture with Discussion/ Assignment/ Seminar / Tutorial
15	Power plant and transmission characteristics. Prediction of vehicle performance.	2	
16	Braking performance. Steering geometry. Steady state handling characteristics.	3	
17	Steady state response to steering input. Transient response characteristics.	3	
18	Directional stability of vehicle.	2	
	Unit V	**L6 T6**	
19	Steady state handling characteristics.	1	Lecture with Discussion
20	Steady state response to steering input.	2	
21	Testing of handling characteristics. Transient response characteristics.	2	
22	Direction control of vehicles .Roll center, Roll axis, Vehicle under side forces.	2	
23	Stability of vehicle running on slope, banked road and during turn.	2	
24	Effect of suspension on cornering, latest trends in Vehicle dynamic testing like four poster, Multi axis simulator, etc.	3	
	MT-II (CO3, CO4, CO5)		
	Total	**60**	

		L	T	P	C
1151AU112	**CAD & APPLIED FEA**	**2**	**2**	**0**	**3**

1. Preamble

This course, CAD and Finite Element Analysis, deals with various modeling techniques and uses different numerical methods for solving a system of governing equations over the domain of a continuous physical system, which is discredited into simple geometric shapes called finite element.

2. Pre-requisite

1150ME202 Engineering Graphics

3. Links to other courses

- Engine Design & Development

4. Course Educational Objectives

Students undergoing this course are expected to

- Achieve fundamental understanding of CAD models to solve diverse problems in Mechanical engineering.
- Gain practical experience in handling 3D modeling software's.
- Know the basic concepts in Finite Element Analysis and governing equation.
- Apply Finite Element Techniques to solve diverse problem in Mechanical Engineering

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Describe the basics of CAD models and solid removal algorithm and Create 3D modeling and assembly of components	K2
C02	Describe the use of tolerance analysis and mass properties	K2
C03	Illustrate the knowledge of mathematical principles of finite element analysis.	K2
C04	Apply finite element techniques to solve 1D problems	K3
C05	Apply finite element techniques to solve 2D problems	K3

6. Correlation of COs with Programme Outcomes :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		L	M									L	H	H
CO2		L	M									L	H	H
CO3		L	M			L						L	H	H
CO4		L	M			L						L	H	H
CO5		L	H			L						L	H	H

H- High; M-Medium; L-Low

7. Course Content

UNIT – I: INTRODUCTION TO CAD **L-6 T-6**

Creation of Lines, Surfaces, Solids, Using Solid Modeling Pack (Prismatic and Revolved Parts). Hidden - Line - Surface - Solid Removal Algorithms Shading - Coloring. Introduction to CAM Software - Edge Cam

UNIT – II: VISUAL REALISM AND ASSEMBLY OF PARTS **L-6 T-6**

Introduction to Parametric and Variational Geometry Based on Software's and Their Principles Creation of Prismatic and Lofted Parts Using These Packages. Assembly of Parts, Tolerance Analysis Mass Property Calculations, Mechanism Simulation.

UNIT – III: INTRODUCTION TO FINITE ELEMENT ANALYSIS **L-6 T-6**

Review of Basic Analysis – Stiffness and Flexibility Matrix for Simple Cases – Governing Equation and Convergence Criteria of Finite Element Method.

UNIT – IV: DISCRETE ELEMENTS **L-6 T-6**

Bar, Frame, Beam Elements – Application to Static, Dynamic and Stability Analysis.

UNIT – V: CONTINUUM ELEMENTS **L-6 T-6**

Various Types of 2-D-Elements Application to Plane Stress, Plane Strain and Axis Symmetric Problems**.**

TOTAL: 60 periods

8. Text Books

1. Ibrahim Zeid "CAD/CAM -- Theory and Practice" 2nd Edition- McGraw Hill,International Edition, 2012.
2. David V.Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw-Hill Edition 2005.

9. References

1. Reddy J.N. "An Introduction to Finite Element Method",3rdEdition McGraw-Hill, 2005.
2. P.Seshu, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd. NewDelhi, 2009.
3. Tirupathi.R. Chandraputla and Ashok D. Belegundu, "Introduction to Finite Elements in Engineering",4thEdition Prentice Hall India, Third Edition, 2011.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	10	20	20
Understand	80	80	90	20	50
Apply				60	30
Analyse					
Evaluate					
Create					

	Assignment

Revised Bloom's Category	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	40	50
Analyse	60	50
Evaluate		
Create		

11. Lecture plan:

S.No.	Topic	No. of periods	Content delivery method
	UNIT-I	**L6 T6**	Lecture with Discussion/ Assignment
1	Creation of lines, surfaces, solids	2	
2	Using solid modeling pack (prismatic and revolved parts).	2	
3	Hidden - Line - Surface	2	
4	Solid removal algorithms shading	2	
5	Coloring	2	
6	Introduction to CAM software – Edgecam	2	
	UT-I (CO1)		
	UNIT-II	**L6 T6**	Lecture with Discussion/ Assignment
7	Introduction to parametric and variational geometry based on software's	2	
8	Principles creation of prismatic and lofted parts using these packages.	3	
9	Assembly of parts	3	
10	Tolerance analysis mass property calculations,	2	
11	Mechanism simulation	2	
	MT-I (CO1 & CO2)		
	UNIT-III	**L6 T6**	Lecture with Discussion/ Assignment
12	Review of basic analysis	3	
13	Stiffness and Flexibility matrix for simple cases	3	
14	Governing equation	3	
15	Convergence criteria of finite element method	3	
	UT-II (CO3)		
	UNIT-IV	**L6 T6**	Lecture with Discussion/ Assignment
16	Bar elements	3	
17	Frame elements	3	
18	beam elements	3	
19	Application to static, dynamic and stability analysis.	3	
	UNIT-V	**L6 T6**	Lecture with Discussion/ Assignment
20	Various types of 2-D-elements	2	
21	Application to plane stress	4	

S.No.	Topic	No. of periods	Content delivery method
22	Application to plane strain	4	
23	Application to axis symmetric	2	
	MT-II (CO3, CO4, CO5)		
	Total	**60**	

1151AU213	FLUID MECHANICS AND MACHINERY	L	T	P	C
		3	0	2	4

1. Preamble:

This course provides an introduction to the properties and behaviour of fluids. It introduces dimensional analysis and enables to apply the concepts in civil engineering, pipe networks and channel.

2. Pre-requisite

1151AU213 Engineering Physics

3. Links to other courses

- Computational Fluid Dynamics

4. Course Educational Objectives

- Apply fundamental knowledge of mathematics to modeling and analysis of fluid flow problems in civil and environmental engineering.
- Illustrate the experiments in pipe flows and open-channel flows and interpreting data from model studies to prototype cases, as well as documenting them in engineering reports.
- Recognise the awareness of disasters caused by an incorrect analysis in hydraulic engineering system.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Comprehend the different concepts and properties associated with fluid and verify the Bernoulli's theorem for its applications.	K3, S3
CO2	Apply the fluid kinematics, boundary layer concepts related to fluid flow and verify those with Orifice meter, Venturi meter and pitot tube.	K3, S3
CO3	Analyze the different types of fluid flow, energy, friction and losses through the pipes and verify it through major/minor loss and rotameter.	K3, S3
CO4	Explain the working and application of various hydraulic turbines and derive the performance curves for Pelton wheel turbine, Francis turbine and Kaplan turbine.	K3, S3
CO5	Explain the working and application of various hydraulic pumps and derive the performance curves for Centrifugal, Reciprocating, Gear and Submersible pump.	K3, S3

6. Correlation of COs with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	M	L						L	H	H
CO2	H	H	H	M	M	L						L	H	H
CO3	H	H	H	M	M	L						L	H	H
CO4	H	H	H	M	M	L						L	H	H
CO5	H	H	H	M	M	L						L	H	H

H- High; M-Medium; L-Low

7. Course Content

UNIT – I: BASIC CONCEPTS AND PROPERTIES L- 9 P-6

Fluid – Definition, Distinction Between Solid and Fluid - Units And Dimensions - Properties of Fluids - Density, Specific Weight, Specific Volume, Specific Gravity, Temperature, Viscosity, Compressibility, Vapour Pressure, Capillary and Surface Tension - Fluid Statics: Concept of Fluid Static Pressure, Absolute and Gauge Pressures - Pressure Measurements by Manometers and Pressure Gauges.

UNIT – II: FLUID KINEMATICS AND BOUNDARY LAYER CONCEPTS L- 9 P-6

Fluid Kinematics - Flow Visualization - Lines of Flow - Types of Flow - Continuity Equation (One Dimensional Differential Forms) - Fluid Dynamics - Equations of Motion -Navier - Stokes's Equation (Statement Only) Euler's Equation Along a Streamline - Bernoulli's Equation – Applications - Venturi Meter, Orifice Meter, Pitot Tube - Boundary Layer Flows, Boundary Layer Thickness, Boundary Layer Separation - Drag and Lift Coefficients.

UNIT – III: FLOW THROUGH PIPES AND DIMENSIONAL ANALYSIS L- 9 P-6

Viscous Flow - Shear Stress, Pressure Gradient Relationship - Laminar Flow Between Parallel Plates - Laminar Flow Through Circular Tubes (Hagen Poiseuille's) - Hydraulic and Energy Gradient - Flow Through Pipes - Darcy -Weisback's Equation - Pipe Roughness -Friction Factor- Minor Losses - Flow Through Pipes in Series And in Parallel - Power Transmission - Dimensional Analysis - Buckingham's π Theorem- Applications - Similarity Laws and Models**.**

UNIT – IV: HYDRAULIC TURBINES L- 9 P-6

Hydro Turbines: Definition and Classifications - Pelton Turbine - Francis Turbine - Kaplan Turbine - Working Principles - Velocity Triangles - Work Done - Specific Speed - Efficiencies - Performance Curve for Turbines.

UNIT – V: HYDRAULIC PUMPS L- 9 P-6

Pumps- Classifications - Centrifugal Pump- Classifications, Working Principles, Priming, Velocity Triangles, Specific Speed, Efficiency and Performance Curves - Reciprocating Pump- Classification, Working Principles, Slip, Performance Curves and Work Saved by Air Vessels - Cavitations in Pumps – Working Principles of Gear Pump and Submersible Pump.

Total: 75 Periods

8. Practical

List of Experiments

1. Verification of Bernoulli's Theorem.
2. Determine the Coefficient of Discharge of given Orifice Meter / Venturimeter.
3. Determine the Coefficient of discharge of given Pitot tube.
4. Determine the Friction Factor of Fluid Flow by Major Loss / Minor loss.
5. Calculate the Rate of Flow using Rotameter.

6. Conduct Experiment and Draw the Performance Characteristic Curves of Centrifugal Pump / Reciprocating Pump.
7. Conduct Experiment and Draw the Performance Characteristic Curves of Gear Pump /Jet Pump.
8. Conduct Experiment and Draw the Performance Characteristic Curves of Submersible Pump.
9. Conduct Experiment and Draw the Performance Characteristic Curves of Pelton Wheel Turbine.
10. Conduct Experiment and Draw the Performance Characteristics Curves of Francis Turbine.
11. Conduct Experiment and Draw the Performance Characteristic Curves of Kaplan Turbine.

Total = 30 Periods

TOTAL (45+30): 75periods

9. Text Books

1. Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi 2013.
2. Bansal, R.K., "Fluid Mechanics and Hydraulics Machines", (7th edition), Laxmi publications (P) Ltd., New Delhi, 2011.

10. References

1. Streeter, V. L. and Wylie E. B., "Fluid Mechanics", McGraw Hill Publishing Co. 2010
2. Kumar K. L., "Engineering Fluid Mechanics", S.Chand& Company Pvt. Ltd, 2014.
3. Robert W.Fox, Alan T. McDonald, Philip J.Pritchard, "Fluid Mechanics and Machinery", 2011.
4. Graebel. W.P, "Engineering Fluid Mechanics", Taylor & Francis, Indian Reprint, 2011

11. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal			University Examination %
	Mid Term Test I %	Mid Term Test II %	Model Practical Exam %	
Remember				
Understand	10	10	10	10
Apply	90	90	90	90
Analyse				
Evaluate				
Create				

12. Rubrics for Internal Assessment

Performance	Excellent (5)	Very good (4)	Good (3)	Average (2)	Low (1)
Observation & Record(5)	On Time Submission with neat presentation	Submission on next day with presentation	Submission within two days time	Submission within two weeks time	Submission after two weeks time
Record (5)	On Time Submission	Submission before next	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time

	with neat presentation	lab with presentation			
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

13. Rubrics for Lab Experiments:-

Performance Indicator	Excellent (100 %)	Very good (80 %)	Good (60 %)	Average (40%)	Low (20%)
Identify the Equipment (10)	Identify all Equipment required	Able to Identify most of the Equipment required	Able to Identify some important Equipment required	Able to Identify few Equipment required	Not able to Identify all Equipment required
Conducting experiment as per procedure/order & readings (20)	Able to conduct the experiment completely as per procedure with the specified/ required reading	Able to conduct the experiment completely as per procedure with few readings	Able to conduct the experiment partially as per procedure with few readings	Able to conduct the experiment partially as per procedure with wrong reading	unable to conduct the experiment completely as per procedure
Formulae & Calculations (40)	Able to write all the formulae and complete the calculations correctly	Able to write all the formulae and complete the calculations partially	Able to write some formulae and complete the calculations partially with mistake in units	Able to write some formulae and unable to complete the calculations	Unable to write all the formulae and complete the calculations
Tabulation & Result (20)	Able to formulate the tabulation completely with correct units and arrive the exact results	Able to formulate the tabulation completely with correct units and arrive the results with deviations	Able to formulate the tabulation completely with incorrect units and arrive the results with deviations	Able to formulate the tabulation partially with incorrect units and arrive the results with much deviations	Unable to formulate the tabulation completely.
Viva- voce (10)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer

14. Lecture plan

S.No	Topics to be covered	No. of periods	Content delivery method
	UNIT -I	**L9 P6**	
1	Fluid – definition, distinction between solid and fluid Units and dimensions	2	Lecture with Discussion &Group Discussion
2	Properties of fluids, density, specific weight, specific volume, specific gravity, temperature, viscosity, Compressibility, vapor pressure,	2	
3	Capillary and surface tension	1	

S.No	Topics to be covered	No. of periods	Content delivery method
4	Fluid statics: concept of fluid static pressure, absolute and gauge pressures	2	
5	Pressure measurements by manometers and pressure gauges.	2	
	UNIT –II	**L9 P6**	
6	Fluid Kinematics - Flow visualization - lines of flow - types of flow - continuity equation (one dimensional differential forms).	2	Lecture with Discussion & Demonstration
7	fluid dynamics - equations of motion -Navier - Stoke's equation (Statement only)	2	
8	Euler's equation along a streamline - Bernoulli's equation – applications -	1	
9	Venturi meter, Orifice meter, Pitot tube	2	
10	Boundary layer flows, boundary layer thickness, boundary layer separation - drag and lift coefficients	2	
	Mid Term Test-I (CO1, CO2)		
	UNIT-III	**L9 P6**	
11	Viscous flow - Shear stress, pressure gradient relationship - laminar flow between parallel plates	1	Lecture with Discussion & Demonstration
12	Laminar flow through circular tubes (Hagen poiseulle's)	2	
13	Hydraulic and energy gradient - flow through pipes - Darcy -weisback's equation - pipe roughness -friction factor- minor losses	2	
14	flow through pipes in series and in parallel - power transmission -	2	
15	Dimensional analysis - Buckingham's π theorem- applications - similarity laws and models**.**	2	
	UNIT IV	**L9 P6**	
16	Hydro turbines, definition and classifications	1	Lecture with Discussion & Demonstration
17	Peltonturbine, Francis turbine, Kaplan turbine, working principles.	3	
18	Velocity triangles , work done , specific speed -	3	
19	Efficiencies, performance curve for turbines.	2	
	UNIT V	**L9 P6**	
20	Pumps- classifications, Centrifugal pump- classifications	3	Lecture with Discussion & Demonstration
21	Working principles, priming, velocity triangles, specific speed, efficiency and performance curves	3	
22	Reciprocating pump, classification, working principles.	1	
23	Slip, performance curves and work saved by air vessels, cavitations in pumps**.**	2	
Mid Term II (CO3, CO4, CO5)			
Total		**75**	

1151AU214	AUTOMOTIVE CHASSIS	L	T	P	C
		3	0	2	4

1. Preamble

This course provides an introduction to the various types of chassis, frames, front axle, universal joint, propeller shaft, torque tube drive, final drives, suspension, brakes and steering.

2. Pre-requisite

1151AU101 Engineering Mechanics

3. Links to other courses

- Automotive Transmission
- Engine Design and Development

4. Course Educational Objectives

Students undergoing this course are expected to

- To understand different types of chassis.
- To gain knowledge about different types of steering geometry and types of front axle.
- To educate the students regarding the ergonomics of an automobile.
- Educate about modern drive line and braking systems.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	List out the types of chassis layouts, frames and materials used for heavy duty, light duty, three wheeler and two-wheeler construction and examine their specification with standards.	K3, S2
C02	Illustrate and verify the concepts, construction, material related to front axle and steering system for a typical heavy duty, light duty, three and two wheeled vehicles.	K2, S2
C03	List and verify the concepts, construction and material used for clutch, gearbox, rear axle, differential, multiaxle and propeller shaft by inspecting the heavy and light duty vehicles.	K2, S2
C04	Consolidate the concepts, types, construction and operation of different suspension systems for heavy duty, light duty, three wheeler and two-wheeled vehicles.	K2, S2
C05	Classify and inspect the different braking system used in heavy duty, light duty, three wheeler and two-wheeled vehicles on the basis of theory, construction and application.	K3, S2

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	H	H	H	H	M	L					M		H	H
CO2	H	H	H	H	M	L					M		H	H
CO3	H	H	H	H	M	L					M		H	H
CO4	H	H	H	H	M	L					M		H	H
CO5	H	H	H	H	M	L					M		H	H

H- High; M-Medium; L-Low

7. Course Content

UNIT – I: INTRODUCTION TO FRAMES L-9 P-6

Types of Chassis Layout With Reference to Power Plant Locations and Drives, Vehicle Frames, Various Types of Frames, Constructional Details, Materials, Testing of Vehicle Frames, Unitized Frame Body Construction, Articulated Vehicle

UNIT – II: FRONT AXLE AND STEERING SYSTEM L-9 P-6

Types of Front Axles, Construction Details, Front Wheel Geometry: Castor, Camber, King Pin Inclination, Toe-In. Conditions for True Rolling Motion of Wheels During Steering, Steering Geometry, Ackerman's and Dave's Steering System, Constructional Details of Steering Linkages, Different Types of Steering Gear Boxes, Turning Radius, Wheel Wobble, Power Assisted Steering, Steering of Crawler Tractors, Electronic Steering Systems - Drive by Wire.

UNIT – III: DRIVE LINE L-9 P-6

Effect of Driving Thrust and Torque Reactions - Hotchkiss Drive, Torque Tube Drive and Radius Rods, Panhard Rods, Propeller Shaft, Universal Joints, Front Wheel Drive, CV Joints, Different Types of Final Drives, 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.

UNIT – IV: SUSPENSION SYSTEM L-9 P-6

Need of Suspension System, Types of Suspension-Active and Passive Suspension, Constructional Details And Characteristics of Leaf, Coil and Torsion Bar Springs, Independent Suspension, Pneumatic Suspension, Shock Absorbers, Recent Advancements in Suspension System, Wheels and Tires - Suspension by Wire.

UNIT – V: BRAKING SYSTEM L-9 P-6

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. Recent Advancements in Braking System, Traction Control and Stability Control – Brake by Wire.

Total: 75 Periods

8. Practical's

List of Experiments

Study and measurement of the following chassis frames

1. Heavy Duty Vehicle Chassis (Leyland, Tata Etc.)
2. Light Duty Vehicle Chassis (Ambassador, Marti Van Etc.)
3. Three Wheeler Chassis
4. Two Wheeler Chassis (Bike And Scooter)

Study, dismantling and assembling of

5. Front Axle
6. Rear Axle
7. Differential
8. Steering Systems Along with Steering Gear Box
9. Braking Systems – Hydraulic Servo Vacuum, Compressed Air Power Brakes.
10. Leaf Spring, Coil Spring, Torsion Bar Spring, Hydraulic Shock Absorber
11. Testing of Shock Absorber, Wheel Chain of Two Wheeler
12. Different Types of Gear Box
13. Transfer Case
14. Clutch Assembly of Different Types

Study, Dismantling and Assembling of Engine Components

15. Multi-Cylinder Petrol Engine
16. Multi-Cylinder Diesel Engine
17. Petrol Engine Fuel System
18. Diesel Engine Fuel System
19. Cooling System
20. Lubrication System

Total : 30 Periods

TOTAL (45 + 30 Practical):75 periods

9. Text Books

1. Kirpal Singh _ "Automobile Engineering"-Standard Publishes Distributors-Delhi-2012
2. Heldt.P.M.- “Automotive Chassis”- Chilton Co., New York- 1990

10. Reference Books

1. Steed W - “Mechanics of Road Vehicles”- Illiffe Books Ltd., London- 1960
2. Newton Steeds and Garrot- “Motor Vehicles”- Butter worths, London- 2000.
3. Judge A.W- “Mechanism of the Car”- Chapman and Halls Ltd., London- 1986
4. Giles.J.G- “Steering, Suspension and tyres”- Iiiffe Book Co., London- 1988.
5. Crouse W.H- “Automotive Chassis and Body”- McGraw-Hill, New York- 1971.

11. Revised Bloom’s based Assessment Pattern

	Internal	

Revised Bloom's Category	Mid Term Test I %	Mid Term Test II %	Model Practical Exam %	University Examination %
Remember		20		10
Understand	30	30		30
Apply	70	50	100	60
Analyse				
Evaluate				
Create				

12. Rubrics for Internal Assessment

Performance	Excellent (5)	Very good (4)	Good (3)	Average (2)	Low (1)
Observation (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

13. Rubrics for Lab Experiments:-

Performance Indicator	Excellent (100 %)	Very good (80 %)	Good (60 %)	Average (40%)	Low (20%)
Identify the Equipment (10)	Identify all Equipment required	Able to Identify most of the Equipment required	Able to Identify some important Equipment required	Able to Identify few Equipment required	Not able to Identify all Equipment required
Conducting experiment as per procedure/order & readings (20)	Able to conduct the experiment completely as per procedure with the specified/ required reading	Able to conduct the experiment completely as per procedure with few readings	Able to conduct the experiment partially as per procedure with few readings	Able to conduct the experiment partially as per procedure with wrong reading	unable to conduct the experiment completely as per procedure
Formulae & Calculations (40)	Able to write all the formulae and complete the calculations correctly	Able to write all the formulae and complete the calculations partially	Able to write some formulae and complete the calculations partially with mistake in units	Able to write some formulae and unable to complete the calculations	Unable to write all the formulae and complete the calculations
Tabulation & Result (20)	Able to formulate the tabulation	Able to formulate the	Able to formulate the	Able to formulate the	Unable to formulate the

	completely with correct units and arrive the exact results	tabulation completely with correct units and arrive the results with deviations	tabulation completely with incorrect units and arrive the results with deviations	tabulation partially with incorrect units and arrive the results with much deviations	tabulation completely.
Viva- voce (10)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer

14. Lecture plan

S.No	Topics to be covered	No. of periods	Content delivery method
	UNIT -I	**(L9-P6)**	
1	Introduction	1	Lecture with Discussion /Assignment/ Seminar/ Tutorial/ Group Discussion/
2	Types of chassis layout with reference to power plant locations and drives	2	
3	Types of front axles	1	
4	Vehicle frames	2	
5	Various types of frames, constructional details	1	
6	Frame materials	1	
7	Testing of vehicle frames unitized frame body construction	1	
	UNIT-II	**(L9-P6)**	
8	construction details, materials	1	Lecture with Discussion/ Demonstration/ Assignment/ Tutorial
9	Front wheel geometry: castor, camber, king pin inclination, toe-in	1	
10	Conditions for true rolling motion of wheels during steering	1	
11	Steering geometry,	1	
12	Ackermann and Davis steering system	1	
13	Constructional details of steering linkages	2	
14	Steering linkages and layouts	1	
15	Turning radius, wheel wobble ,power assisted steering,	1	
	MT-I (CO1, CO2)		
	UNIT-III	**(L9-P6)**	
16	Effect of driving thrust and torque reactions, Hotchkiss drive, torque tube drive and radius rods	1	Lecture with Discussion/ Demonstration/ Assignment/
17	propeller shaft, universal joints, front wheel drive	1	
18	Different types of final drive, double reduction and twin speed final drives	1	
19	Differential principle, construction details of differential unit	1	
20	Non-slip differential, differential locks, differential housings	2	
21	Construction of rear axles, types of loads acting on rear axles	1	

S.No	Topics to be covered	No. of periods	Content delivery method
22	Fully floating, three quarter floating and semi floating rear axles	1	
23	Rear axle housing, Construction of different types of axle housings, multi axle vehicles.	1	
	UNIT IV	**(L9-P6)**	
24	Need of suspension system	1	Lecture with Discussion/ Demonstration/ Tutorial
25	Types of suspension	1	
26	Suspension springs	1	
27	Constructional details and characteristics of leaf spring and coil spring	1	
28	Constructional details of torsion bar springs	1	
29	Independent suspension	1	
30	Rubber suspension	1	
31	Pneumatic suspension	1	
32	Shock absorbers.	1	
UNIT V		**(L9-P6)**	
33	Classification of brakes	1	Lecture with Discussion/ Demonstration/ Assignment/ Tutorial
34	Drum brakes and disc brakes	1	
35	Constructional details	1	
36	Theory of braking	1	
37	Concept of dual brake system	1	
38	Parking brake, material	1	
39	Hydraulic system, vacuum assisted system	1	
40	Air brake system, antilock braking	1	
41	Retarded engine brakes, eddy retarders.	1	
MT 2 (CO3, CO4, CO5)			
Total		**75**	

1151AU215	AUTOMOTIVE ELECTRICAL AND ELECTRONICS	L	T	P	C
		3	0	2	4

1. Preamble

This course makes the students to know the functions, working principles of various automotive electrical & electronics components.

2. Pre-requisite

1150EE101 Basic Electrical Engineering
1150EC101 Basic Electronics Engineering

3. Links to other courses

- Automotive Safety
- Electric and Hybrid Vehicles
- Engine Electronics Management Systems
- Microprocessor and Microcontroller

4. Course Educational Objectives

Students undergoing this course are expected

- To know the concepts and develop basic skills necessary to diagnose automotive electrical problems
- To know Starting, and charging, lighting systems, advanced automotive electrical systems, to include body electrical accessories and basic computer control.
- To explore practically about the components present in an Automotive electrical and electronics system.

5. Course Outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Enumerate the construction, characteristics and maintenance of battery, lighting system and different accessories in a typical automobile after careful inspection.	K2, S2
CO2	Explain the construction, characteristics and maintenance of starting and ignition system and diagnose the ignition system fault of any vehicle.	K2, S2
CO3	List out the principles and characteristics of charging system components and demonstrate their working with suitable tools.	K2, S2
CO4	Enumerate the principles, application, construction and specification of different sensors and actuators usable in typical automobile by suitable testing.	K2, S2
CO5	Describe the principles and architecture of electronics systems and its components present in an automobile related to instrumentation, control, security and warning systems.	K2, S2

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	H	H	H	M	L			L				H	H
CO2	M	H	H	H	M	L			L				H	H
CO3	M	H	H	H	M	L			L				H	H
CO4	M	H	H	H	M	L			L				H	H
CO5	M	H	H	H	M	L			L				H	H

H- High; M-Medium; L-Low

7. Course content

UNIT – I: ELECTRICAL SYSTEMS L-9 P-6

Principle and Construction of Lead Acid and Lithium-Ion Battery, Characteristics of Battery, Rating Capacity and Efficiency of Batteries, Various Tests on Batteries, Maintenance and Charging. Lighting System and Photometry: Insulated and Earth Return System, Details of Head Light and Side Light, LED Lighting System, Head Light Dazzling and Preventive Methods – Horns, Wiper System and Trafficator.

UNIT – II: STARTING AND IGNITION SYSTEM L-9 P-6

Condition at Starting, Behavior of Starter During Starting, Series Motor and its Characteristics, Principle and Construction of Starter Motor, Bendix Type, Solenoid Operated and Axle Type Of Starter Motor, Overrunning Clutch, Over Running Clutch Working of Different Starter Drive Units, Care and Maintenances of Starter Motor, Starter Switches. Spark Plugs. Advance Mechanisms. Different Types of Ignition Systems- Electronic Ignition System and its Types

UNIT – III: CHARGING SYSTEM L-9 P-6

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.

UNIT – IV: SENSORS AND ACTUATORS L-9 P-6

Types of Sensors: Speed, Throttle Position, Exhaust Oxygen Level, Manifold Pressure, Crankshaft Position, Coolant Temperature, Exhaust Temperature, Rain, Headlight and Anti-Theft Sensors, Hot Wire Anemometer and Air Mass Flow Sensor For Engine Application. Solenoids, Stepper Motors, Relay.

UNIT – V: ELECTRONICS SYSTEMS L-9 P-6

Current Trends in Automotive Electronic Engine Management System, Types of EMS, Electromagnetic Interference Suppression, Electromagnetic Compatibility, Electronic Dashboard Instruments, Onboard Diagnostic System, Security , Warning System, Infotainment and Telematics.

Total: 75 periods

8. Practicals

List of Experiments

1. Electrical Lab

1. Testing of Batteries and Battery Maintenance

2. Testing of Starting Motors and Generators
3. Testing of Regulators and Cut – Outs
4. Diagnosis of Ignition System Faults
5. Study of Automobile Electrical Wiring

2. Electronics Lab

1. Study of Rectifiers and Filters
2. Study of Logic Gates, Adder and Flip-Flops
3. Study of SCR and IC Timer
4. Interfacing A/D Converter and Simple Data Acquisition
5. Micro Controller Programming and Interfacing

Total: 30 Periods

Total (45+30): 75 Periods

9. Text Books

1. Young A.P. & Griffiths. L. "Automotive Electrical Equipment", ELBS & New Press-1999.
2. William B.Ribbens "Understanding Automotive Electronics", 5th edition - Butter worth Heinemann Woburn, 1998.
3. Ganesan .V- "Internal Combustion Engines"- Tata McGraw-Hill Co- 2003.

10. References

1. Bechhold "Understanding Automotive Electronics", SAE, 1998.
2. Crouse, W.H "Automobile Electrical Equipment", McGraw-Hill Book Co., Inc., New York, 3rd edition, 1986.
3. Judge A.W "Modern Electrical Equipment of Automobiles", Chapman & Hall, London, 1992.
4. Kholi.P.L "Automotive Electrical Equipment", Tata McGraw-Hill Co., Ltd., New Delhi, 1975.
5. Robert Bosch "Automotive Hand Book", SAE (5th Edition), 2000.
6. Ganesan.V. "Internal Combustion Engines", Tata McGraw-Hill Publishing Co., New Delhi, 2003.

11. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal			University Examination %
	Mid Term Test I %	Mid Term Test II %	Model Practical Exam %	
Remember	20	20	20	20
Understand	80	80	80	80
Apply				
Analyse				
Evaluate				
Create				

12. Rubrics for Internal Assessment

Performance	Excellent (5)	Very good (4)	Good (3)	Average (2)	Low (1)
Observation (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

13. Rubrics for Lab Experiments:-

Performance Indicator	Excellent (100 %)	Very good (80 %)	Good (60 %)	Average (40%)	Low (20%)
Identify the Equipment (10)	Identify all Equipment required	Able to Identify most of the Equipment required	Able to Identify some important Equipment required	Able to Identify few Equipment required	Not able to Identify all Equipment required
Conducting experiment as per procedure/order & readings (20)	Able to conduct the experiment completely as per procedure with the specified/ required reading	Able to conduct the experiment completely as per procedure with few readings	Able to conduct the experiment partially as per procedure with few readings	Able to conduct the experiment partially as per procedure with wrong reading	unable to conduct the experiment completely as per procedure
Formulae & Calculations (40)	Able to write all the formulae and complete the calculations correctly	Able to write all the formulae and complete the calculations partially	Able to write some formulae and complete the calculations partially with mistake in units	Able to write some formulae and unable to complete the calculations	Unable to write all the formulae and complete the calculations
Tabulation & Result (20)	Able to formulate the tabulation completely with correct units and arrive the exact results	Able to formulate the tabulation completely with correct units and arrive the results with deviations	Able to formulate the tabulation completely with incorrect units and arrive the results with deviations	Able to formulate the tabulation partially with incorrect units and arrive the results with much deviations	Unable to formulate the tabulation completely.
Viva- voce (10)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer

14.Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**L9 P6**	
1	Principle and construction of lead acid battery	1	Lecture with discussions/ Seminar/ Assignment
2	Characteristics of battery	1	
3	Rating capacity and efficiency of batteries	1	
4	Various tests on batteries, maintenance and charging	1	
5	Lighting system: insulated and earth return system	1	
6	Details of head light and side light	1	
7	LED lighting system	1	
8	Head light dazzling and preventive methods	1	
9	Horn, wiper system and trafficator	1	
	Unit –II	**L9 P6**	
10	Condition At starting	1	Lecture with discussions/ Seminar/ Assignment
11	Behavior of starter during starting	1	
12	Series motor and its characteristics	1	
13		1	
14	Principle and construction of starter motor	1	
15		1	
16	Working of different starter drive units,	1	
17	Care and maintenances of starter motor, starter switches	1	
18		1	
MT-I (CO1, CO2)			
	Unit-III	**L9 P6**	
19	Generation of direct current, shunt generator characteristics	1	Lecture with discussions/ Seminar/ Case Studies/ Assignment
20	Armature reaction	1	
21	Third brush regulation	1	
22	Cutout, Voltage and current regulators	1	
23	Compensated voltage regulator	1	
24	Alternators principle and construction	2	
25	Bridge rectifiers	1	
26	New developments	1	
	Unit – IV	**L9 P6**	
27	Current trends in automotive electronic engine management system	2	Lecture with discussions/ Seminar/ Case Studies/ Assignment
28	Electromagnetic interference suppression	1	
29	Electromagnetic compatibility	1	
30	Electronic dashboard instruments	1	
31	Electronic dashboard instruments	1	
32	Onboard diagnostic system	2	
33	Security and warning system	1	
	Unit –V	**L9 P6**	
34	Types of sensors	1	

S.No	Topics to be covered	No. of periods	Content Delivery Method
35	Sensor for speed	1	Lecture with discussions/ Seminar/ Lecture with demonstration
36	Throttle position	1	
37	Exhaust oxygen level	1	
38	Manifold pressure, crankshaft position	1	
39	Coolant temperature, exhaust temperature	2	
40	Air mass flow for engine application	1	
41	Solenoids, stepper motors, relay	1	
	MT – II (CO3, CO4, CO5)		
Total		**75**	

1151AU216 AUTOMOTIVE FUELS, LUBRICANTS AND COOLANTS

L	T	P	C
3	0	2	4

1. Preamble

This course automotive fuels and lubricants enable learners to understand the properties of fuels and lubricants for the design and operation of the I.C engines.

2. Pre-requisite

1150CH101 Engineering Chemistry

3. Links to other courses

Fuel conservation & Alternate fuels

4. Course Educational Objectives

Students undergoing this course are expected to

- Understand the manufacturing of fuels and lubricants
- Understand the detailed working of lubricants
- Develop their knowledge in methods involved in testing of fuels and lubricants

5. Course outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the manufacturing & refining process of fuels and lubricants	K2, S2
CO2	Describe various types of frictions in engine and lubrication system and verify the properties through viscometer.	K2, S2
CO3	List the requirements, types and classification of lubricating oils, grease and solid lubricants used in automobiles and verify its physical properties by penetration test.	K2, S2
CO4	Describe the different properties and testing procedures of fuels used in automobiles and verify those with flash and fire point, ASME and aniline distillation, red vapor pressure, carbon residual, copper corrosion, ash, cloud and pour point tests.	K2, S2
CO5	Describe the combustion theories in SI and CI Engines and additives used to enhance the engine performance	K2, S2

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H		H		L		H	H	L		H	H
CO2	H	H	H		H		L		H	H	L		H	H
CO3	H	H	H		H		L		H	H	L		H	H
CO4	H	H	H		H		L		H	H	L		H	H
CO5	H	H	H		H		L		H	H	L		H	H

H- High; M-Medium; L-Low

7. Course content

UNIT – I: MANUFACTURE OF FUELS, LUBRICANTSAND COOLANTS L- 9 P-6

Structure of Petroleum, Refining Process, Fuels, Thermal Cracking, Catalytic Cracking, Polymerization, Alkylation, Isomerisation, Blending, Products of Refining Process. Manufacture of Lubricating Oil Base Stocks, Manufacture of Finished Automotive Lubricants, Ultra-Low Sulphur Diesel, Measurement of Sulphur Content, Coolants Manufacturing.

UNIT – II: THEORY OF LUBRICATIONAND COOLING L- 9 P-6

Fundamentals of Friction and Wear, Introduction to Engine Friction, Total Engine Friction, Effect of Engine Variables on Friction, Hydrodynamic Lubrication, Elasto Hydrodynamic Lubrication, Boundary Lubrication, Bearing Lubrication, Functions of The Lubrication System, Introduction to Design of a Lubricating System, Theory of Cooling.

UNIT – III: LUBRICANTS L- 9 P-6

Specific Requirements for Automotive Lubricants, Oxidation Deterioration and Degradation of Lubricants, Additives and Additive Mechanism, Synthetic Lubricants, Classification of Lubricating Oils, Properties of Lubricating Oils, Tests on Lubricants. Grease, Classification, Properties, Test Used in Grease, Solid Lubricants

UNIT – IV: PROPERTIES AND TESTING OF FUELS L- 9 P-6

Thermo-Chemistry of Fuels, Properties and Testing of Fuels, Relative Density, Calorific Value, Distillation, Vapour Pressure, Flash and Fire Point, Spontaneous Ignition Temperature, Self-Ignition Temperature, Viscosity, Cloud and Pour Point, Flammability, Ignitability, Diesel Index, Api Gravity, Aniline Point.

UNIT – V: COMBUSTION & FUEL RATING L- 9 P-6

Knocking, Octane Rating, CFR Engine, Fuel Requirements –SI And CI Engine, Cetane Rating. Additive - Mechanism, Requirements of an Additive, Petrol Fuel Additives and Diesel Fuel Additives – Specifications of Fuels.

75 Periods

8. Practicals

List of Experiments

1. Temperature Dependence of Viscosity of Lubrication Oil by Redwood Viscometer.
2. Viscosity Index of Lubricating Oil By Say Bolt Viscometer.
3. Flash and Fire Points of Fuels/Lubricants.
4. ASME Distillation Test of Gasoline.
5. Drop Point of Grease and Mechanical Penetration in Grease.
6. Aniline Distillation Test of Gasoline.
7. Calorific Value of Liquid Fuel Using Bomb Calorimeter
8. Reid Vapor Pressure Test.
9. Carbon Residue Test.
10. Copper Corrosion Test.
11. Cloud and Pour Point Test.
12. Ash Content Test.

Total: 30 periods

Total (45+30): 75 Periods

9. Text Books

1. Ganesan.V., "Internal Combustion Engineering", Tata McGraw-Hill Publishing Co., New Delhi, 2012.
2. M.L. Mathur, R.P.Sharma "A course in internal combustion engines", Dhanpatrai publication, 2012.
3. Obert.E.F "Internal Combustion Engineering and Air Pollution", International book Co., 2011.

10. References

1. Brame, J.S.S. and King, J.G. – Fuels – Solids, Liquids, Gaseous, 2012
2. Francis, W – Fuels and Fuel Technology, Vol. I & II, 2010
3. Hobson, G.D. &Pohl.W- Modern Petroleum Technology, 2011
4. A.R.Lansdown – Lubrication – A practical guide to lubricant selection – Pergamon press –2012.
5. Raymond.C.Gunther – Lubrication – Chilton Book Co., -2010.

11. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal			University Examination %
	Mid Term Test I %	Mid Term Test II %	Model Practical Exam %	
Remember	20	20	20	20
Understand	80	80	80	80
Apply				
Analyse				
Evaluate				
Create				

12. Rubrics for Internal Assessment

Performance	Excellent (5)	Very good (4)	Good (3)	Average (2)	Low (1)
Observation (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

13. Rubrics for Lab Experiments

Performance Indicator	Excellent (100 %)	Very good (80 %)	Good (60 %)	Average (40%)	Low (20%)
Identify the Equipment (10)	Identify all Equipment required	Able to Identify most of the Equipment required	Able to Identify some important Equipment required	Able to Identify few Equipment required	Not able to Identify all Equipment required
Conducting experiment as per procedure/order & readings (20)	Able to conduct the experiment completely as per procedure with the specified/ required reading	Able to conduct the experiment completely as per procedure with few readings	Able to conduct the experiment partially as per procedure with few readings	Able to conduct the experiment partially as per procedure with wrong reading	unable to conduct the experiment completely as per procedure
Formulae & Calculations (40)	Able to write all the formulae and complete the calculations correctly	Able to write all the formulae and complete the calculations partially	Able to write some formulae and complete the calculations partially with mistake in units	Able to write some formulae and unable to complete the calculations	Unable to write all the formulae and complete the calculations
Tabulation & Result (20)	Able to formulate the tabulation completely with correct units and arrive the exact results	Able to formulate the tabulation completely with correct units and arrive the results with deviations	Able to formulate the tabulation completely with incorrect units and arrive the results with deviations	Able to formulate the tabulation partially with incorrect units and arrive the results with much deviations	Unable to formulate the tabulation completely.
Viva- voce (10)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer

14.Lecture plan

S.NO	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**L9 P6**	
1	Structure of petroleum	1	Lecture with discussions/ Seminar/ Assignment
2	Refining process, fuels	1	
3	Thermal cracking	1	
4	Catalytic cracking	1	
5	Polymerization, alkylation	1	
6	Isomerisation, blending	1	
7	Products of refining process	1	
8	Manufacture of lubricating oil base stocks	1	
9	Manufacture of finished automotive lubricants	1	
	UT-1(CO1)		
	Unit –II	**L9 P6**	
10	Engine friction: introduction.	1	Lecture with discussions/ Seminar/ Assignment
11	Total engine friction	1	
12	Effect of engine variables on friction	1	
13	Introduction to hydrodynamic lubrication	1	
14	Elasto hydrodynamic lubrication	1	
15	Boundary lubrication	1	
16	Bearing lubrication	1	
17	Functions of the lubrication system	1	
18	Introduction to design of a lubricating system	1	
MT-I (CO1, CO2)			
	Unit-III	**L9 P6**	
19	Specific requirements for automotive lubricants	1	Lecture with discussions/ Seminar/ Assignment
20	Oxidation deterioration	1	
21	Degradation of lubricants	1	
22	Additives and additive mechanism, synthetic lubricants	1	
23	Classification of lubricating oil	1	
24	Properties of lubricating oils	1	
25	Tests on lubricants	1	
26	Grease, classification, properties	1	
27	Test used in grease.	1	
	UT-II (CO3)		
	Unit IV	**L9 P6**	
28	Thermo-chemistry of fuels	1	Lecture with discussions/ Seminar/ Assignment
29	Properties and testing of fuels	1	
30	Relative density, distillation	1	
31	Calorific value	1	
32	Vapour pressure, flash point	1	
33	Spontaneous ignition temperature	1	
34	Viscosity, pour point, flammability,	1	
35	Ignitability, diesel index,	1	

14.Lecture plan

S.NO	Topics to be covered	No. of periods	Content Delivery Method
36	API gravity, aniline point etc.	1	
	Unit V	**L9 P6**	
37	SI Engines – flame propagation and,	1	Lecture with discussions/ Seminar/
38	Mechanism of combustion	1	
39	Normal combustion,	1	
40	Knocking, octane rating, fuel requirements.	1	
41	CI Engine, mechanism of combustion	1	
42	Diesel knock, cetane rating, fuel requirements	1	
43	Additive - mechanism, requirements of an additive	1	
44	Petrol fuel additives	1	
45	Diesel fuel additives – specifications of fuels	1	
	MT – II (CO3, CO4, CO5)		
Total		**75**	

1151AU217	VEHICLE EVALUATION AND MAINTENANCE	L	T	P	C
		3	0	2	4

1. Preamble

This course makes the students to have a complete knowledge of the vehicle maintenance procedures and acquire skills in handling situations where the vehicle is likely to breakdown.

2. Pre-requisite

1151AU107 I.C Engines

1151AU214 Automotive Chassis

3. Links to other courses

- Reconditioning and Maintenance Lab
- Transport Management

4. Course Educational Objectives

Students undergoing this course are expected to

- To develop the basic knowledge of the students in the various maintenance schedules and work shop records.
- To develop the skills of the students in the Maintenance of vehicles.
- To serve as a pre-requisite course for other courses in UG and PG programmes, specialized studies and research.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the importance, types and requirements of vehicle maintenance and related records and schedules.	K2, S2
CO2	Practice the engine overhauling, reconditioning; methods, procedures, tools of cylinder, valves and other engine components.	K3, S2
CO3	Demonstrate the maintenance procedures of clutch, gearbox, steering system, braking system, wheel alignment, door actuating systems and body tinkering	K3, S2
CO4	Demonstrate the construction, testing, fault diagnosis and maintenance of battery, starter motor, alternator, DC generator, ignition, lighting and dashboard instruments.	K3, S2
CO5	Describe the different service and maintenance aspects of fuel system, lubrication system and calibrate of fuel injection pump.	K4, S2

6. **Correlation of COs with Programme Outcomes**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	H	M	M					L		M	M
CO2	H	H	M	H	M	M					L		H	H
CO3	H	H	M	H	M	M					L		M	H
CO4	H	H	M	H	M	M					L		M	H
CO5	H	H	M	H	M	M					L		M	H

H- Strong; M-Medium; L-Low

7. Course Content

UNIT – I: MAINTENANCE OF RECORDS AND SCHEDULES L-9 P-6

Importance of Maintenance, Preventive (Scheduled) and Breakdown (Unscheduled) Maintenance, Requirements of Maintenance, Preparation of Check Lists. Inspection Schedule, Maintenance of Records, Log Sheets and Other Forms, Safety Precautions in Maintenance.

UNIT – II: ENGINE MAINTENANCE L-9 P-6

Dismantling of Engine Components and Cleaning, Cleaning Methods, Visual and Dimensional Inspections, Minor and Major Reconditioning of Various Components, Reconditioning Methods, Engine Assembly, Special Tools Used for Maintenance Overhauling, Engine Tune Up.

UNIT – III: CHASSIS & BODY MAINTENANCE L-9 P-6

Chassis-Mechanical and Automobile Clutch and Gear Box, Servicing and Maintenance, Maintenance Servicing of Propeller Shaft and Differential System. Maintenance and Servicing of Suspension Systems. Brake Systems, Types and Servicing Techniques. Steering Systems, Overhauling and Maintenance. Wheel Alignment, Computerized Alignment and Wheel Balancing. Body-Vehicle Body Maintenance, Minor and Major Repairs. Door Locks and Window Glass Actuating System Maintenance

UNIT – IV: ELECTRICAL AND ELECTRONICS SYSTEM MAINTENANCE L-9 P-6

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, Maintenance of Electronics System - on Board Diagnostics.

UNIT – V: MAINTENANCE OF INTAKE, EXHAUST, FUEL, COOLING & LUBRICATION SYSTEM L-9 P-6

Servicing and Maintenance of Fuel System of Different Types of Vehicles, Calibration and Tuning of Engine for Optimum Fuel Supply. Cooling Systems, Water Pump, Radiator, Thermostat, Anticorrosion and Antifreeze Additives. Lubrication Maintenance, Lubricating Oil Changing, Greasing of Parts, Maintenance of Intake and Exhaust Systems

TOTAL: 75 Periods

8. Practicals

List of Experiments

1. Study and Layout of an Automobile Repair, Service and Maintenance Shop.
2. Study and Preparation of Different Statements/Records Required for the Repair and Maintenance Works.

3. Cylinder Reboring - Checking the Cylinder Bore, Setting the Tool and Reboring.
4. Valve Grinding, Valve Lapping - Setting the Valve Angle, Grinding and Lapping and Checking for Valve Leakage
5. Minor and Major Tune Up of Gasoline and Diesel Engines
6. Study and Checking of Wheel Alignment - Testing of Camber, Caster
7. Testing Kingpin Inclination, Toe-In and Toe-Out.
8. Simple Tinkering, Soldering Works of Body Panels, Study of Door Lock and Window Glass Rising Mechanisms
9. Brake Adjustment and Brake Bleeding.
10. Practice the Following:
    i. Adjustment of Pedal Play in Clutch, Brake, Hand Brake Lever And Steering Wheel Play
    ii. Air Bleeding From Hydraulic Brakes, Air Bleeding of Diesel Fuel System
    iii. Wheel Bearings Tightening and Adjustment
    iv. Adjustment of Head Lights Beam
    v. Removal and Fitting of Tyre and Tube
11. Calibration of Fuel Injection Pump

Total: 30 Periods
Total (45+30): 75 periods

9. Text Book

1. John Duke "Fleet Management", McGraw-Hill Co. 1984.

10. References

1. James D Halderman - Advanced Engine Performance Diagnosis – PHI - 1998.
2. Service Manuals from Different Vehicle Manufacturers.

11. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal			University Examination %
	Mid Term Test I %	Mid Term Test II %	Model Practical Exam %	
Remember				
Understand	60	10	20	10
Apply	40	60	80	80
Analyse		30		10
Evaluate				
Create				

12. Rubrics for Internal Assessment

Performance	Excellent (5)	Very good (4)	Good (3)	Average (2)	Low (1)
Observation (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks' time	Submission after two weeks' time

Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks' time	Submission after two weeks' time
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

13. Rubrics for Lab Experiments

Performance Indicator	Excellent (100 %)	Very good (80 %)	Good (60 %)	Average (40%)	Low (20%)
Identify the Equipment (10)	Identify all Equipment required	Able to Identify most of the Equipment required	Able to Identify some important Equipment required	Able to Identify few Equipment required	Not able to Identify all Equipment required
Conducting experiment as per procedure/order & readings (20)	Able to conduct the experiment completely as per procedure with the specified/ required reading	Able to conduct the experiment completely as per procedure with few readings	Able to conduct the experiment partially as per procedure with few readings	Able to conduct the experiment partially as per procedure with wrong reading	unable to conduct the experiment completely as per procedure
Formulae & Calculations (40)	Able to write all the formulae and complete the calculations correctly	Able to write all the formulae and complete the calculations partially	Able to write some formulae and complete the calculations partially with mistake in units	Able to write some formulae and unable to complete the calculations	Unable to write all the formulae and complete the calculations
Tabulation & Result (20)	Able to formulate the tabulation completely with correct units and arrive the exact results	Able to formulate the tabulation completely with correct units and arrive the results with deviations	Able to formulate the tabulation completely with incorrect units and arrive the results with deviations	Able to formulate the tabulation partially with incorrect units and arrive the results with much deviations	Unable to formulate the tabulation completely.
Viva- voce (10)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer

14. Lecture plan

S.NO	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**L9 P6**	
1	Importance of maintenance	1	Lecture with discussions/
2	preventive (scheduled) and breakdown (unscheduled) maintenance,	2	

S.NO	Topics to be covered	No. of periods	Content Delivery Method
3	requirements of maintenance,	2	Seminar/ Assignment
4	preparation of check lists	2	
5	Inspection schedule, maintenance of records, log sheets and other forms,	1	
6	Safety precautions in maintenance.	1	
	Unit –II	**L9 P6**	
7	Dismantling of engine components and cleaning,	1	Lecture with discussions/ Seminar/ Assignment
8	cleaning methods, visual and dimensional inspections,	2	
9	minor and major reconditioning of various components, reconditioning methods, engine assembly,	2	
10		1	
11	special tools used for maintenance overhauling, engine tune up	1	
12		1	
	MT-I (CO1, CO2)		
	Unit-III	**L9 P6**	
13	Chassis-Mechanical and automobile clutch and gear box,	2	Lecture with discussions/ Seminar/ Case Studies/ Assignment
14	Servicing and maintenance, maintenance servicing of propeller shaft and differential system.	1	
15	Maintenance servicing of suspension systems. Brake systems, types and servicing techniques. Steering systems,	2	
16	Overhauling and maintenance.	1	
17	Body-Vehicle body maintenance, minor and major repairs.	1	
18	Door locks and window glass actuating system maintenance	1	
19	Wheel alignment, computerized alignment and wheel balancing.	1	
	Unit - IV	**L9 P6**	
20	Testing methods for checking electrical components	2	Lecture with discussions/ Seminar/ Case Studies/ Assignment
21	checking battery, starter motor, charging systems	2	
22	DC generator and alternator	2	
23	Ignitions system, lighting systems	1	
24	Fault diagnosis and maintenance of modern electronic controls	1	
26	checking and servicing of dash board instruments	1	
	Unit -V	**L9 P6**	
27	Servicing and maintenance of fuel system of different types of vehicles	2	Lecture with discussions/ Seminar/ Lecture with demonstration
28	calibration and tuning of engine for optimum fuel supply	2	
29	Cooling systems, water pump, radiator,	2	
30	Thermostat, anticorrosion and antifreeze additives	1	
31	Lubrication maintenance	1	
32	lubricating oil changing, greasing of parts	1	
	MT – II (CO3, CO4, CO5)		
	Total	**75**	

1151AU318 ENGINE PERFORMANCE AND EMISSION TESTING LAB

L	T	P	C
0	0	2	1

1. Preamble

This course enables the students to analyze the performance and emission characteristic of a spark ignition and compression ignition engine. It helps a student to identify the effect of pollutants on human health, environment and their measurement and control.

2. Pre-requisite

1151AU107 I.C Engines

3. Links to other courses

- Automotive fuels, lubricants and coolants

4. Course Educational Objectives

Students undergoing this course are expected to

- Impart the fundamental knowledge in different types of dynamometers used for performance testing.
- Understand the concept of valve and port timing diagrams and their significance in internal combustion engines.
- Develop the ability to conduct performance testing of various types of internal combustion engines and to evaluate various performance parameters
- Study and analysis of engine performance characteristics and engine emissions

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Plot and analyze engine performance characteristic	S4
CO2	Perform exhaust gas analysis and comment on adverse implications on environment	S3

6. Correlation of COs with Programme Outcomes :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	H	L	H	L				L	L		H	H
CO2	H	L	H	L	H	L				L	L		H	H

H- Strong; M-Medium; L-Low

7. List of Experiments

1. Study of Hydraulic, Electrical and Eddy Current Dynamometers.
2. Valve Timing Diagram & Port Timing Diagram.
3. Performance and Emission Test on Multi-Cylinder SI Engine.
4. Performance and Emission Test on Multi-Cylinder CI Engine.
5. Retardation Test on I.C. Engines.
6. Heat Balance Test on Automotive Multi-Cylinder SI Engine.
7. Heat Balance Test on Automotive Multi-Cylinder CI Engine.
8. Morse Test on Multi-Cylinder SI Engine.
9. Study of Effect of Carbon Monoxide, Hydrocarbons and Nitrogen Oxides Emissions on Environment.
10. Study of P-θ and P-V Diagrams for IC Engine with Piezo-electric Pick Up, Charge Amplifier, Angle Encoder and PC.

TOTAL = 30 periods

8. Assessment Pattern

Rubrics for Internal Assessment

Performance	Excellent (5)	Very good (4)	Good (3)	Average (2)	Low (1)
Observation (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks' time	Submission after two weeks' time
Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks' time	Submission after two weeks' time
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

9. Rubrics for Model/ University Examination:

Performance Indicator	Excellent (100 %)	Very good (80 %)	Good (60 %)	Average (40%)	Low (20%)
Identify the tools & Equipment (10)	Identify all the tools & Equipment required	Able to Identify most of the tools & Equipment required	Able to Identify some important tools & Equipment required	Able to Identify few tools & Equipment required	Not able to Identify all the tools & Equipment required
Conducting experiment as per	Able to conduct the experiment	Able to conduct the experiment	Able to conduct the experiment	Able to conduct the experiment	unable to conduct the experiment

procedure/order & readings (20)	completely as per procedure with the specified/ required reading	completely as per procedure with few readings	partially as per procedure with few readings	partially as per procedure with wrong reading	completely as per procedure
Formulae & Calculations (40)	Able to write all the formulae and complete the calculations correctly	Able to write all the formulae and complete the calculations partially	Able to write some formulae and complete the calculations partially with mistake in units	Able to write some formulae and unable to complete the calculations	Unable to write all the formulae and complete the calculations
Tabulation & Result (20)	Able to formulate the tabulation completely with correct units and arrive the exact results	Able to formulate the tabulation completely with correct units and arrive the results with deviations	Able to formulate the tabulation completely with incorrect units and arrive the results with deviations	Able to formulate the tabulation partially with incorrect units and arrive the results with much deviations	Unable to formulate the tabulation completely.
Viva- voce (10)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer

		L	T	P	C
1151AU319	**CAD & APPLIED FEA LAB**	**0**	**0**	**2**	**1**

1. Preamble

To introduce the basic design & drafting concepts of automobile components and their simulation and modeling using ANSYS

2. Pre-requisite

1150ME202 Engineering Graphics

3. Links to other courses

- Engine design and development
- Vehicle Design and Data Characteristics

4. Course Educational Objectives

Students undergoing this course are expected to

- To develop the Practical knowledge in designing of automobile components.
- To impart the fundamental knowledge in designing, drafting and simulation.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Understand the complete methodology of design &drafting.	**S2**
C02	Develop skills in modeling and simulation of the automobile engine components using ANSYS.	**S4**

6. Correlation of COs with Programme Outcomes :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	H	H	L	H				L			H	H
CO2	L	L	H	H	L	H				L			H	H

H- Strong; M-Medium; L-Low

7. Course Content

List of Experiments

Design and Analysis of the Following Automobile Components:

1. Piston.
2. Universal Coupling
3. Cylinder Block
4. Connecting Rod

5. Crankshaft.
6. Inlet and Exhaust Valves.

TOTAL = 30 periods

8. Assessment Pattern

Rubrics for Internal Assessment

Performance	Excellent (5)	Very good (4)	Good (3)	Average (2)	Low (1)
Observation (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks' time	Submission after two weeks' time
Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks' time	Submission after two weeks' time
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

Rubrics for Model/ University Examination:

Performance Indicator	Excellent (100 %)	Very good (80 %)	Good (60 %)	Average (40%)	Low (20%)
Identify the tools & Equipment (10)	Identify all the tools & Equipment required	Able to Identify most of the tools & Equipment required	Able to Identify some important tools & Equipment required	Able to Identify few tools & Equipment required	Not able to Identify all the tools & Equipment required
Conducting experiment as per procedure/order & readings (20)	Able to conduct the experiment completely as per procedure with the specified/ required reading	Able to conduct the experiment completely as per procedure with few readings	Able to conduct the experiment partially as per procedure with few readings	Able to conduct the experiment partially as per procedure with wrong reading	unable to conduct the experiment completely as per procedure
Formulae & Calculations (40)	Able to write all the formulae and complete the calculations correctly	Able to write all the formulae and complete the calculations partially	Able to write some formulae and complete the calculations partially with mistake in units	Able to write some formulae and unable to complete the calculations	Unable to write all the formulae and complete the calculations
Tabulation & Result (20)	Able to formulate the tabulation	Able to formulate the	Able to formulate the tabulation	Able to formulate the tabulation	Unable to formulate the

	completely with correct units and arrive the exact results	tabulation completely with correct units and arrive the results with deviations	completely with incorrect units and arrive the results with deviations	partially with incorrect units and arrive the results with much deviations	tabulation completely.
Viva- voce (10)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer

1151AU320 **STRENGTH OF MATERIALS LAB**

L	T	P	C
0	0	2	1

1. Preamble

To supplement the theoretical knowledge gained in strength of materials with practical testing for determining the strength of materials under externally applied loads

2. Pre-requisite

1151AU101 Engineering Mechanics

3. Links to other courses

Mechanics of Machines

4. Course Educational Objectives

Students undergoing this course are expected to

- To understand the theoretical knowledge gained in Mechanics of Solids and conduct practical testing for estimation of material properties under externally applied loads.
- To understand and conduct the microscopic examination of various materials

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Compute the tensile strength ,shear strength, impact strength of the given specimen using different testing methods (UTM, Torsion, Impact Test)	S3
CO2	Analyze the hardness of the given specimen using different testing methods (Brinell, Vickers and Rockwell)	S3
CO3	Predict the bending stress, modulus of rigidity, fatigue strength of the given specimen using different testing methods(compression test, deflection test, fatigue test)	S3
CO4	Evaluate the strain value of the given specimen using Rosette strain gauge	S3

6. Correlation of COs with Programme Outcomes :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1				H								L	M	H
CO2				M								L	M	H
CO3				M								L	M	H
CO4				L								L	M	H

H- Strong; M-Medium; L-Low

7. List of Experiments

1. Tension Test on a Mild Steel Rod
2. Double Shear Test on Mild Steel and Aluminum Rods
3. Torsion Test on Mild Steel Rod.
4. Impact Test on Metal Specimen.
5. Fatigue Test on Aluminum Rod
6. Hardness Testing - Brinell, Vickers and Rockwell Hardness Tester
7. Deflection Test on Beams
8. Compression Test on Helical Springs
9. Strain Measurement Using Rosette Strain Gauge

TOTAL = 30 periods

8. Assessment Pattern

Rubrics for Internal Assessment

Performance	**Excellent (5)**	**Very good (4)**	**Good (3)**	**Average (2)**	**Low (1)**
Observation (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks' time	Submission after two weeks' time
Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks' time	Submission after two weeks' time
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

9. Rubrics for Model/ University Examination:

Performance Indicator	**Excellent (100 %)**	**Very good (80 %)**	**Good (60 %)**	**Average (40%)**	**Low (20%)**
Identify the tools & Equipment (10)	Identify all the tools & Equipment required	Able to Identify most of the tools & Equipment required	Able to Identify some important tools & Equipment required	Able to Identify few tools & Equipment required	Not able to Identify all the tools & Equipment required
Conducting experiment as per procedure/order & readings (20)	Able to conduct the experiment completely as per procedure with the specified/	Able to conduct the experiment completely as per procedure with few readings	Able to conduct the experiment partially as per procedure with few readings	Able to conduct the experiment partially as per procedure with wrong reading	unable to conduct the experiment completely as per procedure

	required reading				
Formulae & Calculations (40)	Able to write all the formulae and complete the calculations correctly	Able to write all the formulae and complete the calculations partially	Able to write some formulae and complete the calculations partially with mistake in units	Able to write some formulae and unable to complete the calculations	Unable to write all the formulae and complete the calculations
Tabulation & Result (20)	Able to formulate the tabulation completely with correct units and arrive the exact results	Able to formulate the tabulation completely with correct units and arrive the results with deviations	Able to formulate the tabulation completely with incorrect units and arrive the results with deviations	Able to formulate the tabulation partially with incorrect units and arrive the results with much deviations	Unable to formulate the tabulation completely.
Viva- voce (10)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer

		L	T	P	C
1151AU321	**MANUFACTURING TECHNOLOGY LAB**	**0**	**0**	**2**	**1**

1. Preamble

This course provides an opportunity to demonstrate the techniques of metal casting processes, welding processes and various types of manufacturing processes.

2. Pre-requisite

1150ME101 Basic Mechanical Engineering

3. Links to other courses

- Engineering Metrology and Measurements

4. Course Educational Objectives

Students undergoing this course are expected to

- To understand the various manufacturing processes and machining related to casting, forming, joining of metals, molding processes materials

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Demonstrate preparation of moulds for casting applications	S3
CO2	Demonstrate various lathe operations.	S3
CO3	Demonstrate different deformation processes of manufacturing.	S3
C04	Demonstrate various welding processes	S3

6. Correlation of COs with Programme Outcomes :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	H	L	H	L				L	L		H	H
CO2	H	L	H	L	H	L				L	L		M	H

H- Strong; M-Medium; L-Low

7. List of Experiments

1. Preparation of Sand Mould With Solid & Split Pattern.
2. Preparation of Sand Mould With Loose Piece Pattern.
3. Preparation of Sand Mould With Core.
4. Eccentric Turning Operation in a Lathe.
5. Taper Turning Using Compound Rest in a Lathe.
6. Thread Cutting and Knurling Operation in a Lathe.

7. Boring and Internal Thread Cutting in a Lathe.
8. Arc Welding
9. Gas Welding.
10. Study of Brazing Process.
11. Study of Injection Molding Process.

TOTAL = 30 periods

8. Assessment Pattern

Rubrics for Internal Assessment

Performance	Excellent (5)	Very good (4)	Good (3)	Average (2)	Low (1)
Observation (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

9. Rubrics for Model/ University Examination:

Performance Indicator	Excellent (100 %)	Very good (80 %)	Good (60 %)	Average (40%)	Low (20%)
Identify the tools & Equipment (10)	Identify all the tools & Equipment required	Able to Identify most of the tools & Equipment required	Able to Identify some important tools & Equipment required	Able to Identify few tools & Equipment required	Not able to Identify all the tools & Equipment required
Conducting experiment as per procedure/order & readings (20)	Able to conduct the experiment completely as per procedure with the specified/ required reading	Able to conduct the experiment completely as per procedure with few readings	Able to conduct the experiment partially as per procedure with few readings	Able to conduct the experiment partially as per procedure with wrong reading	unable to conduct the experiment completely as per procedure
Formulae & Calculations (40)	Able to write all the formulae and complete the calculations correctly	Able to write all the formulae and complete the	Able to write some formulae and complete the calculations partially with	Able to write some formulae and unable to complete the calculations	Unable to write all the formulae and complete the calculations

		calculations partially	mistake in units		
Tabulation & Result (20)	Able to formulate the tabulation completely with correct units and arrive the exact results	Able to formulate the tabulation completely with correct units and arrive the results with deviations	Able to formulate the tabulation completely with incorrect units and arrive the results with deviations	Able to formulate the tabulation partially with incorrect units and arrive the results with much deviations	Unable to formulate the tabulation completely.
Viva- voce (10)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer

		L	T	P	C
1152AU101	**COMBUSTION AND HEAT RANSFER IN ENGINES**	**3**	**0**	**0**	**3**

1. Preamble

To make the students understand the engine combustion and heat transfer aspects through Diffusion flames, combustion process in IC Engines (Conduction, convection & radiation). Stages of combustion in IC Engines Pressure-Crank Angle Diagram and combustion

2. Pre-requisite

1151AU102 Basic Engineering Thermodynamics

3. Links to other courses

- IC Engines

4. Course Educational Objectives

Students undergoing this course are expect to

- To know the various stages of combustion in S.I and C.I ENGINE
- To understand the process of knock & detonation in I.C engines
- Discuss the heat transfer modes and thermal stresses in engine components
- Analyze the combustion process with respect to p-theta diagram and temperature measurement in engine components

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Show the combustion in pre-mixture and diffusion flame, combustion process in IC engine	**K2**
C02	Describe the stages of combustion in SI engine, flame propagation variation among cycle, detonation and effect of engine variables on combustion	**K2**
C03	Explain the droplet formation, stages of combustion, heat release and diesel knock	**K3**
C04	Illustrate the heat transfer modes, thermal stresses in engine components and radiator oil cooler design	**K4**
C05	Explain combustion process with photographic , P-θ diagram in engines, temperature measurement of engine components	**K3**

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	H	M	L		L	L		M	L	M	H

CO2	H	H	H	H	M	L		L	L		M	L	M	H
CO3	H	H	H	H	M	L		L	L		M	L	M	H
CO4	H	H	H	H	M	L		L	L		M	L	M	H
CO5	H	H	H	H	M	L		L	L		M	L	M	H

H- Strong; M-Medium; L-Low

7. Course Content

UNIT I - INTRODUCTION **L-9**

Premixed and Diffusion Combustion Process in IC Engines. First and Second Law of Thermodynamics Applied to Combustion - Combustion Stoichiometry - Chemical Equilibrium, Spray Formation and Droplet Combustion.

UNIT II - NORMAL AND ABNORMAL COMBUSTION IN SI ENGINES **L-9**

Stages of Combustion in SI Engines - Flame Propagation - Rate of Pressure Rise – Cycle -To-Cycle Variation - Abnormal Combustion. Theories of Detonation, Effect of Engine Operating Variables On Combustion.

UNIT III - COMBUSTION AND KNOCK IN CI ENGINES **L-9**

Droplet and Spray Combustion Theory - Stages of Combustion - Delay Period - Peak Pressure - Heat Release - Gas Temperature and Diesel Knock.

UNIT IV - HEAT TRANSFER IN IC ENGINES **L-9**

Basic Definitions - Conduction, Convection and Radiation Heat Transfer. Temperature Distribution and Thermal Stresses in Piston, Cylinder Liner, Cylinder Head, Fins and Valves -Heat Transfer Correlations for Engines. Fin Design, Radiators and Oil Coolers.

UNIT V - MEASUREMENT & SIMULATION TECHNIQUES **L-9**

Photographic Studies of Combustion Processes, Pressure-Crank Angle Diagram in SI And CI Engines. Temperature Measurement in Piston, Cylinder Liner, Cylinder Head and Engine Valves. In Cylinder Flow Measurement Techniques.

TOTAL: 45 Periods

8. Text Books

1. SPALDING. D.B. - 'Some Fundamentals of Combustion' - Butterworth Science Publications, London - 1985.
2. J.l.Ramos, "Modeling of Internal Combustion Engine", Mcgraw hill book company New york 1990

9. Reference Book

1. Irvin Glasman, "Combustion" Academic Press, London, 1987, ISBN 0-12-285851-4.
2. Taylor.E.F. "The Internal Combustion Engines ", International Text Book Co., Pennsylvania, 1982.
3. Ashley Campbel, "Thermodynamic analysis of combustion engine", John book company, Newyork,1979.
4. Heywood J.B "Internal Combustion Engine Fundamentals", McGraw-Hill Book CO., USA - 1995.

10. Revised Bloom's based Assessment Pattern

	Internal	University

Revised Bloom's Category	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	Examination (%)
Remember	20	20			
Understand	80	80	20	20	30
Apply			80	50	50
Analyse				30	20
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	50	60
Analyse	50	50
Evaluate		
Create		

11. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Premixed and diffusion combustion process in IC engines.	2	Lecture with discussions/ Seminar/ Assignment
2	First and Second Law of Thermodynamics applied to combustion	2	
3	Combustion Stoichiometry- chemical equilibrium	1	
4	Spray formation	2	
5	Droplet combustion	2	
	UT-I (CO1)		
	Unit –II	**(9)**	
6	Stages of combustion in SI Engines	1	Lecture with discussions/ Seminar/ Assignment
7	Flame propagation, rate of pressure rise	2	
8	Cycle-to-cycle variation, abnormal combustion.	2	
9	Theories of detonation	2	
10	Effect of engine operating variables on combustion	2	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
11	Droplet and spray combustion theory	2	Lecture with discussions/ Seminar/ Assignment
12	Stages of combustion	2	
13	Delay period, peak pressure	1	
14	Heat release, gas temperature	2	
15	Diesel Knock	2	

S.No	Topics to be covered	No. of periods	Content Delivery Method
	UT-II (CO3)		
	Unit IV	**(9)**	
16	Basic definitions-Conduction, Convection and Radiation heat transfer	1	Lecture with discussions/ Seminar/ Assignment
17	Temperature distribution and thermal stresses in piston	1	
18	Cylinder linear, cylinder head, fins and valves	2	
19	Heat transfer correlations for engines	2	
20	Fin design	2	
21	Radiators and oil coolers	1	
	Unit V	**(9)**	
22	Photographic studies of combustion processes	1	Lecture with discussions/ Seminar
23	Pressure-crank angle diagram in SI and CI engines	2	
24	Temperature measurement in piston	2	
25	Cylinder liner, cylinder head and engine valves.	2	
26	Incylinder flow measurement techniques	2	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

		L	T	P	C
1152AU102	**AUTOMOTIVE EMISSIONAND CONTROL**	**3**	**0**	**0**	**3**

1. Preamble

This course provides an introduction to the vehicle population growth, types of emission, formation of pollutant in SI and CI engine, effect of pollutant on human health, environment, measurement and control.

2. Pre-requisite

1151AU107 I.C. Engines

3. Links to other courses

- Fuel conservation & Alternate fuels
- I.C. Engines

4. Course Educational Objectives

Students undergoing this course are expected to

- To develop the basic knowledge of the students in automobile engines pollution formation & control techniques, Measurement techniques.
- Know the social, cultural, global and environmental responsibilities of the professional engineer, and the principles of sustainable design and development.

5. Course Outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the emission and its effect on human health and environment.	**K2**
CO2	Identify the formation of pollutant in SI engine.	**K2**
CO3	Identify the formation of pollutant in CI engine	**K2**
CO4	Describe the Emission control techniques.	**K2**
CO5	Describe the Emission measurement techniques, Emission Standards and various test procedure	**K2**

6. Correlation of COs with Programme Outcomes :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**H**	**H**	**H**	**L**					**H**				**H**	**M**
CO2	**H**	**H**	**M**	**L**					**H**				**H**	**M**
CO3	**H**	**H**	**H**	**L**					**H**				**H**	**M**
CO4	**H**	**H**	**H**	**L**					**H**				**H**	**M**
CO5	**H**	**H**	**H**	**L**					**H**				**H**	**M**

H- Strong; M-Medium; L-Low

7. Course content

UNIT I INTRODUCTION **L-9**

Vehicle Population Assessment in Metropolitan Cities and Contribution to Pollution, Effects on Human Health and Environment, Global Warming, Types of Emission (Controlled and Uncontrolled Emissions), Transient Operational Effects on Pollution.

UNIT II POLLUTANT FORMATION IN SI ENGINES **L-9**

Pollutant Formation in SI Engines, Mechanism of HC and CO Formation in Four Stroke and Two Stroke SI Engines, NO_x Formation in SI Engines, Effects of Design and Operating Variables on Emission Formation, Evaporative Emission. Two Stroke Engine Pollution.

UNIT III POLLUTANT FORMATION IN CI ENGINES **L-9**

Pollutant Formation in CI Engines, Smoke and Particulate Emissions in CI Engines, Effects of Design and Operating Variables on CI Engine Emissions, NO_x Formation.

UNIT IV CONTROL OF EMISSIONS FROM SI AND CI ENGINES **L-9**

Design of Engine, Optimum Selection of Operating Variables for Control of Emissions, EGR, Catalytic Converters, Catalysts, Fuel Modifications, Two Stroke Engine Pollution Controls. SCR, Lean NO_x Trap and DPF, PCV, Fuel Charcoal Canister.

UNIT V MEASUREMENT TECHNIQUES EMISSION STANDARDS AND TEST PROCEDURE **L-9**

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.

TOTAL: 45 periods

8. Text Books

1. Paul Degobert – Automobiles and Pollution – SAE International SBN-1-56091-563-3, 1991.
2. G.P.Springer ad D.J.Patterson, Engine Emissions, Pollutant formation, Plenum Press, New York,1986.
3. D.J.Patterson and N.A.Henin, ‘Emission from Combustion Engine and their control’, Anna Arbor Science Publication,1985.

9. References

1. SAE Transactions- “Vehicle Emission”- 1982 (3 volumes).
2. Obert.E.F.- “Internal Combustion Engines”- 1988
3. Marco Nute- “ Emissions from two stroke engines, SAE Publication – 1998
4. Ganesan .V- “Internal Combustion Engines”- Tata McGraw-Hill Co- 2003.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	20	20	20	20	20
Understand	80	80	80	80	80
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	20	30
Analyse	80	70
Evaluate		
Create		

11. Lecture plan

S. No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Vehicle population assessment in metropolitan cities and contribution to pollution	2	Lecture with discussions/ Seminar/ Assignment
2	Effects on human health and environment	2	
3	Global warming	1	
4	Types of emission (controlled and uncontrolled emissions)	2	
5	Transient operational effects on pollution	2	
	UT-I (CO1)		
	Unit –II	**(9)**	
6	Pollutant formation in SI Engines	1	Lecture with discussions/ Seminar/ Assignment
7	Mechanism of HC and CO formation in four stroke and two stroke SI engines	2	
8	NOx formation in SI engines	1	
9	Effects of design and operating variables on emission formation	2	
10	Evaporative emission	1	
11	Two stroke engine pollution	2	

S. No	Topics to be covered	No. of periods	Content Delivery Method
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
12	Pollutant formation in CI engines	2	Lecture with discussions/ Seminar/ Assignment
13	Smoke and particulate emissions in CI engines	2	
14	Effects of design and operating variables on CI engine emissions	3	
15	NOx formation	2	
	UT-II (CO3)		
	Unit - IV	**(9)**	
16	Design of engine, optimum selection of operating variables for control of emissions	2	Lecture with discussions/ Seminar/ Case Studies/ Assignment
17	EGR, catalytic converters	1	
18	Catalysts, fuel modifications	1	
19	Two stroke engine pollution controls	2	
20	SCR, lean NOx trap	1	
21	DPF, PCV	1	
22	Fuel charcoal canister	1	
	Unit -V	**(9)**	
23	NDIR, FID,	1	Lecture with discussions/ Seminar/ Lecture with demonstration
24	Chemiluminescent analyzers, Gas Chromatograph	1	
25	smoke meters, emission standards	2	
26	Driving cycles – USA, Japan, Euro and India	2	
27	Test procedures – ECE, FTP Tests	1	
28	SHED Test – chassis dynamometers	1	
29	dilution tunnels	1	
	MT – II (CO3, CO4, CO5)		
	Total	**45**	

		L	T	P	C
1152AU103	**FUEL CONSERVATION AND ALTERNATE FUELS**	**3**	**0**	**0**	**3**

1. **Preamble**

This course enables learners to acquire knowledge in fuel conservation, fuel economy, alternate fuels and the changes in the engine design for handling them and understand various energy systems for use in the automobiles.

2. **Pre-requisite**

1151AU216 Automotive Fuels, Lubricants and Coolants

3. **Links to other courses**

- Automotive Emission & Control
- Automotive Electrical & Electronics

4. **Course Educational Objectives**

Students undergoing this course are expect to

- Understand the types of fuels and its physical and chemical properties.
- Distinguish between the Petrol and Diesel fuels with their properties and will the effect of these on to combustion.
- Learn in depth the various stages and performance and emission characteristics of liquid fuels (alcohols, bio diesels), gaseous fuels (H2, CNG, LPG) and electric and hybrid vehicles.

5. **Course Outcomes**

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Understand the fuel economy, the fuel conservation and the air fuel ratio, carburetors and various types of fuel injection system	**K2**
C02	Know the properties, performance and emission characteristics of liquid fuels like gasoline , alcohol , vegetable oils in both SI and CI engines	**K4**
C03	Know the properties, performance and emission characteristics of gaseous fuels like LPG, CNG, and HYDROGEN.	**K4**
C04	Know the modification of SI and CI engines for various alternative fuels.	**K3**
C05	Familiarize the electric , hybrid and solar powered vehicle	**K4**

6. **Correlation of COs with Programme Outcomes**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	L	H	H			M		L	L	H	M
CO2	H	H	M	L	H	M			M		L	L	H	H
CO3	H	H	M	L	H	M			M		L		M	H
CO4	H	H	H	L	H	H			M		L	L	H	M
CO5	H	H	H	L	H	H			M		L	L	H	M

H- Strong; M-Medium; L-Low

7. **Course Content**

UNIT I FUEL ECONOMY **L-9**

Introduction - Air-Fuel Mixtures and Mixture Requirements - Analysis of Single Jet Carburetor - Exact Analysis of a Carburetor - Fuel Requirements of S.I. Engines. Devices to Meet the Requirements of an Ideal Carburetor, Petrol Injection System, Electronic Fuel Injection System and Rotary Gate Meters Fuel in Injection System. Requirements of a Diesel Injection System, Heat Release Pattern and Fuel Injection, Fuel Spray Patterns, S/V Ratio of Combustion Chamber and Surface Profile of Combustion Chamber.

UNIT II ALCOHOLS AS FUELS **L-9**

Alternative Fuels - Availability of Different Alternative Fuels for Engines. Alcohols – Properties, Production Methods and Usage in Engines. Blending - Dual Fuel Operation - Surface Ignition, Spark Ignition and Oxygenated Additives. Modification Required for SI and CI Engines. Performance, Combustion and Emission Characteristics in Engines. Issues & Limitation in Alcohols.

UNIT III VEGETABLE OILS AS FUELS **L-9**

Vegetable Oils and their Important Properties. Methods of Using Vegetable Oils – Blending, Preheating, Transesterification and Emulsification – Performance, Combustion and Emission Characteristics in Diesel Engines. Modification Required for SI and CI Engines. Issues & Limitation in Vegetable Oils.

UNIT IV HYDROGEN AS ENGINE FUEL **L- 9**

Hydrogen – Properties, Problems, Production Methods, Storage and Safety Aspects. Issues & Limitation in Hydrogen. Methods of Using Hydrogen in Engines. Modification Required for SI and CI Engines. Performance, Combustion and Emission Characteristics In Engines.

UNIT V BIOGAS, NATURAL GAS AND LPG AS FUELS **L-9**

Biogas, Natural Gas and LPG – Properties and Production Methods. CO_2 and H_2S Scrubbing in Biogas, Modifications Required for Use in Engines- Performance, Combustion and Emission Characteristics in Engines. Issues & Limitation in Gaseous Fuels.

TOTAL= 45 Periods

8. Text Book

1. Richard.L. Bechtold- Alternative Fuels Guide Book- SAE International Warrendale-1997.

2. Thipse.S.S., Alternative Fuels; Concepts, Technologies and Developments, Jaico Book Distributors, 2010
3. Gajendra Babu, M. K. and Subhramanian, K. A., Alternative Transportation Fuels, CRC Press, 2013

9. References

1. MaheswarDayal- Energy today & Tomorrow-I&B Horishr India_1982.
2. Nagpal-Power plant engineering- Khanna Pulisher-1991
3. SAE Paper No.840367,841333,841334,841156, Transactions,SAE, USA

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20				
Understand	80	30		10	30
Apply			20	40	20
Analyse		70	80	50	50
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	60	60
Analyse	40	40
Evaluate		
Create		

11. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Introduction, air-fuel mixtures and mixture requirements	1	Lecture with discussions/ Seminar/ Assignment
2	Analysis of single jet carburetor, exact analysis of a carburetor	2	
3	Fuel requirements of S.I. engines	1	
4	Devices to meet the requirements of an ideal carburetor, petrol injection system	1	

S.No	Topics to be covered	No. of periods	Content Delivery Method
5	Electronic fuel injection system, and rotary gate meters fuel in injection system	2	
6	Requirements of a diesel injection system, Heat release pattern and fuel injection, fuel spray patterns	1	
7	S/V ratio of combustion chamber, and surface profile of combustion chamber	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
8	Alternative fuels. Availability of different alternative fuels for engines	1	Lecture with discussions/ Seminar/ Assignment
9	Alcohols – Properties, Production methods and usage in engines	2	
10	Blending, dual fuel operation, surface ignition	1	
11	Spark ignition and oxygenated additives	1	
12	Modification required for SI and CI Engines	1	
13	Performance, combustion and emission Characteristics in engines	2	
14	Issues & limitation in alcohols	1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
15	Vegetable oils and their important properties	1	Lecture with discussions/ Seminar/ Case Studies/ Assignment
16	Methods of using vegetable oils – Blending, preheating	2	
17	Transesterification and emulsification	1	
18	Performance, combustion and emission Characteristics in diesel engines	2	
19	Modification required for SI and CI Engines	2	
20	Issues & limitation in Vegetable Oils	1	
	UT-II (CO3)		
	Unit IV	**(9)**	
21	Hydrogen – Properties, problems, Production methods	2	Lecture with discussions/ Seminar/ Case Studies/ Assignment
22	Storage and safety aspects	1	
23	Issues & limitation in Hydrogen	1	
24	Methods of using hydrogen in engines	2	
25	Modification required for SI and CI Engines	1	
26	Performance, combustion and emission Characteristics in engines	2	
	Unit V	**(9)**	
27	Biogas, Natural gas and LPG – Properties and production methods	2	Lecture with discussions/ Seminar
28	CO2 and H2S scrubbing in Biogas	2	
29	Modifications required for use in Engines	2	
30	Performance, combustion and emission Characteristics in engines	2	
31	Issues & limitation in Gaseous fuels	1	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

		L	T	P	C
1152AU104	**ENGINE TESTING AND CERTIFICATION**	**3**	**0**	**0**	**3**

1. Preamble

This course Engine Testing & Certification imparts knowledge in the area of testing and validation of IC Engines. It enables the learners to expertise themselves in facility engineering, measurements & calibration of equipments used in test cell and analysis of data

2. Pre-Requisite

1151AU318 Engine performance and emission testing lab

1151AU216 Automotive fuels, lubricants and Coolants

3. Links to Other Courses

Automotive Emission and Control

4. Course Educational Objectives

Students undergoing this course are expected to

- Develop in depth knowledge of Engine Testing & Evaluation techniques
- Understand the standards & directives for various types of engine testing
- Develop knowledge on measurements and calibration techniques

5. Course Outcomes:

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Illustrate the requirements of Engine Test Cell Facilities	K2
CO2	Generalize the theory of dynamometers & Calibration procedure	K2
CO3	Explain the test standards, full & part throttle performance & maintenance	K2
CO4	Summarize the Engine Emission Measurement for various driving cycles	K2
CO5	Discuss the advanced engine monitoring devices such as combustion photography, swirl measurement and gas exchange process.	K2

6. Correlation of COs with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	M	M		L	M		M	L	M	H
CO2	H	H	H	M	M	M		L	M		M	L	M	H
CO3	H	H	H	M	M	M		L	M		M	L	M	H

CO4	H	H	H	M	M	M		L	M		M	L	M	M
CO5	H	H	H	M	M	M		L	M		M	L	H	H

H- High; M-Medium; L-Low

7. Course Content

UNIT I ENGINE TEST FACILITIES L-9

Test Cell Requirements - Cell Console & Control Room, Ventilation, Air Conditioning & Exhaust, Cooling, Lubrication/Fuel Supply Systems, Noise & Vibration Control in Test Cells -Electrical Systems.

UNIT II ENGINE DYNAMOMETER & TESTS EQUIPMENTS L-9

Engine Dynamometers, Types of Dynamometers, Dynamometer Panels, Engine Controllers, Data Acquisition System, Fuel Consumption Meter, Air Fuel Ratio Measurement, Oil Consumption Measurement, Temperature & Pressure Measurement, Humidity Measurement, Calibration & Maintenance.

UNIT III ENGINE MEASUREMENTS L-9

Engine Test Standards, Full Throttle & Part Throttle Performance, Road Load Testing, Friction Measurement, Durability, Maintenance.

UNIT IV ENGINE EMISSION MEASUREMENTS IN VARIOUS MODES L-9

Emission Analyzers, Emission Cycles for Commercial Vehicles, Tractors & Gensets, Steady State and Transient Cycles, Dilution Tunnel, Particulate Emissions, Calibration and Maintenance.

UNIT V ADVANCED ENGINE TESTING L-9

Use of Special Equipments, Fuel Injection Pressure, Needle Lift, Combustion Photography, Swirl Measurement.

TOTAL: 45 periods

8. Text Books:

1. A.J.Martyr, M.A.Plint, Engine Testing Theory and Practice, SAE International, Third Edition, 2007.
2. Michael James Plint & Tony Martyr, "Engine Testing - Theory & Practice", 3rd Edition, SAE International, 2007.

9. References:

7. HenizHeisler, "Advanced Engine Technology", Vol.1, SAE International 2002
8. Richard D Atkins, "An Introduction to Engine Testing & Development", ISBN 978-0-7680-2099-1, SAE International 2009.

10. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	

Remember	40	60	20	10	10
Understand	60	40	80	90	90
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	**Assignments**	
	I (CO1 &CO2) (Max marks in %)	**II (CO3&CO4) (Max marks in %)**
Remember		
Understand		
Apply	60	40
Analyse	40	60
Evaluate		
Create		

11. Lecture plan

S.No	**Topics to be covered**	**No. of periods**	**Content Delivery Method**
	Unit –I	**(9)**	
1	Test cell requirements, cell console & control room	2	Lecture with discussions/ Seminar/ Assignment
2	Ventilation	1	
3	Air conditioning & exhaust	1	
4	Cooling, lubrication/fuel supply systems	2	
5	Noise & vibration control in test cells	2	
6	Electrical systems	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
7	Engine dynamometers, types of dynamometers	1	Lecture with discussions/ Seminar/ Assignment
8	Dynamometer panels, Engine controllers	1	
9	Data acquisition system	1	
10	Fuel consumption meter, air fuel ratio measurement	2	
11	Oil consumption measurement	1	
12	Temperature & pressure measurement	1	
13	Humidity measurement	1	
14	Calibration & maintenance	1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
15	Engine test standards	1	Lecture with discussions/ Seminar/ Case Studies/ Assignment
16	Full throttle & part throttle performance	2	
17	Road load testing	2	
18	Friction measurement	2	
19	Durability, maintenance	2	

S.No	Topics to be covered	No. of periods	Content Delivery Method
	UT-II (CO3)		
	Unit - IV	**(9)**	
20	Emission analyzers	1	Lecture with discussions/ Seminar/ Case Studies/ Assignment
21	Emission cycles for commercial vehicles	1	
22	Emission cycles for tractors &gensets	2	
23	Steady state and transient cycles	2	
24	Dilution tunnel	1	
25	Particulate emissions	1	
26	Calibration and maintenance	1	
	Unit -V	**(9)**	
27	Use of special equipments	1	Lecture with discussions/ Seminar
28	Fuel injection pressure	2	
29	Needle lift	2	
30	Combustion photography	2	
31	Swirl measurement	2	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

		L	T	P	C
1152AU105	**ADVANCED THEORY OF I.C. ENGINES**	**3**	**0**	**0**	**3**

1. Preamble

This course imparts knowledge in the advanced developments in automobiles, engines and various emission controlling technologies.

2. Prerequisite

1151AU107 IC Engines

3. Course Educational Objectives

Students undergoing this course are expected to:

- Gain knowledge about the advanced theory and working of I.C engines.
- Express the phenomena of combustion and modeling.

4. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the various working cycles of engine.	K2
CO2	Describe the various types of combustion in IC engines.	K2
CO3	Illustrate the engine combustion parameters.	K3
CO4	Describe the different types of modern engines.	K2
CO5	Explain the modern electronic engine management system (EMS) of IC engines.	K2

(K2 – Understand; **K3** – Apply)

5. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	M	M	L	L	M	L	L	L	M	H
CO2	H	H	H	M	M	M	L		M	L	L	L	M	H
CO3	H	H	H	M	M	M	H		M	L	L	L	M	H
CO4	H	H	H	M	M	M	H		M	L	L	L	M	H
CO5	H	H	H	M	M	M	H		M	L	L	L	M	H

H- High; M-Medium; L-Low

6. Course Content

UNIT I COMBUSTION OF FUELS **L-9**

Chemical Composition and Molecular Structure of Hydrocarbon Fuels. Combustion Stoichiometry of Hydrocarbon Fuels – Chemical Energy and Heat of Reaction Calculations – Chemical Equilibrium and Adiabatic Flame Temperature Calculation. Theory of SI and CI Engine Combustion – Flame Velocity and Area of Flame Front. Fuel Spray Characteristics – Droplet Size, Depth of Penetration and Atomization.

UNIT II ENGINE CYCLE ANALYSIS **L-9**

Ideal Air, Fuel Air Cycle and Actual Cycle Analysis. Progressive Combustion Analysis in SI Engines. Parametric Studies on Work Output, Efficiency and Other Engine Performance.

UNIT III COMBUSTION MODELING **L-9**

Basic Concepts of Engine Simulation – Governing Equations, Classification of Engine Models-Thermodynamic Models for Intake and Exhaust Flow Process – Quasi Steady Flow - Filling and Emptying - Gas Dynamic Models. Thermodynamic Based in Cylinder Models for SI Engine and CI Engines.

UNIT IV – NONCONVENTIONAL IC ENGINES **L-9**

LHR Engines, Surface Ignition Concept and Multi Fuel Engines, Stratified Charge and Lean Burn Engines, Performance and Emission Characteristics, Merits and Demerits of HCCI, GDI, RCCI, GDCI, CRDI, Lean Burn Engines

UNIT V-ELECTRONIC ENGINE MANAGEMENT **L-9**

Computer Control of SI & CI Engines for Better Performance and Low Emissions. Closed Loop Control of Engine Parameters of Fuel Injection And Ignition.

Total: 45 Periods

7. Text Books:

1. Ganesan .V - "IC Engines" - Tata McGraw-Hill, 2012.
2. John B. Heywood, "Internal Combustion Engine Fundamentals", McGraw-Hill Automotive Technology Series ISBN 0-07-1000499-8, 1988.
3. B.P.Pundir, "IC Engines-Combustion and Emissions", 1st ed., Narosa Publishing House, New Delhi

8. References:

1. Richard Stone – "Introduction to IC Engines" – 2nd edition – Macmillan – 1992.
2. BOSCH hand book, edition: 2012

9. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20			20
Understand	80	80	30	70	60
Apply			70	30	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	50	50
Analyse	50	50
Evaluate		
Create		

10. Lecture plan:

S.NO	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Chemical composition and molecular structure of hydrocarbon fuels	1	Lecture with discussions/ Seminar/ Assignment
2	Combustion Stoichiometry of hydrocarbon fuels	1	
3	Chemical energy and heat of reaction calculations	1	
4	Chemical equilibrium and adiabatic flame temperature calculation	2	
5	Theory of SI and CI engine combustion	1	
6	Flame velocity and area of flame front	1	
7	Fuel spray characteristics	1	
8	Droplet size, depth of penetration and atomization	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
9	Ideal air, fuel air cycle and actual cycle analysis	2	Lecture with discussions/ Seminar/ Assignment
10	Progressive combustion analysis in SI engines	2	
11	Parametric studies on work output	1	
12	Parametric studies on efficiency	2	
13	Other engine performance	2	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
14	Basic concepts of engine simulation	1	Lecture with discussions/ Seminar/ Assignment
15	Governing equations	1	
16	Classification of engine models-Thermodynamic models for Intake and exhaust flow process	2	
17	Quasi steady flow	1	
18	Filling and emptying, Gas dynamic Models	2	
19	Thermodynamic based in cylinder models for SI engine and CI engines	2	
	UT-II (CO3)		
	Unit IV	**(9)**	

S.NO	Topics to be covered	No. of periods	Content Delivery Method
20	LHR engines, surface ignition concept and multi fuel engines	2	Lecture with discussions/ Seminar/ Assignment
21	Stratified charge and lean burn engines	2	
22	Performance and emission characteristics, merits and demerits of HCCI, GDI	2	
23	Performance and emission characteristics, merits and demerits of RCCI,GDCI,CRDI	2	
24	Lean burn engines	1	
	Unit V	**(9)**	
25	Computer control of SI engines for better performance and low emissions	3	Lecture with discussions/ Seminar
26	Computer control of CI engines for better performance and low emissions	3	
27	closed loop control of engine parameters of fuel injection and ignition	3	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

		L	T	P	C
1152AU125	**SUPER CHARGING & TURBO CHARGING**	**3**	**0**	**0**	**3**

1. Preamble

The course Super Charging & Turbo Charging is to impart knowledge about supercharger and turbocharger to the students.

2. Pre-requisite

NIL

3. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Know the principles of supercharging	K2
C02	Study about performance and various types of supercharger	K2
C03	Know the principles of turbocharging	K2
C04	Understand the development of turbocharging systems	K2
C05	Understand the concept of matching turbocharger to the engine	K2

4. Correlation with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	L	H							M	M
CO2	H	H	H	M	L	H							L	M
CO3	H	H	H	M	L	H							M	M
CO4	H	H	H	M	L	H							M	M
CO5	H	H	H	M	L	H							M	M

H- High; M-Medium; L-Low

5. Course content

UNIT I SUPERCHARGING **L-9**

Objectives - Effects on Engine Performance - Engine Modification Required - Thermo-Dynamics of Mechanical Supercharging and Turbocharging - Turbocharging Methods - Engine Exhaust Manifolds Arrangements.

UNIT II SUPERCHARGERS **L-9**

Types Of Compressors - Positive Displacement Blowers - Centrifugal Compressors - Performance Characteristic Curves - Suitability For Engine Application - Surging - Matching Of Supercharger Compressor And Engine - Matching Of Compressor, Turbine Engine.

UNIT III TURBOCHARGING **L-9**

Turbocharging Requirements - The Principles of Operation of Turbo Machines - Exhaust Gas Energy Utilization - Charge Air Cooling and Other Applications of Turbochargers.

UNIT IV TURBOCHARGING SYSTEM DEVELOPMENTS **L-9**

Exhaust Waste Gate - Variable Geometry Systems - Turbo Compounding - Waste Gate - Variable Geometry and Compound Systems Compared - Exhaust Gas Recirculation - Electric Drive Turbocharger - Two-Stage Or Series - Turbo Charging - Sequential Turbo Charging –Complex - Hyper Bar And Other Systems

UNIT V MATCHING THE ENGINE AND THE TURBOCHARGER L-9

Introduction - Matching an Engine and Turbocharger at a Given Operating Condition - Modeling a Turbocharged Engine - Turbocharged Engine Operation

Total: 45 periods

6. Text Book

1. Vincent, E.T., Supercharging the I.C. Engines, McGraw-Hill.
2. Watson. and Janota, M.S., Turbocharging the I.C. Engine, MacMillan Co.,1982.

7. References

1. Obert, E.F., Internal Combustion Engines and Air Pollution, Intext Education Publishers, 1980.
2. Richard Stone, Internal Combustion Engines, SAE, 1992.
3. Vincent, E.T., Supercharging the I.C.Engines, McGraw-Hill.
4. Watson. and Janota, M.S., Turbocharging the I.C. Engine, MacMillan Co.,1982.

8. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	10	10	15
Understand	80	80	90	90	85
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	50	60
Analyse	50	40
Evaluate		
Create		

9. Lecture plan

S. No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Objectives - Effects on engine performance	1	Lecture with discussions/ Seminar/ Assignment
2	Engine modification required	2	
3	Thermo-dynamics of Mechanical supercharging and Turbocharging.	2	
4	Turbocharging methods	2	
5	Engine exhaust manifolds arrangements.	2	
	UT-I (CO1)		
	Unit –II	**(9)**	
6	Types of compressors	1	Lecture with discussions/ Seminar/ Assignment
7	Positive displacement blowers, Centrifugal compressors	2	
8	Performance characteristic curves, Suitability for engine application	2	
9	Surging - Matching of supercharger compressor and Engine	2	
10	Matching of compressor, Turbine Engine.	2	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
11	Turbocharging requirements	2	Lecture with discussions/ Seminar/ Assignment
12	The principles of operation of turbo machines	2	
13	Exhaust gas energy utilization,	1	
14	Charge air cooling.	2	
15	Applications of turbochargers	2	
	UT-II (CO3)		
	Unit IV	**(9)**	
16	Exhaust waste gate, Variable geometry systems,	1	Lecture with discussions/ Seminar/ Assignment
17	Turbo compounding, Waste gate,	1	
18	Variable geometry, and compound systems compared,	2	
19	Exhaust gas recirculation, Electric drive turbocharger	2	
20	Two-stage, or series, turbo charging, Sequential turbo charging, Complex	2	
21	Hyper bar and other systems	1	
	Unit V	**(9)**	
22	Introduction.	1	Lecture with discussions/ Seminar
23	Matching an engine and turbocharger at a given operating condition.	2	
24	Modeling a turbocharged engine,	2	
25	Turbocharged engine operation.	2	
26	Turbocharged engine operation.	2	
	MT – II (CO3, CO4, CO5)		

S. No	Topics to be covered	No. of periods	Content Delivery Method
Total		**45**	

		L	T	P	C
1152AU126	**ENGINE TRIBOLOGY**	**3**	**0**	**0**	**3**

1. Preamble

The course explains the range of surface treatments and advanced coatings that are designed to minimize wear, friction and surface oxidation / corrosion in IC engines.

2. Pre-requisite

NIL

3. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Understand and perform basic design calculations of elastohydrodynamic lubrication and contact mechanics problems, including rolling bearing, gears and cams contacts	K2
C02	Calculate surface topographical parameters of Surface properties & Friction	K2
C03	Understand the wear theories, types of wear, mechanism, factors and selection of materials	K2
C04	Understand the basic design calculations of hydrodynamic lubrication problems, including thrust bearings and journal bearings	K2
C05	Understand Rheodynamics (Static) Lubrication characteristics, materials in extreme environments	K2

4. Correlation with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	L	H							M	M
CO2	H	H	H	M	L	H							M	M
CO3	H	H	H	M	L	H							M	M
CO4	H	H	H	M	L	H							M	M
CO5	H	H	H	M	L	H							M	M

H- Strong; M-Medium; L-Low

5. Course content

UNIT I INTRODUCTION **L-9**

Introduction of Tribology - General Tribological Considerations in the Design of Bearings, Gears, Cams, Reciprocating Components. Engine Tribology Basics - Tribological Aspects of Engine Components Such as Bearings, Piston Assembly, Valve Train and Drive Train Components.

UNIT II SURFACE PROPERTIES & FRICTION L-9

Surface Properties: Surface Properties of Metals, Composites, Surface Texture Measurement and Assessment, Statistical Methods of Surface Texture Assessment. Friction: Theories of Friction, Sliding Friction – Rolling Friction Characteristics of Common Metals and Non-Metals – Friction under Different Environments. Engine Friction – Losses and Engine Design Parameters.

UNIT III WEAR AND CRACKING L-9

Wear Theories - Types of Wear and Their Mechanism, Factors Affecting Wear, Selection Of Materials For Different Wear Situations, Measurement Of Wear, Tribometers And Tribometry. Engine Wears Mechanisms, Wear Resistant Materials, Coatings And Failure Mode Analysis.

UNIT IV LUBRICATION & LUBRICANTS L-9

Lubrication: Hydrodynamics, basic concepts, generalized Reynolds equation, types of bearings, Hydrostatic bearing -basic concepts, bearing pads, flat, conical and spherical pad thrust bearing, multi-recess journal and thrust bearings, air and gas lubricated bearings.

Lubricants: Type of lubricants, properties and testing, service, lubrication of tribological components, lubrication system, lubricant monitoring, SOAP, ferrography and other rapid testing methods for lubricants contamination.

Unit V-Rheodynamics (Static) Lubrication L-9

Non-Newtonian fluids, characteristics, general recommendations of lubricants, SAE & other cloud numbers, thixotopic materials and Bingham solids, grease lubrication, tribology of components in extreme environments like vacuum, pressure and temperature

TOTAL: 45 Periods

6. Text Books

1 Bowden, F.P. & Tabor, D., “Friction and Lubrication of Solids”, Oxford University Press 1986.
2 Ernest Rabinowiez z, “ Friction and Wear of Materials” Inter science Publishers, 1995.
3 Neale, M.J., Tribology – Hand Book, Butterworth, 1995.
4 Fuller D.D., Theory and Practice of Lubrication of Engineers: John Wiley Sons, 1984.

7. References

1. Cameron, A. "Basic Lubrication Theory", Ellis Herward Ltd. Uk, 1981.
2. Hulling, J. (Editor) --"Principles of Tribology", Macmillan, 1984.
3. Williams J.A. "Engineering Tribology", Oxford Univ. Press, 1994.
4. Neale M.J, "Tribology Hand Book ", Butterworth Heinemann, 1995.
5. Bhushan. B. Modern Tribology Handbook, Volumes 1 & 2. - Boca Raton A.O.: Crc Press, 2000. – 1760 P.
6. Stachowiak G., Batchelor A.W. Engineering Tribology. - New York A.O.: Butterworth-Heinemann; 2001. – 744.
7. Garkunov D.N. Scientific Discoveries in Tribo-Technologies. No-Wear Effect under Friction. Hydrogen Wears of Metals. - Moscow: Maa Publishing House; 2007.

8. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	10	10	15
Understand	80	80	90	90	85
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	50	60
Analyse	50	40
Evaluate		
Create		

9. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Introduction of Tribology	1	Lecture with discussions/ Seminar/ Assignment
2	General tribological considerations in the design of bearings, gears, cams, reciprocating components	2	
3	Engine Tribology Basics	2	
4	Tribological aspects of engine components such as bearings, piston assembly	2	
5	Valve train and drive train components	2	
	UT-I (CO1)		
	Unit –II	**(9)**	
6	Surface properties of metals, composites	1	Lecture with discussions/ Seminar/ Assignment
7	Surface texture measurement and assessment, statistical methods of surface texture assessment.	2	
8	Theories of friction, Sliding friction – Rolling friction	2	

S.No	Topics to be covered	No. of periods	Content Delivery Method
9	Characteristics of common metals and non-metals – friction under different environments.	2	
10	Engine friction – Losses and engine design parameters.	2	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
11	Wear theories, types of wear and their mechanism, factors affecting wear	2	Lecture with discussions/ Seminar/ Assignment
12	Selection of materials for different wear situations, measurement of wear	2	
13	Tribometers and Tribometry	1	
14	Engine wears mechanisms, wear resistant materials	2	
15	Coatings and failure mode analysis.	2	
	UT-II (CO3)		
	Unit IV	**(9)**	
16	Hydrodynamics, basic concepts	1	Lecture with discussions/ Seminar/ Assignment
17	Generalized Reynolds equation, types of bearings,	1	
18	Hydrostatic bearing -basic concepts, bearing pads, flat, conical and spherical pad thrust bearing	2	
19	Multi-recess journal and thrust bearings, air and gas lubricated bearings.	2	
20	Type of lubricants, properties and testing, service, lubrication of tribological components, lubrication system, lubricant monitoring,	2	
21	SOAP, ferrography and other rapid testing methods for lubricants contamination.	1	
	Unit V	**(9)**	
22	Non-Newtonian fluids, characteristics	1	Lecture with discussions/ Seminar
23	General recommendations of lubricants	2	
24	SAE & other cloud numbers	2	
25	Thixotopic materials and Bingham solids, grease lubrication	2	
26	Tribology of components in extreme environments like vacuum, pressure and temperature	2	
	MT – II (CO3, CO4, CO5)		
	Total	**45**	

		L	T	P	C
1152AU106	**TWO AND THREE WHEELERS**	**3**	**0**	**0**	**3**

1. Preamble

This course makes the students to know and understand the constructional details operating characteristics and vehicle design aspects of two and three wheeled vehicles.

2. Pre requisite

1151AU214 Automotive chassis

3. Course Educational Objectives

Students undergoing this course are expected to

- To develop the basic knowledge of the students in constructional details of two and Three Wheelers.
- To develop the skills of the students in the operating principles.

4. Course Outcomes:

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Know the working of two and four stroke engines	K2
C02	Explain the functioning of clutch and gear box	K2
C03	Know the wheels, tyres, suspensions and braking systems	K2
C04	Familiarize the latest models of two wheelers	K2
C05	Explain the operations of three wheelers and latest models of three wheelers	K2

5. Correlation of COs with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	M	M	H		H					M	M	M
CO2	H	M	M	M	H		H					M	L	M
CO3	H	M	M	M	H		H					M	M	M
CO4	H	M	M	M	H		H					M	M	M
CO5	H	M	M	M	H		H					M	M	M

H- Strong; M-Medium; L-Low

6. Course Content:

UNIT I POWER UNIT **L-9**

Two Stroke SI Engine, Four Stroke SI Engine - Merits and Demerits. Symmetrical and Unsymmetrical Port Timing Diagrams. Types of Scavenging Processes: Merits and Demerits, Scavenging Pumps. Rotary Valve Engine, Fuel System, Lubrication System. Magneto Coil and Battery Coil Spark Ignition System, Electronic Ignition System. Starting System - Kick Starter System.

UNIT II CHASSIS AND SUB-SYSTEMS **L-9**

Mainframe and Its Types - Chassis and Shaft Drive - Single, Multiple Plates and Centrifugal Clutches. Gear Box and Gear Controls - Front and Rear Suspension Systems - Shock Absorbers - Panel Meters and Controls on Handle Bar.

UNIT III BRAKES, WHEELS AND TYRES L-9

Drum Brakes, Disc Brakes, Front and Rear Brake Links, Layouts - Spoke Wheel, Cast Wheel, Disc Wheel and Disc Types - Tyres and Tubes.

UNIT IV TWO WHEELERS L-9

Study and Comparison of Specification and Features of Major Indian Models of Mopeds, Scooters and High Performance Vehicles. Injection Systems, Silencer Design and After Treatment Devices.

UNIT V THREE WHEELERS L-9

Study and Comparison of Specification and Features of Indian Models. Auto Rickshaws, Pickup Van, Delivery Van and Trailer. Maintenance & Fault Tracing, Injection Systems, Silencer Design and After Treatment Devices

Total: 45 Periods

7. Textbooks

1. Irving.P.E. - Motor Cycle Engineering - Temple Press Book, London – 1992.
2. The Cycle Motor Manual - Temple Press Limited, London – 1990.

8. References

1. Encyclopedia of Motorcycling - 20 volume Marshall, Cavensih, UK – 1989.
2. BrayantR.V,Vespa - Maintenance and Repair Series – S.Chand& Co., New Delhi – 1986
3. Raymond Broad Lambretta - A Practical Guide to maintenance and repair – S.Chand& Co., New Delhi – 1987

9. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	40	30	40	20	50
Understand	60	70	60	80	50
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments

	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	30	30
Analyse	70	70
Evaluate		
Create		

10. Lecture plan:

S.No.	Topic	No. of periods	Content Delivery methods
	Unit-I	**(9)**	
1	Introduction	1	Lecture with discussion/ Assignment/ Seminar/ Case studies
2	Two stroke SI engine	1	
3	Four stroke SI engine	1	
4	Merits and demerits	1	
5	Symmetrical and unsymmetrical port timing diagrams	1	
6	Types of scavenging processes	1	
7	Merits and demerits, scavenging pumps	1	
8	Rotary valve engine, Fuel system. Lubrication system	1	
9	Magneto coil and battery coil spark ignition system, electronic ignition system. Starting system, Kick starter system.	1	
	UT-I (CO1)		
	Unit–II	**(9)**	
10	Mainframe and its types	1	Lecture with discussion/ Assignment/ Seminar/ Case studies
11	Chassis and shaft drive	1	
12	Single, multiple plates and centrifugal clutches	1	
13	Gear box and gear controls	1	
14	Front and rear suspension systems	1	
15	Front and rear suspension systems	1	
16	Shock absorbers	1	
17	Panel meters	1	
18	Controls on handle bar	1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
19	Drum brakes	1	Lecture with discussion/ Assignment/ Seminar/ Case studies
20	disc brakes	1	
21	front and rear brake links	1	
22	layouts	1	
23	Spoked wheel	1	
24	cast wheel	1	

S.No.	Topic	No. of periods	Content Delivery methods
25	disc wheel	1	
26	disc types	1	
27	Tyres and tubes	1	
	UT-II (CO3)		
	Unit IV	**(9)**	
28	Case study of major Indian models of motorcycles	1	Lecture with discussion/ Assignment/ Seminar/ Case studies
29	Case study of major Indian models of motorcycles	1	
30	scooters and mopeds	1	
31	TVS mopeds	1	
32	TVS motorcycles	2	
33	Hero motorcycles	1	
34	Bajaji scooters and motorcycles	1	
35	Yamaha, Royal Enfield motorcycles	1	
	Unit V	**(9)**	
36	Case study of Indian models	1	Lecture with discussion/ Assignment/ Seminar/ Case studies/ Group discussion
37	Case study of Indian models	1	
38	Auto rickshaws	1	
39	pickup van	1	
40	delivery van	1	
41	trailer	2	
42	Maintenance of three wheeler	1	
43	Fault tracing trouble shooting	1	
	MT – II (CO3, CO4, CO5)		
	Total	**45**	

1152AU107 COMPUTATIONAL FLUID DYNAMICS **L T P C**

3 0 0 3

1. Preamble

This Course provides an in-depth introduction to Computational Fluid Dynamics, Principles of governing equations and their derivations, classification of partial differential equations (PDEs), boundary conditions, and analysis techniques used in computational solutions of fluid mechanics problems. It also emphasis on introductory concepts in finite difference as applied to PDEs in fluid mechanics; fundamentals of spatial discretization and error and stability analyses; Basics for grid generation techniques.

2. Pre-Requisites

1151AU213 Fluid Mechanics & Machinery

3. Links To Other Courses

- Finite element analysis

4. Course Educational Objectives

Students undergoing this course are expected:

- To understand the governing equations of fluid flow, incompressible inviscid flow.
- To understand the behavior of airflow over streamlined and bluff bodies with particular emphasis on 2D circular cylinder, airfoil and wing sections in the incompressible flow regime.

5. Course Outcomes :

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Familiar with the differential equations for flow phenomena and numerical methods for their solution	K3
CO2	Familiar with the basic procedures and able to select suitable grid generation techniques for fluid flow	K4
CO3	Discretize governing equations using Finite difference methods and carry out numerical error and stability analyses.	K3
CO4	Identify the suitable techniques to analyse the Strong and Weak Formulations of a Boundary Value Problem	K3
CO5	Apply finite volume techniques to solve 1-D, 2-D and Non linear system problems	K3

6. Correlation of COs with Programme Outcomes :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	H	H			M		L		H	H
CO2	H	H	H	M	H	H			L		L		H	H
CO3	H	H	H	M	H	H			H		L		H	H
CO4	H	H	H	M	H	H			M		L		H	H
CO5	H	H	H	M	H	H			M		L		H	H

H- High; M-Medium; L-Low

7. Course Content

UNIT I FUNDAMENTAL CONCEPTS L-9

Introduction - Basic Equations of Fluid Dynamics - Incompressible In Viscid Flows - Source, Vortex and Doublet Panel, Methods - Lifting Flows Over Arbitrary Bodies - Mathematical Properties of Fluid Dynamics Equations - Elliptic, Parabolic and Hyperbolic Equations - Well Posed Problems - Discretization of Partial Differential Equations. Explicit Finite Difference Methods of Subsonic, Supersonic and Viscous Flows

UNIT II GRID GENERATION L-9

Structured Grids - Types and Transformations - Generation of Structured Grids - Unstructured Grids - Delany Triangulation.

UNIT III DISCRETIZATION L-9

Boundary Layer Equations and Methods of Solution - Implicit Time Dependent Methods For Inviscid and Viscous Compressible Flows - Concept of Numerical Dissipation – Stability Properties of Explicit and Implicit Methods - Conservative Upwind Discretization For Hyperbolic Systems - Further Advantages of Upwind Differencing.

UNIT IV FINITE ELEMENT TECHNIQUES L-9

Overview of Finite Element Techniques in Computational Fluid Dynamics. Strong and Weak Formulations of a Boundary Value Problem.

UNIT V FINITE VOLUME TECHNIQUES L-9

Finite Volume Techniques - Cell Centered Formulation - Lax - Vendoroff Time Stepping - Runge - Kutta Time Stepping - Multi - Stage Time Stepping - Accuracy -. Cell Vertex Formulation - Multistage Time Stepping - FDM -Like Finite Volume Techniques – Central and Up-Wind Type Discretization - Treatment of Derivatives. Flux – Splitting Schemes.Pressure Correction Solvers – SIMPLE, PESO. Vorticity Transport Formulation. Implicit/Semi-Implicit Schemes.

TOTAL: 45 periods

8. Text Books

1. Fletcher, C.A.J., “Computational Techniques for Fluid Dynamics”, Vols. I and II,Springer - Verlag, Berlin, 1988.
2. Muralidhar, K., and Sundararajan, T., “Computational Fluid Flow and Heat Transfer”,Narosa Publishing House, New Delhi, 1995.

3. Ghoshdasdidar, P.S., "Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd., 1998.
4. Subas, V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.

9. References

1. John F. Wendt (Editor), "Computational Fluid Dynamics - An Introduction", Springer – Verlag, Berlin, 1992
2. Charles Hirsch, "Numerical Computation of Internal and External Flows", Vols. I and II. John Wiley & Sons, New York, 1988
3. Klaus A Hoffmann and Steve T. Chiang. "Computational Fluid Dynamics for Engineers", Vols. I & II Engineering Education System, P.O. Box 20078, W. WichitaK.S., 67208 - 1078 USA, 1993
4. Anderson, Jr.D., "Fundamentals of Aerodynamics", McGraw-Hill, 2000

10. Revised Bloom's based Assessment Pattern :

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember					
Understand	20		20	20	10
Apply	80	40	80	80	70
Analyse		60			20
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	80	70
Analyse	20	30
Evaluate		
Create		

11. Lecture plan:

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Introduction - Basic Equations of Fluid Dynamics	1	Lecture with discussions/ Seminar/ Assignment
2	Incompressible In viscid Flows: Source, vortex and doublet panel, methods	1	
3	Lifting flows over arbitrary bodies	1	
4	Mathematical properties of Fluid Dynamics Equations	1	
5	Elliptic, Parabolic and Hyperbolic equations	1	
6	Well posed problems - discretization of partial Differential Equations	1	
7	Explicit finite difference methods of subsonic	1	
8	Explicit finite difference methods of supersonic	1	
9	Explicit finite difference methods of viscous flows	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
10	Structured grids.	2	Lecture with discussions/ Seminar/ Assignment
11	Types and transformations.	2	
12	Generation of structured grids.	2	
13	Unstructured grids.	2	
14	Delany triangulation	1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
15	Boundary layer Equations and methods of solution	1	Lecture with discussions/ Seminar/ Case Studies/ Assignment
16	Implicit time dependent methods for inviscid	1	
17	Implicit time dependent methods for viscous compressible flows	2	
18	Concept of numerical dissipation	1	
19	Stability properties of explicit	1	
20	Stability properties of implicit methods	1	
21	Conservative upwind discretization for Hyperbolic systems	1	
22	Further advantages of upwind differencing	1	
	UT-II (CO3)		
	Unit IV	**(9)**	
23	Overview of Finite Element Techniques in Computational Fluid Dynamics.	3	Lecture with discussions/ Seminar/ Assignment
24	Strong Formulations of a Boundary Value Problem	3	
25	Weak Formulations of a Boundary Value Problem	3	
	Unit V	**(9)**	
26	Finite Volume Techniques	1	Lecture with discussions/ Seminar
27	Cell Centered Formulation - Lax - Vendoroff Time Stepping	1	
28	Runge - Kutta Time Stepping	1	
29	Multi - stage Time Stepping - Accuracy	1	
30	Cell Vertex Formulation	1	
31	Multistage Time Stepping	1	

S.No	Topics to be covered	No. of periods	Content Delivery Method
32	FDM -like Finite Volume Techniques	1	
33	Central and Up-wind Type Discretization - Treatment of Derivatives.	1	
34	Flux – splitting schemes. Pressure correction solvers – SIMPLE, PESO. Vorticity transport formulation. Implicit/semi-implicit schemes	1	
	MT 2 (CO3, CO4, CO5)		
Total		**45**	

		L	T	P	C
1152AU108	**VEHICLE BODY ENGINEERING**	**3**	**0**	**0**	**3**

1. Preamble

This course imparts knowledge in the construction of vehicles, concept aerodynamics, and different types of car and passenger bus bodies.

2. Pre-requisite

1151AU214 Automotive Chassis

3. Links to other courses

- Vehicle Design & Data Characteristics
- Automotive Chassis
- I.C Engines
- Automotive Safety

4. Course Educational Objectives

Students undergoing this course are expected

- To develop the basic knowledge of the students in design of the vehicle body to give maximum comfort for the passengers and exposed to the methods of stream lining the vehicle body to minimize drag.
- To develop the skills of the students in the areas of car body design, bus body design, active and passive safety.

5. Course outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Discuss the different types of car body design and its safety features.	K2
CO2	Select a suitable body optimization techniques to minimize drag and able to describe the wind tunnel testing procedure.	K2
CO3	Classify the various types of bus body construction and able to identify the body layout.	K2
CO4	Describe the different types of commercial vehicles and its design.	K2
CO5	Explain the various types of materials and painting techniques used in automobiles.	K2

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	H			L				L		M	L
CO2	H	H	M	H			L				L		H	M
CO3	H	H	M	H			L				L		M	M
CO4	H	H	M	H			L				L		L	H
CO5	H	H	M	H			L				L		H	H

H- High; M-Medium; L-Low

7. Course content

UNIT I CAR BODY **L-9**

Types - Saloon, Convertibles, Limousine, Estate Car, Racing and Sports Car. Visibility - Regulations, Driver's Visibility, Tests For Visibility, Methods of Improving Visibility and Space In Cars. Safety - Safety Design, Safety Equipments For Cars. Car Body Construction - Design Criteria, Prototype Making, Initial Tests, Crash Tests on Full Scale Model, Dummies and Instrumentation

UNIT II VEHICLE AERODYNAMICS **L-9**

Objectives - Vehicle Drag and Types - Various Types of Forces and Moments, Effects of Forces and Moments, Side Wind Effects on Forces and Moments, Various Body Optimization Techniques For Minimum Drag, Wind Tunnel Testing - Flow Visualization Techniques, Scale Model Testing, Component Balance to Measure Forces And Moments.

UNIT III BUS BODY **L-9**

Types - Mini Bus, Single Decker, Double-Decker, Two Level and Articulated Bus. Bus Body Layout - Floor Height, Engine Location, Entrance and Exit Location, Seating Dimensions. Constructional Details - Frame Construction, Double Skin Construction, Types of Metal Sections Used, Regulations, Conventional And Integral Type Construction.

UNIT IV COMMERCIAL VEHICLE **L-9**

Types of Body - Flat Platform, Drop Side, Fixed Side, Tipper Body, Tanker Body And Haulage Vehicle. Light Commercial Vehicle Body Types. Dimensions of Driver's Seat Relation to Controls. Drivers Cab Design.

UNIT V BODY MATERIALS, TRIM AND MECHANISMS **L-9**

Steel Sheet, Timber, Plastic, GRP, Properties of Materials - Corrosion, Anticorrosion Methods. Selection of Paint And Painting Process. Body Trim Items. Body Mechanisms.

TOTAL: 45 periods

8. Text Books

1. J.Powloski - "Vehicle Body Engineering" - Business Books Ltd, London -1989

9. References

1. Giles.J.C.- "Body construction and design"- Liiffe Books Butterworth & Co. - 1971.
2. John Fenton - "Vehicle Body layout and analysis" - Mechanical Engg. Publication Ltd., London – 1982.

3. Braithwaite.J.B. - "Vehicle Body building and drawing" - Heinemann Educational Books Ltd., London – 1977.

10. Revised Bloom's based Assessment Pattern :

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	40	40	40	40	20
Understand	60	60	60	60	80
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	20	10
Analyse	80	90
Evaluate		
Create		

11. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Types: saloon, convertibles, limousine, estate car, racing and sports car	1	Lecture with discussions/ Seminar/ Assignment
2	Visibility: regulations, driver's visibility	1	
3	Tests for visibility	1	
4	Methods of improving visibility and space in cars	1	
5	Safety: safety design, safety equipments for cars	1	
6	Car body construction; design criteria, prototype making, initial tests	2	
7	Crash tests on full scale model	1	
8	Dummies and Instrumentation	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
9	Objectives, Vehicle drag and types	1	
10	Various types of forces and moments	1	

S.No	Topics to be covered	No. of periods	Content Delivery Method
11	Effects of forces and moments	1	Lecture with discussions/ Seminar/ Assignment
12	Side wind effects on forces and moments	1	
13	Various body optimization techniques for minimum drag	2	
14	Wind tunnel testing: flow visualization techniques	1	
15	Scale model testing	1	
16	Component balance to measure forces and moments	1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
17	Types: mini bus, single decker, double-decker, two level and articulated bus	2	Lecture with discussions/ Seminar/ Assignment
18	Bus body layout; floor height, engine location, entrance and exit location, seating dimensions	2	
19	Constructional details: frame construction, double skin construction	2	
20	Types of metal sections used, Regulations	1	
21	Conventional and integral type construction	2	
	UT-II (CO3)		
	Unit IV	**(9)**	
22	Types of body; flat platform, drop side, fixed side	2	Lecture with discussions/ Seminar/ Assignment
23	Tipper body, tanker body and Haulage vehicle	2	
24	Light commercial vehicle body types	2	
25	Dimensions of driver's seat relation to controls	1	
26	Drivers cab design	2	
	Unit V	**(9)**	
27	Steel sheet, timber, plastic, GRP	2	Lecture with discussions/ Seminar
28	Properties of materials	1	
29	Corrosion, anticorrosion methods	2	
30	Selection of paint and painting process	2	
31	Body trim items.Body mechanisms	2	
	MT – II (CO3, CO4, CO5)		
	Total	**45**	

		L	T	P	C
1152AU109	**OFF HIGHWAY VEHICLES**	**3**	**0**	**0**	**3**

1. Preamble

This course imparts knowledge in the vehicles used for agriculture, army and construction purposes and earth movers.

2. Prerequisite

1151AU214 Automotive Chassis
1151AU108 Automotive Transmission

3. Links to other Courses

Automotive chassis, vehicle body engineering

4. Course Educational Objectives

Students undergoing this course are expected to:

- Gain knowledge about the vehicles used in agriculture, mining and construction.
- Gain knowledge about the working of different systems in special vehicles.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the different types of cranes and compactions used in market and would be in position to select and discuss the right type for the given application	K2
CO2	Explain the different types of excavator and graders, further, would be able to enumerate and explain the different sub systems	K2
CO3	Describe the construction and working of haulage vehicle and lift trucks in the perspective of their applications	K3
CO4	Describe the specifications, functions, merits and demerits of different types and subsystems of rooters, scarifiers and scrapers	K2
CO5	Explain the different types of tractors and other special vehicles in the perspective of different types, application, requirement and availability in the market	K2

(K2 – Understand; **K3** – Apply)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	H	L	H		L	L						M	L
CO2	M	H	L	H		L	L						M	L
CO3	M	H	L	H		L	L						L	L
CO4	M	H	L	H		L	L						M	M
CO5	M	H	L	H		L	L						L	M

H- High; M-Medium; L-Low

7. Course Content

UNIT I CRANES & COMPACTION VEHICLES L-9

CRANES - General Description, Specifications and Functions, Excavator Mounted Cranes, Mobile Cranes With Strut and Cantilever Type Jibs, Tractor Towed and Tractor Mounted Cranes. COMPACTION VEHICLES - General Description, Specification and Functions, Smooth Wheeled Rollers, Pneumatic Tired Rollers, Agricultural Rollers, Sheep's Foot Rollers - Vibrating Compactors.

UNIT II EXCAVATORS & GRADERS L-9

EXCAVATORS: General Description, Specification and Functions, Classification Based on Attachments, Face Shovel, Drag Shovel, Hoe, Drag-Line and Grab or Clam Shell, Advantages and Limitations.

GRADERS: Description, Specification of Tractor Towed Graders and Motor Graders, Classification and Functions of Graders, Functional Details of Spreading, Mixing, Ditching, Bank Sloping, Snow Removal, Stripping, Scarifying and Finishing, Elementary Details of Transmission System (Coupling, Clutches, Gear Box, Driving Axles, Propeller Shafts), Running Gear and Operating Equipment Air Braking System - Hydraulic System and Its Components, Steering System of Lights, Medium and Heavy Graders, Merits and Limitations of Graders.

UNIT III HAULAGE VEHICLES & LIFT TRUCKS L-9

HAULAGE VEHICLES - General Description, Specification and Functions, Self-Propelled and Tractor Towed Haulage Vehicles and Pneumatic – Tires, Dumpers – Front Tipping - Trucks – Rear Tipping, Tractor Towed Semi-Trailers and Trailers (Rear and Side Tipping, Bottom Dumping).

LIFT TRUCKS - General Description, Specification and Functions, Fork Lift Trucks, Alternative Front End Equipment (Attachments) – Jib Arm, Shovel Bucket, Squeeze Clamp, Boom, Fork Extensions, Barrel Forks. Scissors Lift Trucks - Applications in Industry, Advantages and Disadvantages.

UNIT IV ROOTERS AND SCARIFIERS & SCRAPERS L-9

ROOTERS AND SCARIFIERS - General Description, Specification and Functions, Tractor Towed Rooters and Scarifiers {Heavy Duty (Roller)/ Light Duty (Grader)} Back Rippers for Bull and Angle Dozers.

SCRAPERS - General Description, Specification and Functions, Tractor Towed and Motorized Scrapers, Scraper Work in Cutting, Cambering, Side Hill Cutting, Spreading on Embankments, Compaction of Fill Merits and Demerits.

UNIT V TRACTORS & OTHER SPECIAL PURPOSE VEHICLES L-9

TRACTORS - General Description, Specification and Functions, Light, Medium and Heavy Wheeled Tractors, Crawler Tracks Mounted / Wheeled-Bull Dozers, Tilt Dozers and Angle Dozers, Front End Loaders, Factors Affecting Efficiency of Output of Tractors, Simple Problems, Merits and Demerits.

OTHER SPECIAL PURPOSE VEHICLES - Mining and Surveillance General Description, Specification and Functions, Ambulance, Oil Tankers, Surveillance Vehicle, Television Recording Mobile, Reefer Vehicle, Double Decker Bus, Vestibule Bus, Fire Fighting Vehicle

Total: 45 Periods

8. Text Books :

1. Ian Andrew Norman, "Heavy Duty Vehicle systems", third edition, Delmar-Thomson Learning ltd.
2. Robert L Peurifoy, "Construction, planning, equipment and methods" Tata McGraw Hill Publishing company Ltd.
3. Nakra C.P., "Farm machines and equipments" Dhanparai Publishing company Pvt. Ltd

9. References :

1. Her Majesty's Stationery, "Military Engineering – Volume 26".
2. Heinz Heisler, "Vehicle and Engine Technology" second edition, SAE-1999, USA.
3. SAE Handbook Vol. III., Society of Automotive Engineers, 1997

10. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	40	40		20	20
Understand	60	60	30	60	50
Apply			70	20	30
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1(CO1 &CO2) (Max marks in %)	2(CO3&CO4) (Max marks in %)
Remember		
Understand		
Apply	60	40
Analyse	40	60
Evaluate		
Create		

11. Lecture plan:

S. No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I (9)		
1	Cranes: General description, specifications and functions,	1	

S. No	Topics to be covered	No. of periods	Content Delivery Method
2	Excavator mounted cranes	1	Lecture with discussions/ Seminar/ Assignment
3	Mobile cranes with strut and cantilever type jibs	1	
4	Tractor towed and tractor mounted cranes	1	
5	Compaction Vehicles: General description, specification and functions	1	
6	Smooth wheeled rollers	1	
7	Pneumatic tired rollers	1	
8	Agricultural rollers,	1	
9	Sheep's foot rollers ; vibrating compactors	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
10	Excavators: General description, specification and functions	1	Lecture with discussions/ Seminar/ Assignment
11	Classification based on attachments, face shovel	1	
12	Drag shovel, hoe, drag-line, Grab or clam shell, advantages and limitations.	1	
13	GRADERS: Description, specification of tractor towed graders and motor graders	1	
14	Classification and functions of graders, functional details of spreading, mixing, ditching	1	
15	Bank sloping, snow removal, stripping, scarifying, and finishing,	1	
16	Elementary details of transmission system (coupling, clutches, gear box, driving axles, propeller shafts),	1	
17	Running gear and operating equipment air braking system; hydraulic system and its components	1	
18	Steering system of lights, medium and heavy graders, merits and limitations of graders	1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
19	Haulage Vehicles: General description, specification and functions	1	Lecture with discussions/ Seminar/ Case Studies/ Assignment
20	Self-propelled and tractor towed haulage vehicles	1	
21	Pneumatic – tires, dumpers – front tipping	1	
22	Trucks – rear tipping,	1	
23	Tractor towed semi-trailers	1	
24	Trailers (rear and side tipping, bottom dumping). LIFT	1	
25	Trucks: General description, specification and functions,	1	
26	Fork lift trucks, alternative front end equipment (attachments) – jib arm, shovel bucket, squeeze clamp, boom	1	
27	Fork extensions, barrel forks. Scissors lift trucks - applications in industry, advantages and disadvantages	1	
	UT-II (CO3)		
	Unit IV	**(9)**	

S. No	Topics to be covered	No. of periods	Content Delivery Method
28	Rooters and scarifiers: General description, specification and functions,	1	Lecture with discussions/ Seminar/ Case Studies/ Assignment
29	Tractor towed rooters	1	
30	Scarifiers {heavy duty (roller)/ light duty (grader)}	1	
31	Back rippers for bull and angle dozers.	1	
32	Scrapers: General description, specification and functions,	1	
33	Tractor towed and motorized scrapers,	1	
34	Scraper work in cutting, cambering,	1	
35	Side hill cutting, spreading on embankments	1	
36	Compaction of fill merits and demerits	1	
	Unit V	**(9)**	
37	Tractors: General description, specification and functions,	1	Lecture with discussions/ Seminar/ Lecture with demonstration
38	Light, medium and heavy wheeled tractors,	1	
39	Crawler tracks mounted / wheeled-bull dozers, tilt dozers and angle dozers, front end loaders,	1	
40	Factors affecting efficiency of output of tractors, simple problems, merits and demerits.	1	
41	Other special purpose vehicles: General description, specification and functions	1	
42	Ambulance, Oil tankers surveillance vehicle	1	
43	Television recording Mobile	1	
44	Reefer vehicle, Double Decker bus	1	
45	Vestibule bus, Fire fighting vehicle	1	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

		L	T	P	C
1152AU110	**AUTOMOTIVE AERODYNAMICS**	**3**	**0**	**0**	**3**

1. Preamble

The course is meant to give the learners an introduction and an enhancement of their knowledge in the field of vehicle aerodynamics. It includes: overview of fundamentals of fluid mechanics, Boundary layers and Vorticity, Bluff body aerodynamics, Aerodynamic forces on road vehicles; their evaluation and possible strategies for their control. Design aspects of external and internal flows in vehicles.

2. Pre-requisite:

1151AU214 Automotive Chassis

3. Links to other courses

- Vehicle Body Engineering
- Automotive Safety

4. Course Educational Objectives

Students undergoing this course are expected to

- Provide guidance to industry on reducing the aerodynamic drag in heavy truck vehicles
- Develop innovative drag reducing concepts that are operationally and economically sound
- Establish a database of experimental, computational, and conceptual design information
- Demonstrate the potential of new drag-reduction concepts

5. Course Outcomes :

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Evaluate basic fluid theory.	K3
CO2	Apply CFD to a range of problems.	K3
CO3	Understand lift, drag and down force definitions and calculations.	K2
CO4	Demonstrate a knowledge and understanding of aerodynamics in automotive field.	K3
CO5	Explain the principles and functions of wind tunnel.	K2

(K2-understand, K3-Apply, K4-Analysis)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	L					L	L		H	M
CO2	H	H	H	M	L					L	L		H	M
CO3	H	H	H	M	L					L	L		M	M
CO4	H	H	H	M	L					L	L		M	L
CO5	H	H	H	M	L					L	L		M	M

H- High; M-Medium; L-Low

7. Course Content

UNIT I - INTRODUCTION **L-9**

Scope and Historical Development Trends - Fundamental of Fluid Mechanics - Flow Phenomenon Related To Vehicles - External & Internal Flow Problem - Resistance To Vehicle Motion - Performance - Fuel Consumption And Performance - Potential of Vehicle Aerodynamics.

UNIT II - AERODYNAMIC DRAG OF CARS **L-9**

Cars as a Bluff Body - Flow Field Around Car - Drag Force - Types of Drag Force - Analysis of Aerodynamic Drag -Drag Coefficient of Cars - Strategies for Aerodynamic Development - Low Drag Profiles, Lift, Body Styling

UNIT III - SHAPE OPTIMIZATION OF CARS **L-9**

Front End Modification - Front And Rear Wind Shield Angle - Boat Tailing - Hatch Back, Fast Back And Square Back - Dust Flow Patterns at the Rear - Effects of Gap Configuration - Effect of Fasteners.

The Origin of Forces and Moments on Vehicle - Side Wind Problems - Methods to Calculate Forces and Moments - Vehicle Dynamics Under Side Winds - The Effects of Forces and Moments.

UNIT IV- VEHICLE HANDLING **L-9**

Characteristics of Forces and Moments - Dirt Accumulation on the Vehicle - Wind Noise - Drag Reduction in Commercial Vehicles.

UNIT V - WIND TUNNELS FOR AUTOMOTIVE AERODYNAMIC **L-9**

Introduction – Principle of Wind Tunnel Technology – Limitation of Simulation – Stress with Scale Models – Full Scale Wind Tunnels – Measurement Techniques – Equipment and Transducers – Road Testing Methods – Numerical Methods.

Total: 45 Periods

8. Text Book

1. Wolf – Heinrich Hucho, Aerodynamics of Road Vehicles, SAE, **ISBN No:** 978-0-7680-0029-0, 1998.
2. Heinz Heisler, "Advanced Vehicle Technology", second edition, Butterworth – Heinemann, New York, 2002

9. Reference Books

1. Pope. A., Wind Tunnel Testing, John Wiley & Sons, 2nd edition, New York, 1974.
2. Sumantran. V, Gino Sovran, Vehicle Aerodynamics, SAE, 1994

10. Revised Bloom's based Assessment Pattern :

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember			50		15
Understand	10	10	50	50	15
Apply	90	90		50	70

Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	80	80
Analyse	20	20
Evaluate		
Create		

11. Lecture plan

S.No	Topics to be covered	No. of periods	Content delivery method
	UNIT -I	**(9)**	
1	Scope – historical development trends	1	Lecture with Discussion /Assignment/ Seminar
3	Fundamentals of fluid mechanics	1	
4	Flow phenomenon related to vehicles	2	
5	External flow problems.	2	
6	Internal flow problems.	1	
7	Resistance to vehicle motion	1	
8	Performance – Fuel consumption and performance	1	
	UT-I (CO1)		
	UNIT –II	**(9)**	
9	Bluff body	1	Lecture with Discussion/ Demonstration/ Assignment/ Tutorial
10	Flow field around car	1	
11	Drag force	1	
12	Types of drag force	2	
13	Drag force coefficient	1	
14	Analysis of aerodynamic drag	1	
15	Drag coefficient of cars	1	
16	Strategies for aerodynamic development	1	
	MT-I (CO1, CO2)		
	UNIT-III	**(9)**	
17	Front and modification	1	Lecture with Discussion/ Demonstration/ Assignment/
18	Front wind shield angle	1	
19	Rear wind shield angle	1	
20	Boat tailing	1	
21	Hatch back,	1	
22	Fast back and square back	1	
23	Dust flow patterns at the rear	1	

S.No	Topics to be covered	No. of periods	Content delivery method
24	Effect of gap configuration& Effect of fasteners.	2	
	UT-II (CO3)		
	UNIT IV	**(9)**	
25	The origin of force and moments on a vehicle	1	Lecture with Discussion/ Demonstration/ Tutorial
26	Side wind problems	1	
27	Methods to calculate forces and moments	1	
28	Vehicle dynamics Under side winds	1	
29	The effects of forces and moments	1	
30	Characteristics of forces and	1	
31	Characteristics of moments	1	
32	Dirt accumulation on the vehicle	1	
33	Wind noise	1	
	UNIT V	**(9)**	
34	Drag reduction in commercial vehicles.	1	Lecture with Discussion/ Demonstration/ Assignment/ Tutorial
35	Introduction – Principles of wind tunnel technology	1	
36	Limitation of simulation	1	
37	Stress with scale models	1	
38	Full scale wind tunnels	1	
39	Measurement techniques	1	
40	Equipment and transducers	1	
41	Road testing methods	1	
42	Numerical methods	1	
	MT 2 (CO3, CO4, CO5)		
	Total	**45**	

1152AU127

L T P C

CAD/CAM TECHNOLOGY IN AUTOMOTIVE ENGINEERING

3 0 0 3

1. Preamble

To study how computer can be applied in mechanical engineering design

2. Pre-requisite

NIL

3. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Explain the basic concepts and underlying theory of modeling and the usage of models in Automobile applications	K2
C02	Explain the homogenous transformation of 2D and 3D curves and surfaces	K2
C03	Compare the different types of modeling techniques and explain the central role solid models play in the successful completion of CAD/CAM-based product development	K2
C04	Describe the manufacturing planning and control	K2
C05	Explain the process planning and shop floor control using CAD/CAM	K2

4. Correlation with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	L	H							H	H
CO2	H	H	H	M	L	H							M	H
CO3	H	H	H	M	L	H							H	H
CO4	H	H	H	M	L	H							L	L
CO5	H	H	H	M	L	H							M	H

H- Strong; M-Medium; L-Low

5. Course content

UNIT I INTRODUCTION TO CAD/CAM **L-9**

The Design Process Morphology of Design, Product Cycle Computer Aided Design, Benefits of CAD. Basic Concepts of CAD - Principles of Computer Graphics. CAD/CAM Data Base Development and Data Base Management Systems. Programming And Interface Hardware – Computer Aided Process Monitoring - Adaptive Control, On-Line Search Strategies.

UNIT II CURVES & SURFACES AND 2D & 3D TRANSFORMATION **L-9**

Analytic Curves and Surfaces, 2D Homogenous Transformations- Translation, Rotation, Reflection, Scaling, Shearing and Combined Transformation 3D Homogenous Transformation - Translation, Rotation, Reflection, Scaling, Shearing and Combined Transformation 3D Viewing Transformation – Panning, Rotation, Reflection, Shearing and Zooming.

UNIT III COMPUTER AIDED DRAFTING AND SOLID MODELING L-9

Graphic Software - Coordinate Representation - Graphic Functions, Software Standards. Graphical Kernal System (GKS) - Initial Graphics Exchange System (IGES) - Graphic Packages. Geometric Modeling - Wire Frame, Surface and Solid Models - CSG and B-REP Techniques - Features of Solid Modeling Packages.

UNIT IV COMPUTER AIDED MANUFACTURING L-9

Manufacturing Planning and Control - CAD/CAM Integration - Principles of Computer Integrated Manufacturing - Hierarchical Network of Computers – Local Area Networks - Process Planning - Computer Aided Process Planning – Retrieval and Generative Approaches.

UNIT V COMPUTER AIDED PROCESS PLANNING AND SHOP FLOOR CONTROL L-9

Computer Integrated Production Management System - Master Production Schedule - Material Requirement Planning - Inventory Management - Manufacturing and Design Data Base - Capacity Planning - Shop Floor Control - Functions - Order Release – Order Scheduling - Order Progress - Factory Data Collection.

6. Text Books

1. Radhakrishnan. P, Subramanyan. S, Raju. V, CAD/CAM/CIM, New Age International Publishers(P) Ltd., 2006.

7. References

1. Groover. M. P, Automation, Production Systems and Computer Integrated Manufacturing, Prentice Hall, 2007.
2. Mortenson, M, E, “Geometric modeling”, John Willey & Sons, 1985.
3. Roger.D.F and Adams.J.A, “Mathematical elements of computer graphics”, McGraw Hill, 1990.
4. Ibrahim Zeid, “CAD/CAM Theory and practice”, TATA McGraw hill corporation co.ltd,1988.
5. Hearn, Donald and Pauline Baker. M, “Computer Graphics”, Prentice Hall, 1986.

8. Revised Bloom’s based Assessment Pattern

Revised Bloom’s Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	10	10	15
Understand	80	80	90	90	85
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	50	60
Analyse	50	40
Evaluate		
Create		

9. Lecture plan

S. No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	The design process Morphology of design, Product cycle	1	Lecture with discussions/ Seminar/ Assignment
2	Computer Aided Design, Benefits of CAD. Basic concepts of CAD - principles of computer graphics.	2	
3	CAD/CAM data base development and data base management systems.	2	
4	Programming and interface hardware – computer aided process monitoring -	2	
5	Adaptive control, on-line search strategies.	2	
	UT-I (CO1)		
	Unit –II	**(9)**	
6	Analytic curves and surfaces	1	Lecture with discussions/ Seminar/ Assignment
7	2D homogenous transformations- translation, rotation, reflection, scaling, shearing and combined transformation	2	
8	3D homogenous transformation - translation, rotation, reflection	2	
9	Scaling, shearing and combined transformation	2	
10	3D viewing transformation – panning, rotation, reflection, shearing and zooming.	2	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
11	Graphic software: coordinate representation- graphic functions, software standards.	2	Lecture with discussions/ Seminar/ Assignment
12	Graphical Kernal system (GKS) - Initial graphics exchange system (IGES) - Graphic packages.	2	
13	Geometric Modeling - Wire frame, Surface	1	
14	Solid models - CSG and B-REP Techniques	2	

S. No	Topics to be covered	No. of periods	Content Delivery Method
15	Features of Solid Modeling Packages.	2	
	UT-II (CO3)		
	Unit IV	**(9)**	
16	Manufacturing Planning and Control	1	Lecture with discussions/ Seminar/ Assignment
17	CAD/CAM Integration	1	
18	Principles of Computer Integrated Manufacturing	2	
19	Hierarchical Network of Computers, Local Area Networks	2	
20	Process Planning, Computer Aided Process Planning	2	
21	Retrieval and Generative approaches.	1	
	Unit V	**(9)**	
22	Computer Integrated Production Management System	1	Lecture with discussions/ Seminar
23	Master Production Schedule, Material Requirement Planning	2	
24	Inventory Management, Manufacturing and Design Data Base	2	
25	Capacity Planning, Shop Floor Control, Functions	2	
26	Order release, Order Scheduling, Order progress, Factory data collection.	2	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

		L	T	P	C
1152AU128	**QUALITY CONTROL AND RELIABILITY ENGINEERING**	**3**	**0**	**0**	**3**

1. Preamble

This course provides the essentiality of SQC, sampling and reliability engineering. Study on various types of control charts, six sigma and process capability to help the students understand various quality control techniques. Reliability engineering focuses on the dependability, failure mode analysis, reliability prediction and management of a system

2. Pre-requisite

NIL

3. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Explain the basic concepts in Statistical Process Control	K2
C02	Apply statistical sampling to determine whether to accept or reject a production lot	K2
C03	Predict lifecycle management of a product by applying reliability engineering techniques.	K2
C04	Analyze data to determine the cause of a failure	K2
C05	Estimate the reliability of a component by applying RDB, FMEA and Fault tree analysis.	K2

4. Correlation with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	L	H							M	L
CO2	H	H	H	M	L	H							H	M
CO3	H	H	H	M	L	H							L	H
CO4	H	H	H	M	L	H							M	M
CO5	H	H	H	M	L	H							L	H

H- High; M-Medium; L-Low

5. Course content

UNIT I STATISTICAL QUALITY CONTROL **L-9**

Methods and Philosophy of Statistical Process Control - Control Charts for Variables and Attributes – Cumulative Sum and Exponentially Weighted Moving Average Control Charts -Other SPC Techniques – Process - Capability Analysis - Six Sigma Concept.

UNIT II ACCEPTANCE SAMPLING **L-9**

Acceptance Sampling Problem - Single Sampling Plans for Attributes – Double Sampling - Multiple Sampling - Sequential Sampling - Military Standards – The Dodge Roming Sampling Plans – Random Sampling.

UNIT III RELIABILITY ENGINEERING L-9

Definition of Reliability – Performance and Reliability - Reliability Requirements – System Life Cycle – Mean Time Between Failures – Mean Time To Failure – Mortality Curve - Availability – Maintainability.

UNIT IV FAILURE DATA ANALYSIS L-9

Statistical Failures of Components – Failure Distributions – Bath Tub Curve – Negative Exponential Distribution – Normal Distribution - Log Normal Distribution – Gamma Distribution - Weibull Distribution Life Distribution Measurements – Accelerated Life Tests -Data Requirements for Reliability.

UNIT V RELIABILITY PREDICTION AND MANAGEMENT L-9

Failure Rate Estimates - Effect of Environment and Stress - Series and Parallel Systems - RDB Analysis – Standby Systems - Complex Systems – Reliability Demonstration Testing- Reliability Growth Testing - Duane Curve - Risk Assessment – FMEA and Fault Tree Analysis.

6. Text Books

1. Khanna O.P, "Statistical Quality Control", Dhanpat Rai Publications (P) Ltd., 2001.
2. Lewis E.E, "Introduction to Reliability Engineering", John Wiley and Sons, 1987.

7. References

1. Mohamed Zairi, "Total Quality Management for Engineers", Woodhead Publishing Limited 1991.
2. Harvid Noori and Russel, "Production and Operations Management – Total Quality and Responsiveness", McGraw-Hill Inc, 1995.
3. Douglus C. Montgomery, "Introduction to Statistical Quality Control", 2nd Edition, John Wiley and Sons, 1991.

8. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	10	10	15
Understand	80	80	90	90	85
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	50	60
Analyse	50	40
Evaluate		
Create		

9. Lecture plan

S. No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Methods and Philosophy of Statistical Process Control	1	Lecture with discussions/ Seminar/ Assignment
2	Control Charts for Variables and Attributes	2	
3	Cumulative sum and Exponentially weighted moving average control charts	2	
4	Other SPC Techniques – Process	2	
5	Capability Analysis, Six sigma concept	2	
	UT-I (CO1)		
	Unit –II	**(9)**	
6	Acceptance Sampling Problem	1	Lecture with discussions/ Seminar/ Assignment
7	Single sampling plans for attributes	2	
8	Double sampling, multiple sampling, sequential sampling	2	
9	Military standards	2	
10	The Dodge Roming sampling plans, Random sampling.	2	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
11	Definition of reliability, Performance and reliability	2	Lecture with discussions/ Seminar/ Assignment
12	Reliability requirements, System life cycle	2	
13	Mean time between failures	1	
14	Mean time to failure ,Mortality Curve	2	
15	Availability, Maintainability.	2	
	UT-II (CO3)		
	Unit IV	**(9)**	
16	Statistical failures of components	1	Lecture with discussions/ Seminar/ Assignment
17	Failure distributions, Bath tub curve	1	
18	Negative exponential distribution, Normal distribution, log normal distribution	2	
19	Gamma distribution, Weibull distribution.	2	
20	Life distribution measurements, Accelerated life tests	2	
21	Data requirements for reliability	1	

S. No	Topics to be covered	No. of periods	Content Delivery Method
	Unit V	**(9)**	
22	Failure rate estimates	1	Lecture with discussions/ Seminar
23	Effect of environment and stress, Series and Parallel systems	2	
24	RDB analysis, Standby Systems, Complex Systems	2	
25	Reliability demonstration testing, Reliability growth testing - Duane curve, Risk assessment	2	
26	FMEA and Fault tree analysis	2	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

		L	T	P	C
1152AU132	**ADVANCED 3D MODELLING**	**2**	**0**	**2**	**3**

8. Preamble

This course is used to develop the complete skill & knowledge in 3D Modelling and drafting techniques

9. Pre-requisite

NIL

10. Course Educational Objectives

Students undergoing this course are expected to

- Gain practical experience in handling 3D modeling software's.
- Achieve fundamental understanding of CAD models to solve diverse problems in Automobile engineering.
- Know the concepts in Modeling and Assembling a components.

11. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	To Study the Features of modeling software's user interface	K2
CO2	To learn basic geometric modeling techniques and terminologies	K2
CO3	Understand the use of sketch based features and transformation features	K2
CO4	To learn the assembly approaches	K2
CO5	Understand the Virtual representations of a structure and to communicate the design Intent.	K2

12. Correlation of COs with Programme Outcomes :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	L	H							H	H
CO2	H	H	H	M	L	H							M	H
CO3	H	H	H	M	L	H							H	H
CO4	H	H	H	M	L	H							L	L
CO5	H	H	H	M	L	H							M	H

H- High; M-Medium; L-Low

13. Course Content

UNIT I INTRODUCTION **L-6, P-6**

Introduction to Unigraphics NX, About NX Gateway, Getting Started, NX Graphical User Interface - Title Bar, Menu Bar, Toolbar, Radial Toolbar, Selection Bar, Cue and Status Line, Dialog Rail, Resource Bar, Navigators,HD3D Tools, Integrated Browser, Palettes, Roles, Full Screen, View Orientation - Trimetric, Isometric, View Commands, Rotate, Pan, Zoom In/Out, Quick Pick, Quick

Pick, Categories, Coordinate System- Absolute Coordinate System, WCS, Absolute Coordinate, Work Coordinate System. View Triad, Multiple Graphics Window, Information Window, Keyboard Accelerators, Dialog Box File Management - Creating New Files, Opening Files and Saving Files.

UNIT II SKETCHER **L-6, P-6**

Creating Sketches - Profile, Line, Arc, Circle, Fillet, Chamfer, Rectangle, Polygon, Studio Pline, Fit Spline, Ellipse, Conic Editing Sketches - Quick Trim, Quick Extend, Make Corner, Offset Curve, Pattern Curve, Mirror Curve, Intersection Point, Derived Lines Constraints - Geometric Constraints, Auto Constraint, Inferred Constraint, Dimensional Constraints, Auto Dimension, Animate Dimension, Continuous Auto Dimension. Basic Terminologies - Feature, Body, Solid Body, Sheet, Face, Section Curves, Guide Curves. Creating Primitives - Block, Cylinder, Cone, Sphere, Boss, Pocket, Emboss, Slot, Groove. Feature Modeling Commands-Creating Extrude Features, Creating Revolve Features.

UNIT III PART MODELING **L-6, P-6**

Datums - Creating Datum Planes, Axis, Point. Creating Sweep Features-Swept, Sweep Along Guide, Variable Sweep, Creating Tube Feature Hole - General Hole, Drill Size Holes, Screw Clearance Holes, Threaded Holes Dart, Thread, Shell, Draft, Draft Body, Scale Creating Blend And Chamfer. Instance Feature - Rectangular Array, Circular Array, Pattern Face, Mirror Feature, Mirror Body Feature Operations - To Divide Face, Trim Body , Split Body, Boolean Commands, User Defined Feature, Creating Feature Group, Layer Settings, To Measure Distance Between Geometries, To Measure Angle Between Geometries, To Measure Bodies And Face Geometries, To Find Geometric Properties - Synchronous Modeling.

UNIT IV ASSEMBLY **L-6, P-6**

Introduction To Assembly Modeling, Assembly Approaches Assembly Constrains - Angle, Bond, Centre, Concentric, Distance, Fit, Parallel, Perpendicular, Touch Align Component Array - Linear Array, Circular Array, Feature Instance Array Moving a Component, Replacing Component, Repositioning Component, Mirroring Assembly. Creating a New Component, Creating a New Parent, Assembly Clearance, Creating Exploded Views, Assembly Sequencing With Motion. Creating Deformable Parts, Finding Degrees of Freedom. Assembly Envelopes.

UNIT V DRAFTING AND DETAILING **L-6, P-6**

Creating the Sheets and Editing the Sheets, Standard Settings. Creating Drawing Views - Base View, Drawing View, Projected View. Section View - Simple Section, Stepped Section, Half Section, Revolved Section, Folded Section, Unfolded Section, Pictorial Section, Half Pictorial Section, Break Out Section Detail View Creating Broken View Appling Dimensions - Inferred Dimension, Horizontal Dimension, Vertical Dimension, Parallel Dimension, Perpendicular Dimension, Angular Dimension, Cylindrical Dimension, Hole Dimension, Diameter Dimension, Chamfer Dimension, Radius or Radius of Curvature Dimension, Radius To Centre, Folded Radius, Thickness Dimension, Arc Length, Horizontal Chain Dimension, Vertical Chain Dimension, Horizontal Baseline Dimension, Vertical Baseline Dimension, Ordinate Dimension. Creating Annotations, Datum Feature, Symbols, Feature Control Frame, Placing Datum Target Symbol. Creating The Centerline, Axis, Hatch And Fill Options Creating Table And Part List.

TOTAL: 30+30=60 Periods

14. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	10	10	20
Understand	80	80	90	90	80
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember	20	20
Understand	80	80
Apply		
Analyse		
Evaluate		
Create		

8. Lecture plan

S.No	Topics to be covered	No. of periods	Content delivery method
	UNIT -I	**(L6-P6)**	
1	Introduction to Unigraphics NX, About NX Gateway, Getting Started, NX Graphical User Interface - Title bar, Menu bar	2	Lecture with Discussion /Assignment/ Seminar/ Tutorial/ Group Discussion/
2	Radial toolbar, Selection bar, Cue and status line, Dialog rail, Resource bar, Navigators,HD3D tools, Integrated browser, Palettes, Roles, Full screen,	2	
3	View orientation- trimetric, isometric, View commands, Rotate ,Pan, Zoom in/out, Quick pick, Quick pick, categories,	2	
4	Coordinate system- absolute coordinate system, WCS, Absolute coordinate, Work coordinate system.	2	
5	View triad, Multiple graphics window, Information window, Keyboard accelerators	2	
6	Dialog box File management - Creating new files, Opening files and Saving files.	2	
	UT-I (CO1)		
	UNIT-II	**(L6-P6)**	

S.No	Topics to be covered	No. of periods	Content delivery method
7	Creating Sketches - Profile, Line, Arc, Circle, Fillet, Chamfer, Rectangle, Polygon, Studio pline, Fit spline, Ellipse, Conic	2	Lecture with Discussion/ Demonstration/ Assignment/ Tutorial
8	Editing sketches - Quick trim, Quick extend, Make corner, Offset curve, Pattern curve, Mirror curve, Intersection point,	2	
9	Derived lines Constraints - Geometric constraints, Auto constraint, Inferred constraint, Dimensional constraints,.	2	
10	Auto dimension, Animate dimension, Continuous auto dimension. Basic terminologies - Feature, Body, Solid body, Sheet, Face, Section curves, Guide curves.	2	
11	Creating Primitives - Block, Cylinder, Cone, Sphere, Boss, Pocket, Emboss, Slot, Groove.	2	
12	Feature modeling commands-Creating Extrude features, Creating Revolve features	2	
	MT-I (CO1, CO2)		
	UNIT-III	**(L6-P6)**	
13	Datums - Creating Datum planes, Axis, Point. Creating Sweep Features-Swept, Sweep along guide, variable sweep, Creating	2	Lecture with Discussion/ Demonstration/ Assignment/
14	Tube feature Hole - General hole, Drill size holes, Screw clearance holes, Threaded holes Dart, Thread, Shell, Draft, Draft body, Scale Creating Blend and Chamfer..	2	
15	Instance feature - Rectangular array, Circular array, Pattern face, Mirror feature, Mirror body Feature Operations	2	
16	To Divide face, Trim body , Split body, Boolean commands, User defined feature, Creating Feature group, Layer settings,	2	
17	To measure distance between geometries, To measure angle between geometries,	2	
18	To measure bodies and face geometries, To find geometric properties. Synchronous Modeling	2	
	UT-II (CO3)		
	UNIT IV	**(L6-P6)**	
19	Introduction to Assembly Modeling, Assembly approaches Assembly constrains	2	Lecture with Discussion/ Demonstration/ Tutorial
20	Angle, Bond, Centre, Concentric, Distance, Fit, Parallel, Perpendicular, Touch align Component array - Linear array, Circular array.	2	
21	Feature instance array Moving a component, Replacing component, Repositioning component, Mirroring assembly.	2	
22	Creating a New Component, Creating a new parent, Assembly clearance	2	
23	Creating exploded views, Assembly sequencing with motion.	2	

S.No	Topics to be covered	No. of periods	Content delivery method
24	Creating deformable parts, finding degrees of freedom. Assembly envelopes	2	
UNIT V (L6-P6)			
25	Creating the Sheets and Editing the Sheets, Standard settings. Creating drawing views- Base view, Drawing view, projected view.	2	Lecture with Discussion/ Demonstration/ Assignment/ Tutorial
26	Section view- Simple section, Stepped section , Half section, Revolved section, Folded section, Unfolded section, Pictorial section, Half pictorial section, Break out section	2	
27	Detail view Creating Broken view Appling dimensions- Inferred Dimension, Horizontal Dimension, Vertical Dimension, Parallel Dimension, Perpendicular dimension	2	
28	Angular dimension, Cylindrical Dimension, Hole dimension, Diameter Dimension, Chamfer Dimension, Radius or Radius of Curvature Dimension, Radius to Centre, Folded Radius,	2	
29	Thickness Dimension, Arc Length, Horizontal Chain Dimension, Vertical Chain Dimension, Horizontal Baseline Dimension, Vertical Baseline Dimension, Ordinate Dimension.	2	
30	Creating Annotations, Datum feature, symbols, feature control frame, placing datum target symbol. Creating the Centerline, Axis, Hatch and fill options Creating Table and Part list.	2	
	MT 2 (CO3, CO4, CO5)		
Total		**60**	

		L	T	P	C
1152AU111	**MODERN VEHICLE TECHNOLOGY**	**3**	**0**	**0**	**3**

1. Preamble

This course gives a wide knowledge to the student about recent development in vehicle technology.

2. Pre requisite

1151AU107 I.C Engines

3. Links to other Courses

- Two and three wheeler
- Electric hybrid vehicle

4. Course Educational Objectives

Students undergoing this course are expected to

- To develop the recent trending knowledge in the Automobile field.
- To develop the skills of the students in recent safety precaution principles.

5. Course Outcomes:

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Know the recent developments in Alternate power generation for a vehicle.	K2
C02	Familiarize with advanced suspension, Braking, and Safety systems in automobile.	K2
C03	Know efficient Noise and pollution control techniques in automobiles	K2
C04	Know the Various Vehicle operation and control systems.	K3
C05	Know the Vehicle automated tracks.	K2

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	L	M	L					L		H	L
CO2	H	H	M	L	M	L					L		M	H
CO3	H	H	M	L	M	L					L		M	L

CO4	H	H	M	L	M	L					L		M	L
CO5	H	H	M	L	M	L					L		M	L

H- High; M-Medium; L-Low

7. Course Content

UNIT – I DRIVER INFORMATION SYSTEMS L-9

Introduction, Driver Support Systems – Driver Information, Driver Perception, Driver Convenience, Driver Monitoring. Vehicle Support Systems – General Vehicle Control, Collision Avoidance, Vehicle Status Monitoring.

UNIT – II DRIVER ASSISTANCE SYSTEMS L-9

Global Positioning Systems, Geographical Information Systems, Navigation Systems, Automotive Vision System, Road Recognition, Driver Assistance Systems - Connected Vehicles, Autonomous Vehicles

UNIT – III SAFETY SYSTEMS L-9

Active and Passive Safety Systems, Airbags, Seat Belt Tightening System, Collision Warning Systems, Child Lock, Anti Lock Braking Systems, Traction Control, Electronic Stability Programme. Crash Worthiness of Vehicle, Vehicle Crash Testing, Testing With Dummies. Security Systems - Anti Theft Technologies, Smart Card System, Number Plate Coding.

UNIT – IV COMFORT SYSTEMS L-9

Active Suspension Systems, Requirement and Characteristics, Different Types, Power Steering, Collapsible and Tiltable Steering Column, Power Windows, Biometric Systems. Adaptive Control Systems: Adaptive Cruise Control, Adaptive Noise Control, Anti Spin Regulation.

UNIT – V ELECTRONIC ENGINE MANAGEMENT L-9

Single Point and Multipoint Injection System, Working of Electronic Fuel Injector, Different Types of Electronic Fuel Injection Systems Like L, K, KE, LU, LH and Motronic, ME & MH Systems, Cylinder Cut-Off Technology.

Total: 45 Periods

8. Text Book

1. K.K. Ramalingam, "Automobile Engineering", Scitech Publications Pvt. Ltd., 2005
2. Crouse/Anglin "Automotive Mechanics"
3. T. Kenneth Garrett, Kenneth Newton and William Steeds, "The Motor Vehicle" 13th Edition, Butterworth-Heinemann Limited**,** London, 2005.
4. "Automotive technology " H.Hertz

9. References

1. Beranek. L.L. Noise Reduction, McGraw-Hill Book Co., Inc, Newyork, 1993
2. Bosch Hand Book, 3rd Edition, SAE,1993

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	

Remember	20	20	10	10	10
Understand	80	80	90	20	80
Apply				70	10
Analyse					
Evaluate					
Create					

Revised Bloom's Category	**Assignment**	
	I (CO1 & CO2 addressed) (Max marks in %)	**II (CO3 & CO4 addressed) (Max marks in %)**
Remember		
Understand		
Apply	20	20
Analyse	80	80
Evaluate		
Create		

11. Lecture plan:

S.NO	**Topics to be covered**	**No. of periods**	**Content Delivery Method**
	Unit –I	**(9)**	
1	Introduction	1	Lecture with discussions/ Seminar/ Assignment
2	Driver support systems	1	
3	Driver information, driver perception	1	
4	Driver convenience	1	
5	Driver monitoring	1	
6	Vehicle support systems	1	
7	General vehicle control	1	
8	Collision avoidance	1	
9	Vehicle status monitoring	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
10	Global positioning systems	2	Lecture with discussions/ Seminar/ Assignment
11	Geographical information systems	1	
12	Navigation systems	1	
13	Automotive vision system	2	
14	Road recognition	1	
15	Driver assistance systems	2	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
16	Active and passive safety systems	1	Lecture with discussions/ Seminar/
17	Airbags, seat belt tightening system	1	
18	Collision warning systems, child lock	1	
19	Anti lock braking systems	1	

S.NO	Topics to be covered	No. of periods	Content Delivery Method
20	Traction control, Electronic Stability Programme	1	Case Studies/ Assignment
21	Crash worthiness of vehicle	1	
22	Vehicle crash testing, testing with dummies	1	
23	Security Systems: Anti theft technologies	1	
24	Smart card system, number plate coding.	1	
	UT-II (CO3)		
	Unit IV	**(9)**	
25	Active suspension systems	1	Lecture with discussions/ Seminar/ Case Studies/ Assignment
26	Requirement and characteristics, different types	1	
27	Power steering	1	
28	Collapsible and tiltable steering column	1	
29	Power windows	1	
30	Biometric systems	1	
31	Adaptive cruise control	1	
32	Adaptive noise control	1	
33	Anti spin regulation, cylinder cut- off technology.	1	
	Unit V	**(9)**	
34	The Feedback control carburetor	1	Lecture with discussions/ Seminar
35	Single point and multipoint injection system	2	
36	Working of electronic fuel injector	1	
37	Different types of electronic fuel injection systems	1	
38	L, K, KE, LU, LH and Motronic, ME & MH systems	4	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

		L	T	P	C
1152AU112	**MICROPROCESSOR AND MICROCONTROLLER**	**3**	**0**	**0**	**3**

1. **Preamble**
   This course is to make the students to understand the architecture, programming and interfacing of system design of microprocessors and microcontrollers.
2. **Pre-requisite:**
   1150EC101 Basic Electronics Engineering
3. **Links to other courses**
   - Automotive electrical and electronic systems.
4. **Course Educational Objectives**
   Students undergoing this course are expected to
   - Know the internal organization, addressing modes and instruction sets of 8085 processor.
   - Know the various functional units of 8051 microcontroller.
   - Understand embedded C and assembly language program by using 8051 Instruction sets and addressing modes.
   - Know the various peripheral devices such as 8255, 8279, 8251, 8253, 8259 and 8237.
   - Understand microcontroller based system design for various applications.

5. **Course Outcomes**
   Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Develop an ALP in 8085 microprocessor using the internal organization for the given specification	**K2**
CO2	Describe the architecture and functional block of 8051 microcontroller	**K2**
CO3	Develop an embedded C and ALP in 8051 microcontroller using the internal functional blocks for the given specification	**K3**
CO4	Explain various peripherals devices such as 8255, 8279, 8251, 8253,8259 and 8237	**K2**
CO5	Explain microcontroller application like temperature control, Traffic light System, Power Windows, Wiper Control, TPMS, Throttle control and ABS	**K2**

6. **Correlation of COs with Programme Outcomes**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	L	L	M	M	H	L							H	H
CO2	L	L	M	M	H	L							H	H
CO3	L	L	M	M	H	L							M	M
CO4	L	L	M	M	H	L							L	L
CO5	L	L	M	M	H	L							M	H

H- High; M-Medium; L-Low

7. Course content

UNIT I 8085 CPU **L- 9**

8085 Architecture – Pin Diagram - Memory Interfacing – I/O Interfacing- Timing Diagram- Instruction Set - Addressing Modes – Assembly Language Programming- Comparison of 8 Bit (8085) and 16 Bit (8086) Processors.

UNIT II 8051 ARCHITECTURE **L- 9**

Architecture – Memory Organization – I/O Ports and Circuits - Timers - Interrupts – Serial Communication - Interfacing of External Memory - Interfacing LCD & Keyboard - RTC.

UNIT III 8051 PROGRAMMING **L- 9**

Addressing Modes - Instruction Set - Assembly Language Programming and C Programming– Timer Counter Programming – Serial Communication Programming- Interrupt Programming.

UNIT IV PERIPHERAL DEVICES **L -9**

Parallel Peripheral Interface (8255) - Timer / Counter (8253) - Keyboard and Display Controller (8279) - USART (8251) - Interrupt Controller (8259) - DMA Controller (8237).

UNIT V MICROCONTROLLER APPLICATIONS **L -9**

Temperature Control System - Motor Speed Control System – Traffic Light System – Power Windows, Wiper Control, TPMS, Throttle Control and ABS

Total: 45 periods

8. Text Books

1. Ramesh S Gaonkar, Microprocessor Architecture, Programming and application with 8085, 6th Edition, Penram International Publishing. (UNIT 1&4)

2. Muhammad Ali Mazidi , Janice Gillispie Mazidi and Rolin D McKinlay, The 8051 microcontroller and embedded systems using assembly and C, second edition Pearson education Asia.(UNIT 2 & 3)

3. Mohamed Rafiquzzaman, Microprocessor and Microcomputer based system design, second edition, CRC press (UNIT 5)

9. References

1. Kenneth J Ayala, The 8051 Microcontroller Architecture Programming and Application, third Edition, Penram International Publishers.

2. A.K Ray & K.M. Burchandi, Advanced Microprocessor and peripherals Architectures, Programming and interfacing “, second edition, Tata McGraw-Hill

10. Revised Bloom’s based Assessment Pattern

Revised Bloom’s Category	Internal				University Examination %
	Unit Test- I	Mid Term Test I	Unit Test- II	Mid Term Test II	

	%	%	%	%	
Remember	30	30			
Understand	70	70	60	70	60
Apply			40	30	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	**Assignments**	
	I (CO1 & CO2 addressed) (Max marks in %)	**II (CO3 & CO4 addressed) (Max marks in %)**
Remember		
Understand		
Apply	50	50
Analyse	50	50
Evaluate		
Create		

11. Lecture plan

S. No	**Topics to be covered**	**No. of periods**	**Content Delivery Method**
	Unit –I	**(9)**	
1	8085 Architecture	1	Lecture with discussions/ Seminar/ Assignment
2	Pin diagram, Memory interfacing	2	
3	I/O interfacing, Timing Diagram	2	
4	Instruction Set, Addressing modes	1	
5	Assembly language programming	2	
6	Comparison of 8 bit (8085) and 16 bit (8086) processors	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
7	Architecture , memory organization	2	Lecture with discussions/ Seminar/ Assignment
8	I/O ports and circuits-Timers	2	
9	Interrupts –serial communication	1	
10	Interfacing of External memory	2	
11	Interfacing LCD & Keyboard-RTC	2	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
12	Addressing modes -instruction set	2	Lecture with discussions/ Seminar/ Case Studies/ Assignment
13	Assembly language programming and C Programming	2	
14	Timer Counter Programming	2	
15	Serial Communication Programming	2	
16	Interrupt Programming	1	
	UT-II (CO3)		

S. No	Topics to be covered	No. of periods	Content Delivery Method
	Unit IV	**(9)**	
17	Parallel peripheral Interface (8255)	2	Lecture with discussions/ Seminar/ Case Studies/ Assignment
18	Timer / Counter (8253)	1	
19	Keyboard and Display Controller (8279)	2	
20	USART (8251)	1	
21	Interrupt Controller (8259)	1	
22	DMA Controller (8237)	2	
	Unit V	**(9)**	
23	Temperature control system	1	Lecture with discussions/ Seminar/ Lecture with demonstration
24	Motor speed control system	2	
25	Traffic light System	1	
26	Power Windows, Wiper Control	2	
27	TPMS	2	
28	Throttle control and ABS	1	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

		L	T	P	C
1152AU113	**ENGINE ELECTRONICS AND MANAGEMENT SYSTEMS**	**3**	**0**	**0**	**3**

1. **Preamble**
   This course imparts knowledge about the sensors and electronic components used in an automobile and the engine control system.
2. **Prerequisite**
   1151AU215 Automotive Electrical and Electronics

3. **Related Courses**
   - IC Engines
   - Automotive chassis
4. **Course Educational Objectives**
   Students undergoing this course are expected to:
   - Gain knowledge about the construction and working of electronic components in an engine management system.
   - Gain knowledge about how the combustion and pollution can be varied by sensors.

5. **Course Outcomes**
   Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the basic electronic components and controls used in sensors	K2
CO2	Explain the different types of sensors used in an automobile engine	K2
CO3	Describe the ignition and injection methods used in an SI engine	K3
CO4	Describe the fuel injection systems in a diesel engine and the emission control systems	K3
CO5	Explain the electronic systems used in the fuel control system and the dash board unit.	K2

(K2 – Understand; K3 – Apply)

6. **Correlation of COs with Programme Outcomes**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	L	M	L					L		M	M
CO2	H	H	M	L	M	L					L		M	M
CO3	H	H	M	L	M	L					L		M	H

CO4	H	H	M	L	M	L					L		H	H
CO5	H	H	M	L	M	L					L		H	H

H- High; M-Medium; L-Low

7. Course Content

UNIT I FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS L-9

Components for Electronic Engine Management System, Open and Closed Loop Control Strategies, PID Control, Look Up Tables, Introduction to Modern Control Strategies Like Fuzzy Logic and Adaptive Control. Switches, Active Resistors, Transistors, Current Mirrors/Amplifiers, Voltage and Current References, Comparator, Multiplier. Amplifier, Filters, A/D and D/A Converters.

UNIT II SENSORS AND ACTUATORS L-9

Inductive, Hall Effect, Thermistors, Piezo Electric, Piezoresistive, Based Sensors. Throttle Position, Mass Air Flow, Crank Shaft Position, Cam Position, Engine Speed Sensor, Exhaust Oxygen Level (Two Step, Linear Lambda and Wideband), Knock, Manifold Temperature and Pressure Sensors. Solenoid, Relay (Four and Five Pin), Stepper Motor

UNIT III SI ENGINE MANAGEMENT L-9

Layout and Working of SI Engine Management Systems. Group and Sequential Injection Techniques. MPFI, GDI, Advantages of Electronic Ignition Systems. Types of Solid State Ignition Systems and their Principle of Operation, Contactless (BREAKERLESS) Electronic Ignition System, Electronic Spark Timing Control.

UNIT IV CI ENGINE MANAGEMENT L-9

Fuel Injection System Parameters Affecting Combustion, Noise and Emissions in CI Engines. Electronically Controlled Unit Injection System - Common Rail Fuel Injection System. Working of Components Like Fuel Injector, Fuel Pump, Rail Pressure Limiter, Flow Limiter, EGR Valve.

UNIT V DIGITAL ENGINE CONTROL SYSTEM L-9

Cold Start and Warm Up Phases, Idle Speed Control, Acceleration and Full Load Enrichment, Deceleration Fuel Cutoff. Fuel Control Maps, Open Loop and Closed Loop Control – Integrated Engine Control System, Electromagnetic Compatibility – EMI Suppression Techniques – Electronic Dash Board Instruments – Onboard Diagnosis System.

Total: 45 periods

8. Text Books:

1. Understanding Automotive Electronics William B Ribbens, SAE 1998
2. Automobile Electronics by Eric Chowanietz SAE

9. References:

1. Diesel Engine Management by Robert Bosch, SAE Publications, 3rd Edition, 2004
2. Gasoline Engine Management by Robert Bosch, SAE Publications, 2nd Edition, 2004

10. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I	Mid Term Test I	Unit Test- II	Mid Term Test II	

	%	%	%	%	
Remember	40	20			10
Understand	60	80	20	20	50
Apply			80	80	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 &CO2) (Max marks in %)	II (CO3&CO4) (Max marks in %)
Remember		
Understand		
Apply	60	40
Analyse	40	60
Evaluate		
Create		

11. Lecture plan

S. No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Components for electronic engine management system	1	Lecture with discussions/ Seminar/ Assignment
2	Open and closed loop control strategies	1	
3	PID control	1	
4	Look up tables	1	
5	Introduction to modern control strategies like Fuzzy logic and adaptive control	1	
6	Switches, active resistors, Transistors, Current mirrors/amplifiers	1	
7	Voltage and current references, Comparator, Multiplier	1	
8	Amplifier, filters	1	
9	A/D and D/A converters.	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
10	Inductive, Hall Effect, Thermistors, piezo electric, piezoresistive, based sensors.	1	Lecture with discussions/ Seminar/ Assignment
11	Throttle position sensor	1	
12	Mass air flow sensor	1	
13	Crank shaft position, cam position sensor	1	
14	Engine speed sensor	1	

S. No	Topics to be covered	No. of periods	Content Delivery Method
15	Exhaust oxygen level (two step, linear lambda and wideband)sensor	1	
16	Knock sensor	1	
17	Manifold temperature and pressure sensors.	1	
18	Solenoid, relay (four and five pin), stepper motor.	1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
19	Layout and working of SI engine management systems	2	Lecture with discussions/ Seminar/ Case Studies/ Assignment
20	Group and sequential injection techniques	1	
21	Electronic ignition systems and advantages	2	
22	Types of solid state ignition systems and their principle of operation	1	
23	Contactless (BREAKERLESS) electronic ignition system	2	
24	Electronic spark timing control.	1	
	UT-II (CO3)		
	Unit IV	**(9)**	
25	Fuel injection system parameters affecting combustion, noise and emissions in CI engines.	3	Lecture with discussions/ Seminar/ Case Studies/ Assignment
26	Electronically controlled Unit Injection system	2	
27	Common rail fuel injection system	1	
28	Working of components like fuel injector	1	
29	Fuel pump, rail pressure limiter, flow limiter	1	
30	EGR valve	1	
	Unit V	**(9)**	
31	Cold start and warm up phases	1	Lecture with discussions/ Seminar/ Lecture with demonstration
32	Idle speed control	1	
33	Acceleration and full load enrichment	1	
34	Deceleration fuel cutoff	1	
35	Fuel control maps	1	
36	Open loop and closed loop control	1	
37	Integrated engine control system	1	
38	Electromagnetic compatibility – EMI Suppression techniques	1	
39	Electronic dash board instruments – Onboard diagnosis system	1	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

		L	T	P	C
1152AU114	**AUTOMOTIVE SAFETY**	**3**	**0**	**0**	**3**

1. Preamble

This course imparts understanding of role of safety systems in automobiles through technology.

2. Pre-Requisite

1150EC101 Basic Electronics Engineering

3. Links to Other Courses

- Vehicle Body Engineering
- Automotive chassis

4. Course Educational Objectives

Students undergoing this course are expected to

- Gain knowledge about the vehicles structural crashworthiness and crash testing
- Gain knowledge about the working of vehicle vision safety systems

5. Course Outcomes:

On successful completion of this course students will be able to:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Identity different safety systems and vehicle structural crashworthiness	K2
CO2	Analyse and simulate vehicle in barrier impacts	K2
CO3	Design vehicle safety systems	K3
CO4	Determine the fundamentals of light ,vision and colour	K2
CO5	Analyse pedestrian safety by use of light measurement and testing	K3

6. Correlation of COs with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	H	H	L	H		L	L						H	L

CO 2	H	H	L	H		L	L						H	H
CO 3	H	H	L	H		L	L						M	H
CO 4	H	H	L	H		L	L						L	L
CO 5	H	H	L	H		L	L						M	H

H- High; M-Medium; L-Low

7. Course Content

UNIT I INTRODUCTION VEHICLE SAFETY, STRUCTURAL CRASHWORTHINESS AND CRASH TESTING L-9

Automotive Safety-Active and Passive Safety, Driver Assistance Systems in Automobiles, Definitions and Terminology. Balance of Stiffness and Toughness Characteristics and Energy Absorption Characteristics of Vehicle Structures, Design of Crash Crumple Zones, Modeling and Simulation Studies, Optimization of Vehicle Structures for Crash Worthiness, Types of Impacts, and Impact With Rebound, Movable Barrier Tests, Analysis and Simulation of Vehicle in Barrier Impacts, Roll Over Crash Tests, Behavior of Specific Body Structures in Crash Testing, Photographic Analysis of Impact Tests.

UNIT II ERGONOMICS AND HUMAN RESPONSE TO IMPACT L-9

Importance of Ergonomics in Automotive Safety, Locations of Controls, Anthropometry, Human Impact Tolerance Determination of Injury Thresholds, Severity Index, Study of Comparative Tolerance, Application of Trauma for Analysis of Crash Injuries. Injury Criteria's and Relation with Crash and Modeling and Simulation Studies in Dummy.

UNIT III VEHICLE SAFETY SYSTEMS L-9

Survival Space Requirements, Restraints Systems Used Automobiles, Types of Safety Belts, Head Restraints, Air Bags Used in Automobiles, Use of Energy Absorbing Systems in Automobiles, Impact Protection from Steering Controls, Design of Seats for Safety, Types of Seats Used in Automobiles. Importance if Bumpers in Automobiles, Damageability Criteria in Bumper Designs. Introduction to the Types of Safety Glass and their Requirements and Rearward Field of Vision in Automobiles, Types of Rear View Mirrors and their Assessment. Warning Devices, Hinges and Latches etc., Active Safety

UNIT IV FUNDAMENTALS OF LIGHT, VISION AND COLOUR L-9

Electromagnetic Radiation and Light, Propagation of Light, Spectral Sensitivity of Light, Measures of Radiation and Light, Standard Elements for Optical Control. Illuminant Calculations, Derivation of Luminous Flux from Luminous Intensity, Flux Transfer and Inter Reflection, Luminance Calculations, Discomfort Glare, Eyes as an Optical System Visual Processing, Lighting For Results, Modes of Appearance, Pointers for Lighting Devices. Nature of the Color Tri-Chromatic Colorimetry, Surface Color, Color Spaces and Color Solids, Color Rendering.

UNIT V LIGHT MEASUREMENTS, TESTING EQUIPMENT, CALIBRATION AND PHOTOMETRIC PRACTICE L-9

Basics of Standards and Detectors, Spectral Measurements and Colorimetry, Illuminant Meters and Luminance Meters, Colorimeters. Fundamentals of Equipment Used for Light Measurement in Automotive Field - Gonio- Photometer, Reflecto-Meter, Colorimeter, Integrating Sphere, Types, Application, Coordinates System, Types of Sensors and Working Principle, Construction, Characteristics Etc. Used in Different Equipment. National and International Regulations, Test Requirements and Testing Procedure

Total: 45 Periods

8. Text Books:

1. Watts, A. J., et al "Low speed Automobile Accidents" Lawyers and Judges 1996
2. Jullian Happian-Smith 'An Introduction to Modern Vehicle Design' SAE, 2002
3. Johnson, W., and Mamalis, A.G., "Crashworthiness of Vehicles, MEP, London, 1995
4. Edward .A, Lamps and Lighting, Hodder & Stoughton, London, 1993.
5. Bosch –automotive -handbook ,edition 5-SAE Publication-2000

9. References:

1. Keitz H. A. E, Light calculations and Measurements, Macmillan, 1971.
2. Olson L. P, Forensic aspects of driver perception and response, Lawyers and Judges 1996.
3. Pantazis. M, Visual instrumentation: Optical design & engineering Principles, McGraw - Hill 1999.
4. Matthew Huang, "Vehicle Crash Mechanics".
5. David C. Viano, "Role of the Seat in Rear Crash Safety".
6. Jeffrey A. Pike, "Neck Injury".
7. Ching-Yao Chan, "Fundamentals of Crash Sensing in Automotive Air Bag Systems".
8. Rollover Prevention, Crash Avoidance, Crashworthiness, Ergonomics and Human Factors", SAE Special Publication, November 2003.

10. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	40	20			10
Understand	60	80	20	40	50
Apply			80	60	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 &CO2) (Max marks in %)	II (CO3&CO4) (Max marks in %)

Remember		
Understand		
Apply	20	20
Analyse	80	80
Evaluate		
Create		

11. Lecture plan

S. No.	Topics to be covered	No. of periods	Content delivery method
	Unit –I	**(9)**	
1	Design of the body for safety, energy equation, engine location	3	Lecture with discussion/ Assignment/ Seminar
2	Deceleration of vehicle inside passenger compartment	3	
3	Deceleration on impact with stationary and movable obstacle	3	
4	Concept of crumble zone	3	
	UT-I (CO1)		
	Unit –II	**(9)**	
5	Active safety: driving safety, conditional safety, perceptibility safety,	2	Lecture with discussion/ Assignment/ Seminar
6	Operating safety passive safety: exterior safety	2	
7	Interior safety	2	
8	Deformation behavior of vehicle body,	1	
9	Speed and acceleration characteristics of passenger compartment on impact.	1	
10	Speed and acceleration characteristics of passenger compartment on impact.	1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
11	Airbags, electronic system for activating air bags	1	Lecture/ Lecture with discussion/ Assignment/ Seminar
12	Seat belt, regulations, automatic seat belt tightener system	2	
13	Collapsible & tiltable steering column, bumper design for safety. Collision warning systems, child lock	2	
14	Antilock braking systems	1	
15	Electronic stability control system/traction control system.	1	
16	Vision enhancement, road recognition system, Anti theft technologies	1	
17	Smart card system, number plate coding, central locking system	1	
	UT-II (CO3)		
	Unit IV	**(9)**	
18	Active suspension systems, requirement and characteristics,	2	Lecture/ Lecture with
19	Different types, Vehicle Handling and Ride characteristics of f road vehicle, pitch, yaw, bounce control,	2	

S. No.	Topics to be covered	No. of periods	Content delivery method
20	Power windows, thermal management system, adaptive noise control.	2	discussion/ Assignment
21	Steering and mirror adjustment, central locking system ,	1	
22	Garage door opening system, tyre pressure control system	1	
23	Rain sensor system, environment information system	1	
	Unit V	**(9)**	
24	Traffic routing system - Automated highway systems	2	Lecture/ Lecture with discussion/ Assignment
25	Lane warning system – Driver Information System, driver assistance systems	2	
26	Data communication within the car, Driver conditioning warning	2	
27	Route Guidance and Navigation Systems – vision enhancement system	2	
28	In-Vehicle Computing – Vehicle Diagnostics system – Hybrid / Electric and Future Cars – Case studies	1	
	MT – II (CO3, CO4, CO5)		
	Total	**45**	

		L	T	P	C
1152AU115	**ELECTRIC AND HYBRID VEHICLES**	**3**	**0**	**0**	**3**

1. Preamble

This course is intended for learning the Fundamentals of Automobile Hybrid vehicles. This course is gives the brief ideas of Hybrid vehicles propulsion methods- Hybrid architecture- Hybrid power plant specifications- Fuel cell technology - and Non electric Hybrid propulsion systems.

2. Pre-requisite

1151AU215 Automotive Electrical and Electronics

1151AU107 I.C Engines

3. Links to other courses

- Automotive Electrical and Electronics.
- Automotive Transmission

4. Course Educational Objectives

Students undergoing this course are expected to

- To develop the basic knowledge of the students in electric and hybrid vehicles.
- To develop the skills of the students in the area of working and types of electric motors.
- To develop the detailed knowledge about batteries.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Illustrate the concept of electric vehicles and its propulsion systems.	**K2**
C02	State the concept of hybrid architecture and power plant	**K2**
C03	List the energy storage systems.	**K2**

C04	Explain about the fuel cells.	**K2**
C05	Illustrate the non electric hybrid propulsion systems.	**K2**

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H		M						L		H	M
CO2	H	H	H		M						L		M	M
CO3	H	H	H		M						L		L	L
CO4	H	H	H		M						L		L	L
CO5	H	H	H		M						L		M	M

H- Strong; M-Medium; L-Low

7. Course Content:

UNIT I INTRODUCTION TO ROAD VEHICLES AND PROPULSION SYSTEM L-9

Hybrid Vehicles - Performance Characteristics of Road Vehicles - Calculation of Road Load- Predicting Fuel Economy - Grid Connected Hybrids.

Propulsion Methods - DC Motors Series Wound- Shunt Wound- Compound Wound and Separately Excited Motors AC Motors Induction – Synchronous - Brushless DC Motor- Switched Reluctance Motors.

UNIT II HYBRID ARCHITECTURE AND POWER PLANT SPECIFICATIONS L-9

Hybrid Architecture - Series, Parallel and Series Parallel Configuration Locomotive Drives – Switching - Load Tracking Architecture - Pre Transmission Parallel and Combined Configurations Mild Hybrid- Power Assist - Dual Mode- Power Split - Power Split With Shift- Continuously Variable Transmission (CVT) - Wheel Motors.

Hybrid Power Plant Specifications - Grade and Cruise Targets - Launching And Boosting -Braking and Energy Recuperation - Drive Cycle Implications - Engine Friction Reduction, Engine Downsizing, Range and Performance - Usage Requirements.

UNIT III DRIVE SYSTEM AND ENERGY STORAGE TECHNOLOGY L-9

Sizing the Drive System, Matching Electric Drive and ICE, Sizing the Propulsion Motor, Power Electronics. Energy Storage Technology, Battery Basics, Lead Acid Battery, Different Types of Batteries, Battery Parameters.

UNIT IV FUEL CELLS L-9

Fuel Cell Characteristics - Fuel Cell Types – Alkaline Fuel Cell - Proton Exchange Membrane - Direct Methanol Fuel Cell - Phosphoric Acid Fuel Cell - Molten Carbonate Fuel Cell - Solid Oxide Fuel Cell- Hydrogen Storage Systems- Reformers - Fuel Cell EV - Super and Ultra Capacitors - Flywheels.

UNIT V NON-ELECTRIC HYBRID PROPULSION SYSTEMS L-9

Nonelectric Hybrid Propulsion Systems - Short Term Storage Systems Flywheel Accumulators - Continuously Variable Transmissions Hydraulic Accumulators Hydraulic Pumps/Motors - Pneumatic Hybrid Engine Systems Operation Modes.

TOTAL: 45 periods

8. Text Books

1. Hybrid and Alternative Fuel Vehicles (2nd Edition) (Professional Technician) by James D. Halderman and Tony Martin (Feb 7, 2010)
2. How Your Car Works: Your Guide to the Components & Systems of Modern Cars, Including Hybrid & Electric Vehicles (Rac Handbook) by ArvidLinde (Oct 15, 2011)

9. References

1. Electric and Hybrid Vehicles by Iqbal Husain (Jul 16, 2011)
2. Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives by Chris Mi, M. AbulMasrur and David WenzhongGao (Jul 5, 2011)

10. **Revised Bloom's based Assessment Pattern :**

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	30	40	40	40	40
Understand	70	60	60	60	60
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	60	60
Analyse	40	40
Evaluate		
Create		

11. Lecture plan:

S. No.	Topic	No. of periods	Content Delivery methods
	Unit-I	**(9)**	
1	Hybrid Vehicles: Performance characteristics of road vehicles	2	Lecture with discussion/ Assignment/ Seminar/ Case studies
2	Calculation of road load- predicting fuel economy- grid connected hybrids.	2	
3	Propulsion methods: DC motors series wound- shunt wound- compound wound and separately excited motors AC motors	2	

S. No.	Topic	No. of periods	Content Delivery methods
4	Induction- synchronous- brushless DC motor- switched reluctance motors.	2	
5	Seminar	1	
	UT-I (CO1)		
	Unit–II	**(9)**	
6	Hybrid architecture: Series configuration locomotive drives- series parallel switching- load tracking architecture.	2	Lecture with discussion/ Assignment/ Seminar
7	Pre transmission parallel and combined configurations	1	
8	Mild hybrid- power assist- dual mode- power split- power split with shift	1	
9	Continuously Variable transmission (CVT) - wheel motors.	2	
10	Hybrid power plant specifications: Grade and cruise targets- launching and boosting- braking and energy recuperation-	2	
11	Drive cycle implications- engine fraction engine downsizing and range and performance- usage requirements.	1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
12	Drive system, Matching electric drive and ICE,	3	Lecture with discussion/ Assignment/ Seminar
13	Sizing the propulsion motor, sizing power electronics.	3	
14	Energy storage technology, Battery basics, leads acid battery	2	
15	different types of batteries, battery parameters	1	
	UT-II (CO3)		
	Unit IV	**(9)**	
16	Fuel cell characteristics- fuel cell types – alkaline fuel cell- proton exchange Membrane.	2	Lecture with discussion/ Assignment/ Seminar/ Case studies
17	direct methanol fuel cell- phosphoric acid fuel cell	2	
18	molten carbonate fuel cell	3	
19	solid oxide fuel cell- hydrogen storage systems- reformers-	3	
20	fuel cell EV- super and ultra capacitors- flywheels	2	
	Unit V	**(9)**	
21	Nonelectric Hybrid Propulsion Systems: Short Term Storage Systems	3	Lecture with discussion/ Assignment/ Seminar/ Case studies/ Group discussion
22	Flywheel Accumulators. Modes	2	
23	Continuously Variable Transmissions Hydraulic	2	
24	Hydraulic Pumps/Motors- Pneumatic Hybrid Engine Systems Operation	1	
25	Revision	1	
26	Seminar	1	
	MT – II (CO3, CO4, CO5)		
	Total	**45**	

		L	T	P	C
1152AU124	**AUTOMOTIVE ECU DESIGN AND WIRING HARNESS**	**3**	**0**	**0**	**3**

1. Preamble

This course provides the fundamentals of basic hardware components to the sophistication of digital control systems algorithms. It will start with a review of automotive sensors and actuators technologies and progress with the fundamental notions of digital signal processing and digital control system design which are necessary to the engineer who works with computer-controlled systems

2. Pre Requisite

NIL

3. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the principles of basic electronic components related with automobiles.	K2
CO2	Understand the basic principles of control system and embedded system in automobile	K2
CO 3	Study about the working of operating system in automobile	K2
CO4	Study about components of electronic control unit	K2
CO5	Understand the wiring harness in automobile	K2

4. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M		M	M					L	L	M	M
CO2	L	H	M		M	M					L	L	M	M
CO3	M	H	M		M	M					L	L	L	L
CO4	L	H	M		M	M					L	L	L	L
CO5	L	H	M		M	M					L	L	M	M

H- Strong; M-Medium; L-Low

5. Course Content

UNIT- I FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS L-9

Semiconductor Devices, Diodes, Rectifier Circuit, Transistors, Transistor Amplifiers, Operational Amplifiers, Logic Gates, Flip-Flops. ADC and its Types, DAC and its Types. Manufacturing of Semiconductor Components and Circuits.

UNIT- II CONTROL SYSTEMS AND EMBEDDED SYSTEMS L-9

Open-Loop and Closed-Loop Control Systems - Modeling, Block Diagrams, Discrete Systems, Time - Discrete Systems, Value - Discrete Systems and Signals, State Machines.

Embedded Systems - Microcontroller Construction, Memory Technologies - Read/Write Memory, Non-Erasable, Read-Only Memory, Reprogrammable Nonvolatile Memory, Microcontroller Programming, Program Version and Data Version, Functional Principles of Microcontrollers, Principal Microcontroller Operations, Microprocessor Architecture and Instruction Set, I/O Module Architecture.

UNIT- III AUTOMOTIVE SOFTWARE L-9

Real-Time Systems, Distributed and Networked Systems, System Reliability, Safety, Monitoring and Diagnostics.

UNIT- IV ELECTRONIC CONTROL UNIT L-9

Operating Conditions, Design, Data Processing, Digital Modules in the Control Unit.

UNIT- V WIRING HARNESS L-9

Wiring Harness and Cables, Wiring System Interfaces, Circuit Protection, Circuit Diagrams.

6. Text book

1. Jörg Schäuffele Thomas Zurawka, Automotive Software Engineering: Principles, Processes, Methods, and Tools, SAE International, Fachverlage GmbH, Wiesbaden, Germany, 2003, ISBN 3-528-01040-1
2. William B. Ribbens, Understanding Automotive Electronics, Fifth Edition, Butterworth–Heinemann publications, 1998.

7. References

1. Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive, 5th Edition, Robert Bosch GmbH, 2007.
2. Najamuz Zaman, Automotive Electronics Design Fundamentals, Springer International Publishing Switzerland 2015

8. Revised Bloom's based Assessment Pattern

	Internal	University

Revised Bloom's Category	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	Examination (%)
Remember	20	20	10	10	15
Understand	80	80	90	90	85
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	50	60
Analyse	50	40
Evaluate		
Create		

9. Lecture plan

S. No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Semiconductor devices	1	Lecture with discussions/ Seminar/ Assignment
2	Diodes, rectifier circuit, transistors, transistor amplifiers, operational amplifiers	2	
3	Logic gates, flip-flops.	2	
4	ADC and its types, DAC and its types.	2	
5	Manufacturing of semiconductor components and circuits.	2	
	UT-I (CO1)		
	Unit –II	**(9)**	
6	Open-Loop and Closed-Loop Control Systems	1	Lecture with discussions/ Seminar/ Assignment
7	Modeling, Block Diagrams, Discrete Systems, Time-Discrete Systems, Value-Discrete Systems and Signals, Machines.	2	
8	Embedded Systems: Microcontroller Construction, Memory Technologies: Read/Write Memory, Non-Erasable, Read-Only Memory, Reprogrammable Nonvolatile Memory	2	
9	Microcontroller Programming, Program Version and Data Version, Functional Principles of Microcontrollers	2	

S. No	Topics to be covered	No. of periods	Content Delivery Method
10	Principal Microcontroller Operations, Microprocessor Architecture and Instruction Set, I/O Module Architecture.	2	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
11	Real-Time Systems	2	Lecture with discussions/ Seminar/ Assignment
12	Distributed and Networked Systems	2	
13	System Reliability	1	
14	Safety	2	
15	Monitoring and Diagnostics	2	
	UT-II (CO3)		
	Unit IV	**(9)**	
16	Operating conditions	2	Lecture with discussions/ Seminar/ Assignment
17	Design	2	
18	Data processing	2	
19	Digital modules in the control unit	2	
20	Digital modules in the control unit	1	
	Unit V	**(9)**	
21	Wiring harness	1	Lecture with discussions/ Seminar
22	cables	2	
23	Wiring system interfaces	2	
24	Circuit Protection	2	
25	Circuit Diagrams	2	
	MT – II (CO3, CO4, CO5)		
	Total	**45**	

		L	T	P	C
1152AU129	**MICRO ELECTRO MECHANICAL SYSTEMS**	**3**	**0**	**0**	**3**

1. Preamble

This course explain the MEMS sensors and actuators are used for intelligent embedded systems interacting with automobiles

2. Pre-requisite

NIL

3. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	List the micro fabrication procedures of silicon chips & its mechanical properties	K2
C02	Explain the working of Electrostatic sensors and its applications in real time scenario	K2
C03	Demonstrate the design and fabrication methods of thermal sensors and its applications	K2
C04	Illustrate the fabrication process of Piezo electric sensors and actuators & applications	K2
C05	Explain the magnetic actuators & Micro fluid applications towards medical applications	K2

4. Correlation with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	L	H							L	L
CO2	H	H	H	M	L	H							M	M
CO3	H	H	H	M	L	H							M	M
CO4	H	H	H	M	L	H							M	M
CO5	H	H	H	M	L	H							M	M

H- Strong; M-Medium; L-Low

5. Course content

UNIT I FOUNDATION IN MICROSYSTEMS L-9

Review of Microelectronics Manufacture and Introduction to MEMS - Overview of Micro Systems Technology, Laws of Scaling - The Multi Disciplinary Nature of MEMS - Survey of Materials Central to Micro Engineering - Applications of MEMS in Various Industries

UNIT II MICRO MANUFACTURING TECHNIQUES L-9

Photolithography - Film Deposition, Etching Processes - Bulk Micro Machining, Silicon Surface Micro Machining - LIGA Process - Rapid Micro Product Development.

UNIT III MICRO SENSORS L-9

Introduction, Micro-Sensor Measurement Principle, Micro-Sensor Fabrication Techniques, Modeling, Micro Pressure Sensors, Micro Accelerometer, Sensors, Micro Thermal Sensors, Micro Floor Sensors, Micro Chemical Sensors, Micro Optical Sensors, Micro Sensor for Humidity and Displacement, Application of Micro Sensors, MEMS Based Gyro

UNIT IV MICRO ACTUATORS L-9

Introduction, Classification of Micro Actuators, Electro Static, Optical Micro – Actuators Energy Conversion and Force Generation-Electromagnetic Actuators, Reluctance Motors, Piezoelectric Actuators, Bi-Metal-Actuator Friction and Wear -Transducer Principles

UNIT V INTRODUCTION TO MICRO/NANO FLUIDS L-9

Fundamentals of Micro Fluidics- Micro Pump – Introduction – Types - Mechanical Micro Pump Non Mechanical Micro Pumps, Actuating Principles, Design Rules for Micro Pump – Modeling and Simulation, Verification and Testing –Applications.

TOTAL: 45 periods

6. Text Books

1. Chang Liu, "Foundations of MEMS", Pearson International Edition, 2006.
2. Marc Madou , "Fundamentals of microfabrication",CRC Press, 1997.

7. References

1. Richard, W., Heine Carl R. Loper Jr. and Philip, C., Rosenthal, Principles of Metal Casting, McGraw-Hill Book Co., 1980.
2. IS: 1602 – 1960 Code for testing of variable speed internal Combustion engines for Automobile Purposes, 1966.

8. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	10	10	15
Understand	80	80	90	90	85
Apply					

Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	50	60
Analyse	50	40
Evaluate		
Create		

9. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Review of microelectronics manufacture and introduction to MEMS	1	Lecture with discussions/ Seminar/ Assignment
2	Overview of micro systems technology, Laws of scaling	2	
3	The multi disciplinary nature of MEMS	2	
4	Survey of materials central to micro engineering	2	
5	Applications of MEMS in various industries	2	
	UT-I (CO1)		
	Unit –II	**(9)**	
6	Photolithography	1	Lecture with discussions/ Seminar/ Assignment
7	Film deposition, Etching Processes	2	
8	Bulk micro machining, silicon surface micro machining	2	
9	LIGA process	2	
10	Rapid micro product development.	2	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	

S.No	Topics to be covered	No. of periods	Content Delivery Method
11	Introduction, Micro-sensor measurement principle, Micro-sensor fabrication techniques, modeling	2	Lecture with discussions/ Seminar/ Assignment
12	Micro pressure sensors, Micro accelerometer, sensors, Micro thermal sensors	2	
13	Micro floor sensors, Micro chemical sensors	1	
14	Micro optical sensors, Micro sensor for humidity and displacement	2	
15	Application of micro sensors, MEMS based gyro	2	
	UT-II (CO3)		
	Unit IV	**(9)**	
16	Introduction, classification of micro actuators, electro static, optical micro	1	Lecture with discussions/ Seminar/ Assignment
17	Actuators Energy conversion and force generation	1	
18	Electromagnetic Actuators, Reluctance motors	2	
19	Piezoelectric actuators	2	
20	Bi-metal-actuator Friction and wear	2	
21	Transducer principles	1	
	Unit V	**(9)**	
22	Fundamentals of micro fluidics	1	Lecture with discussions/ Seminar
23	Micro pump – introduction – Types	2	
24	Mechanical Micro pump Non mechanical micro pumps, Actuating Principles	2	
25	Design rules for micro pump	2	
26	Modeling and simulation, Verification and testing – Applications.	2	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

		L	T	P	C
1152AU116	**TRANSPORT MANAGEMENT**	**3**	**0**	**0**	**3**

1. Preamble

This course provides the knowledge of fleet management, motor vehicle act and cost reduction of fleet operations and maintenance

2. Pre-requisite

NIL

3. Links to other Courses

- Automotive safety
- Quality management
- Engineering economics

3. Course Educational Objectives

Students undergoing this course are expected to

- Manage a transport fleet and their related activities for minimizing operational cost.

4. Course Outcomes:

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Apply the principles of personnel management	K3
C02	Describe the various transport systems and advantages of motor transport.	K2
C03	Assess the operating costs for transport vehicles and estimate the fare structure.	K3
C04	Apply the Motor Vehicle Act in fleet management	K3
C05	Apply the various Maintenance activities to vehicles	K3

5. Correlation of COs with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H			H	H		H					H	M	L
CO2	H			H	H		H					H	M	L
CO3	H			H	H		H					H	M	M
CO4	H			H	H		H					H	L	M
CO5	H			H	H		H					H	L	M

H- Strong; M-Medium; L-Low

6. Course Content:

UNIT I INTRODUCTION L-9

Personnel Management - Objectives and Functions of Personnel Management, Psychology, Sociology and their Relevance to Organization, Personality Problems. Selection Process - Job Description, Employment Tests, Interviewing, Introduction to Training Objectives, Advantages, Methods of Training, Training Procedure, Psychological Tests.

UNIT II TRANSPORT SYSTEMS L-9

Introduction to Various Transport Systems. Advantages of Motor Transport. Principle Functions of Administrative, Traffic, Secretarial and Engineering Divisions. Chain of Responsibility Forms of Ownership by State, Municipality, Public Body and Private Undertakings.

UNIT III SCHEDULING AND FARE STRUCTURE L-9

Principal Features of Operating Costs for Transport Vehicles with Examples of Estimating The Costs. Fare Structure and Method of Drawing Up of a Fare Table. Various Types of Fare Collecting Methods. Basic Factors of Bus Scheduling. Problems on Bus Scheduling.

UNIT IV MOTOR VEHICLES ACT L-9

Traffic Signs, Fitness Certificate, Registration Requirements, Permit Insurance, Constructional Regulations, Description of Vehicle-Tankers, Tippers, Delivery Vans, Recovery Vans, Power Wagons and Fire Fighting Vehicles. Spread Over, Running Time, Test for Competence to Drive.

UNIT V MAINTENANCE L-9

Preventive Maintenance System in Transport Industry, Tyre Maintenance Procedures. Causes for Uneven Tyre Wear - Remedies, Maintenance Procedure for Better Fuel Economy, Design of Bus Depot Layout.

Total: 45 Periods

7. Textbooks

1. John Duke - Fleet Management – McGraw-Hill Co, USA -1984.
2. Kitchin.L.D., - Bus Operation - Illiffee and Sons Co., London, III edition – 1992

8. References

1. Government Motor Vehicle Act –Publication on latest act to be used as on date

9. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember		40			10
Understand	10	60	10	10	10
Apply	90		90	90	80
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	30	30
Analyse	70	70
Evaluate		
Create		

10. Lecture plan:

S.No.	Topic	No. of periods	Content Delivery methods
	Unit-I	**(9)**	
1	Personnel management; objectives and functions of personnel management	1	Lecture with discussion/ Assignment/ Seminar
2	Psychology, sociology and their relevance to organization	1	
3	Personality problems	1	
4	Selection process: job description	1	
5	Employment tests, interviewing,	1	
6	Introduction to training objectives	1	
7	Advantages, methods of training	1	
8	Training procedure	1	
9	Psychological tests	1	
	UT-I (CO1)		
	Unit–II	**(9)**	
10	Introduction to various transport systems	1	
11	Advantages of motor transport	1	
12	Principe l function of administrative	1	

S.No.	Topic	No. of periods	Content Delivery methods
13	Traffic, secretarial divisions	1	Lecture with discussion/ Assignment/ Seminar
14	Engineering divisions	1	
15	Chain of responsibility	1	
16	Forms of ownership by state	1	
17	Municipality undertakings.	1	
18	Public body and private undertakings.	1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
19	Principal features of operating costs for transport vehicles with examples of estimating the costs.	1	Lecture with discussion/ Assignment/ Seminar
20		1	
21	Fare structure and method of drawing up of a fare table	1	
22		1	
23	Various types of fare collecting methods	1	
24	Basic factors of bus scheduling	1	
25	Problems on bus scheduling.	1	
26	Revision	1	
27	Seminar	1	
	UT-II (CO3)		
	Unit IV	**(9)**	
28	Traffic signs, fitness certificate	1	Lecture with discussion/ Assignment/ Seminar
29	Registration requirements	1	
30	Permit insurance	1	
31	Constructional regulations, description of vehicle-tankers	1	
32	Constructional regulations, description of vehicle- tippers, delivery vans, recovery vans,	2	
33	Power wagons and fire fighting vehicles	1	
34	Spread over, running time	1	
35	Test for competence to drive.	1	
	Unit V	**(9)**	
36	Preventive maintenance system in transport industry	1	Lecture with discussion/ Assignment/ Seminar
37	Tyre maintenance procedures.	1	
38	Causes for uneven tyre wear	1	
39	Remedies for uneven tyre wear;	1	
40	Maintenance procedure for better fuel economy	1	
41	Design of bus depot layout.	2	
42	Revision	1	
43	Seminar	1	
	MT – II (CO3, CO4, CO5)		
	Total	**45**	

		L	T	P	C
1152AU117	**INTEGRATED PRODUCT DEVELOPMENT**	**3**	**0**	**0**	**3**

1. Preamble:
This course is designed to provide the knowledge about the concepts of various tools and approaches available for product development.

2. Prerequisite:
1150MA202 Engineering Mathematics-I

3. Link to other Courses:
- Total Quality Management.

4. Course Educational Objectives:
Students undergoing this course are expected to:
- Understand the concepts of tools and techniques in the Integrated Product Development area of the Engineering Services industry.
- Relate the engineering topics into real world engineering applications.

5. Course Outcomes:
Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Summarise the various trends affecting product decision	K2
CO2	Identify the requirements to create new product	K3
CO3	Compare different techniques involved in design creation and design testing	K2
CO4	Rephrase the methods of model creation and integration between software and hardware.	K2
CO5	Illustrate the need of end of life and patenting.	K2

(K1 – Remember; **K2** – Understand; **K3** – Apply ;.)

6. Correlation of COs with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		L			M							L	L	M
CO2						M						L	H	H
CO3	M	H			L							L	M	M
CO4	L					M						L		M
CO5		M				L						L	L	M

H- High; M-Medium; L-Low

7. Course Content:

UNIT I FUNDAMENTALS OF PRODUCT DEVELOPMENT L-9

Global Trends Analysis and Product Decision - Types of Various Trends Affecting Product Decision - Social Trends - Technical Trends - Economical Trends - Environmental Trends - Political/ Policy Trends - PESTLE Analysis. Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development - Overview of Product Development Methodologies - Product Life Cycle - Product Development Planning and Management .

UNIT II REQUIREMENTS AND SYSTEM DESIGN L-9

Requirement Engineering: Types of Requirements- Requirement Engineering- Analysis - Traceability Matrix and Analysis - Requirement Management. System Design & Modeling - Introduction to System Modeling - Introduction to System Optimization - System Specification- Sub-System Design- Interface Design.

UNIT III DESIGN AND TESTING L-9

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept Generation Techniques - Concept Screening & Evaluation - Concept Design - S/W Architecture - Hardware Schematics and Simulation - Detailed Design - Component Design and Verification - High Level Design/Low Level Design of S/W Programs - S/W Testing - Hardware Schematic - Component Design - Layout and Hardware Testing.

UNIT IV IMPLEMENTATION & INTEGRATION L-9

Prototyping: Types of Prototypes – Introduction to Rapid Prototyping and Rapid Manufacturing. System Integration – Testing - Certification and Documentation - Introduction to Manufacturing /Purchase and Assembly of Systems - Integration of Mechanical, Embedded and S/W Systems - Introduction to Product Verification and Validation Processes - Product Testing Standards, Certification and Documentation.

UNIT V SUSTENANCE ENGINEERING AND BUSINESS DYNAMICS L-9

Sustenance - Maintenance and Repair - Enhancements Product End of Life (EoL), Obsolescence Management - Configuration Management - EoL Disposal. The Industry - Engineering Services Industry Overview - Product Development in Industry Versus Academia The IPD Essentials - Introduction to Vertical Specific Product Development Processes - Product Development Trade–Offs - Intellectual Property Rights and Confidentiality - Security and Configuration Management

TOTAL=45 periods

8. Text Books:

1. NASSCOM student Handbook "Foundation Skills in Integrated Product Development".
2. Anita Goyal, Karl T Ulrich, Steven D Eppinger, “Product Design and Development “, 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9

9. References:

1. George E.Dieter, Linda C.Schmidt, “Engineering Design”, McGraw-Hill International Edition, 4th Edition, 2009, ISBN 978-007-127189-9
2. Kevin Otto, Kristin Wood, “Product Design”, Indian Reprint 2004, Pearson Education,ISBN. 9788177588217

3. YousefHaik, T. M. M. Shahin, "Engineering Design Process", 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141
4. Clive L.Dym, Patrick Little, "Engineering Design: A Project-based Introduction", 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7
5. Product Design Techniques in Reverse Engineering and New Product Development, KEVIN OTTO & KRISTIN WOOD, Pearson Education (LPE), 2001.
6. The Management and control of Quality-6th edition-James R. Evens, William M Lindsay Pub:son south-western(www.swlearning.com)

10. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	40		20	10	10
Understand	60	40	80	90	70
Apply		60			20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 &CO2) (Max marks in %)	II (CO3&CO4) (Max marks in %)
Remember		
Understand	20	20
Apply	80	80
Analyse		
Evaluate		
Create		

11. Lecture plan:

S.No	Topic	No. of periods	Content Delivery Methods
	UNIT I	**9**	
1	Types of various trends affecting product decision	1	Lecture with discussion/ assignment/ seminar/ case studies
2	Social Trends	1	
3	Technical Trends		
4	Economical Trends		
5	Environmental Trends		
6	Political/ Policy Trends		
7	PESTLE Analysis.	1	
8	Overview of Products and Services	1	
9	Types of Product Development	2	
10	Overview of Product Development methodologies	1	
11	Product Life Cycle	1	
12	Product Development Planning and Management.	1	
	Unit Test I (CO1)		
	UNIT II	**9**	
13	Types of Requirements	1	Lecture with discussion/ lecture with demonstration/ assignment/ seminar/ case studies
14	Requirement Engineering & Analysis	1	
15	Traceability Matrix and Analysis	1	
16	Requirement Management	1	
17	Introduction to System Modeling	1	
18	Introduction to System Optimization	1	
19	System Specification	1	
20	Sub System Design	1	
21	Interface Design.	1	
	Mid Term I (CO1, CO2)		
	UNIT III	**9**	
22	Industrial Design and User Interface Design	1	Lecture with discussion/ lecture with demonstration/ assignment/ seminar/ case studies
23	Introduction to Concept generation Techniques		
24	Concept Screening & Evaluation	1	
25	Concept Design	1	
26	S/W Architecture	1	
27	Hardware Architecture		
28	Component Design and Verification	1	
29	High Level Design/Low Level Design of S/W Programs	1	
30	S/W Testing	1	
31	Hardware Schematic	1	
32	Component design		
33	Layout and Hardware Testing Schematics and simulation	1	
	Unit Test II (CO3)		
	UNIT IV	**9**	
34	Introduction to Rapid Prototyping	1	

35	Rapid Manufacturing	1	Lecture with discussion/ lecture with demonstration/ assignment/ seminar/ case studies
36	Introduction to Manufacturing/Purchase	1	
37	Assembly of Systems	1	
38	Integration of Mechanical	1	
39	Embedded and S/W systems	1	
40	Introduction to Product verification and validation processes	1	
41	Product Testing standards.	1	
42	Certification	1	
43	Documentation		
	UNIT V	**9**	
44	Maintenance and Repair	1	Lecture with discussion/ seminar/ case studies
45	Enhancements		
46	Obsolescence Management	1	
47	Configuration Management	1	
48	EoL Disposal	1	
49	Engineering Services Industry overview	1	
50	Product development	1	
51	Introduction to vertical specific product development processes	1	
52	Product development Trade offs		
53	Intellectual Property Rights and Confidentiality	1	
54	Security and configuration management in Industry versus Academia	1	
	Mid Term II (CO3, CO4,CO5)		
Total		**45**	

		L	T	P	C
1152AU118	**TOTAL QUALITY MANAGEMENT**	**3**	**0**	**0**	**3**

1. Preamble:

This course Total Quality Management concept and principles and the various tools are available to achieve Total Quality Management, and to enhance the statistical approach for quality control. To create awareness about the ISO and QS certification process and its needs for the industries

2. Prerequisite:

NIL

3. Link to other Courses:

NIL

4. Course Educational Objectives :

Students undergoing this course are expected to

- Demonstrate knowledge of quality management principles, techniques and philosophies.
- Apply statistical process control technique to improve the quality.
- Demonstrate knowledge of TQM tools for industries.
- Apply appropriate techniques for reliability assessment.
- Demonstrate knowledge of advanced techniques for reliability engineering..

5. Course Outcomes :

The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Demonstrate knowledge of quality management principles, techniques and philosophies	K2
CO2	Apply statistical process control technique to improve the quality.	K2
CO3	Demonstrate knowledge of TQM tools for industries.	K2
CO4	Apply appropriate techniques for reliability assessment.	K2
CO5	Demonstrate knowledge of advanced techniques for reliability engineering.	K2

6. Correlation of COs with Programme Outcomes :

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L		H	M	H		L			H			L	L
CO2	L		M		M	L				H			M	M
CO3	L				H	H	L	M					M	L
CO4		M	L			M		L			M		L	L
CO5	L		H		M		L				M		M	M

H- High; M-Medium; L-Low

7. Course Content

UNIT I INTRODUCTION **L-9**

Definition of Quality, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Strategic Planning, Deming Philosophy, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen

UNIT II STATISTICAL PROCESS CONTROL (SPC) **L-9**

The Seven Tools of Quality, Statistical Fundamentals, Population and Sample, Normal Curve, Control Charts For Variables And Attributes, Process Capability, Concept of Six Sigma, New Seven Management Tools.

UNIT III TQM TOOLS AND QUALITY SYSTEMS **L-9**

Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, Need For ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Quality Auditing

UNIT IV INTRODUCTION TO RELIABILITY **L-9**

Importance of Reliability, Performance Cost and Reliability, Quality and Safety, System Configuration with Examples, Stochastic Processes, Bathtub Concept, MTBF, MTTR, Hazard Rate, Failure Rate, Probability and Sampling, Cumulative Probability Distribution Function, Data and Distributions.

UNIT V RELIABILITY IN DESIGN AND LIFE CYCLE COSTING **L-9**

Survival Rate, Bath-Tub Curve Analysis of Characteristics of Failure Regimes, Design Synthesis, Reliability Effort Function, Safety Margin, Allocation of Reliabilities by AGREE, ARINC, Proportional Distribution of Unreliability, Heuristic Method, Mean and Median Methods.

Total: 45 periods

8. Text Books:

1. Joel E. Rose, Total Quality Management, 3rd Edition, Kogan Page Ltd., USA 1999
2. Srinath, L. S., Reliability Engineering, Affiliated East West Press, New Delhi 2005

9. References:

1. James R.Evans& William M.Lidsay, "The Management and Control of Quality", (5th Edition), South-Western (Thomson Learning), 2002 (ISBN 0-324-06680-5).
2. Feigenbaum.A.V. "Total Quality Management", McGraw Hill, 1991.
3. Zeiri. "Total Quality Management for Engineers", Wood Head Publishers, 1991.
4. E. E. Lewis, "Introduction to Reliability Engineering", John Wiley and Sons.
5. S. S. Rao, "Reliability Engineering".

10. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	20	20	20	20	15
Understand	80	80	80	80	85
Apply					
Analyse					
Evaluate					
Create					

1.

Revised Bloom's Category	Assignments	
	I (CO1 & CO2) (Max marks in %)	II (CO3 & CO4) (Max marks in %)
Remember		
Understand		
Apply	30	20
Analyze	70	80
Evaluate		
Create		

11. Lecture plan:

S.No.	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Definition of Quality, Historical Review	1	Lecture with discussions/ Seminar/ Case Studies
2	Principles of TQM, Leadership – Concepts	1	
3	Role of Senior Management,	1	
4	Quality Council	1	
5	Strategic Planning	1	
6	Deming Philosophy	1	
7	Continuous Process Improvement – Juran Trilogy	1	
8	PDSA Cycle	1	
9	5S, Kaizen	1	
	Unit Test I (CO1)		
	Unit –II	**(9)**	
10	The seven tools of quality	1	Lecture with discussions Seminar Assignment
11	Statistical Fundamentals	1	
12	Food chains, food webs		
13	Ecological pyramids	1	
14	Population and Sample	1	
15	-Normal Curve	1	

S.No.	Topics to be covered	No. of periods	Content Delivery Method
16	Control Charts for variables and attributes	1	
17	Process capability	1	
18	Concept of six sigma	1	
19	New seven Management tools	1	
	Mid Term I (CO1, CO2)		
	Unit-III	**(9)**	
20	Quality Function Deployment (QFD)	1	Lecture with discussions Seminar Case Studies Demonstrations
21	House of Quality, QFD Process	1	
22	Benefits, Taguchi Quality Loss Function	1	
23	Total Productive Maintenance (TPM) – Concept	1	
24	Improvement Needs,	1	
25	Need for ISO 9000 and Other Quality Systems	1	
26	ISO 9000:2000 Quality System– Elements	1	
27	Implementation of Quality System	1	
28	Quality Auditing	1	
	Unit Test II (CO3)		
	Unit IV	**(9)**	
29	Importance of reliability	1	Lecture with discussions Seminar Case Studies Assignment
30	Performance cost and reliability	1	
31	Quality and safety	1	
32	System configuration with examples,	1	
33	Stochastic processes	1	
34	Bathtub concept	1	
35	MTBF, MTTR, hazard rate	1	
36	Failure rate, probability and sampling	1	
37	Cumulative probability distribution function, data and distributions.	1	
	Unit V	**(9)**	
38	Survival rate	1	Lecture with discussions Seminar
39	Bath-tub curve analysis of characteristics of failure regimes	1	
40	Design synthesis,	1	
41	Reliability effort function, safety margin	1	
42	Allocation of reliabilities by AGREE	1	
43	ARINC, proportional distribution of unreliability	1	
44	Heuristic method, mean and median methods.	1	
45	Revision	1	
	Mid Term Test II (CO3,CO4,CO5)		
	Total	**45**	

		L	T	P	C
1152AU119	**AUTOMOTIVE MATERIALS**	**3**	**0**	**0**	**3**

1. Preamble

This course imparts the knowledge on the structure, properties, heat treatment, mechanical property evaluation and applications of ferrous and non-ferrous metals to select the appropriate material for suitable applications.

2. Prerequisite

1150PH101 Engineering Physics

3. Links to other courses

- Engine Design and Development
- Vehicle Design and Data Characteristics

4. Course Educational Objectives

Students undergoing this course are expected to:

- Gain knowledge in properties and structures of solids.
- Acquire the knowledge about various phase diagrams of both ferrous and non-ferrous metals.
- Attain knowledge in heat treatment of steels, properties of non ferrous alloys and evaluate the mechanical properties of different metals.
- Impart the knowledge about the failure mechanism of ductile and brittle materials.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the different crystallographic structures and crystal imperfection in solids	K2
CO2	Explain the different types of phase diagrams and properties of ferrous and non ferrous metals.	K2
CO3	Apply different heat treatment process in metal industries.	K3
CO4	Distinguish different strengthening mechanism and fracture.	K2
CO5	Interpret the mechanical properties of the given material.	K2

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	L	L				M		M		M	H
CO2	H	H	H	L	L				M		M		M	M
CO3	H	H	H	L	L				M		M		M	M
CO4	H	H	H	L	L				M		M		M	M
CO5	H	H	H	L	L				M		M		H	H

H- High; M-Medium; L-Low

7. Course Content

UNIT I CRYSTALLOGRAPHY L-9

Classification of Materials, Engineering Properties of Materials, Structure of Solid Materials- BCC, FCC & HCP Structures - Atomic Packing Factor - Miller Indices, Crystallographic Direction, Crystallographic Plane, Solid Solution, Types of Solid Solution, Crystal Imperfection - Point Defects, Line Defects – Edge Dislocation, Screw Dislocation, Surface Defects and Volume Defects.

UNIT II FERROUS AND NON FERROUS METALS AND PHASE DIAGRAM L-9

Introduction to Phase Diagram, Gibbs Phase Rule, Binary Equilibrium Diagram, Isomorphus System - Tie Line Rule and Lever Rule, Iron-Iron Carbide Diagram, Effect of Alloying Additions on Steel (Mn, Si, Cr, Mo, V Ti & W) , Types of Steel - HSLA - Maraging Steels – Trip Steels, Tool Steels, Types Stainless Steels —Types of Cast Irons - Copper and its Alloys – Aluminum and its Alloys.

UNIT III HEAT TREATMENT L-9

Importance of Heat Treatment – TTT - Time Temperature Transformation Diagram (Isothermal Transformation Diagram), CCT Diagram – Cooling Curves Superimposed on I.T. Diagram, Types of Heat Treatment Processes – Different Types of Annealing Process, Normalizing, Quenching and Tempering of Steel – Hardenability - Grossman's Critical Diameter, Jominy End Quench Test – Austempering, Martempering Case Hardening, Carburizing, Nitriding, Cyaniding, Carbonitriding – Flame and Induction Hardening.

UNIT IV MECHANICAL PROPERTIES OF MATERIALS & FRACTURE L-9

Mechanisms of Plastic and Elastic Deformations, Slip and Twinning, Recover Recrystallization and Grain Growth - Strengthening Mechanism - Strain Hardening, Precipitation Hardening, Refinement of Grain, Solid Solution Strengthening, Types of Fracture - Ductile and Brittle Fracture - Griffith's Theory, Creep - Mechanisms of Creep - Creep Resistant Materials, Fatigue Failure - Sn Curve - Factors Affecting Fatigue Life, Prevention of Fatigue Failure.

UNIT V MECHANICAL TESTING L-9

Tensile Test - Stress Strain Curves for Ductile and Brittle Materials - Mild Steel, Copper, Concrete and Cast Iron, Proof Stress, Yield Point Phenomenon - Compression and Shear Loads, Hardness Tests (Brinell, Vicker's and Rockwell) - Impact Test- Izod and Chorpy, Fatigue and Creep Test, Fracture Toughness Tests. Non- Destructive Testing Processes.

Total: 45 Periods

8. Text Books

1. Sidney H. Avner, Introduction to Physical Metallurgy, Tata Mcgraw Hill, 2010.
2. Raghavan V. Physical Metallurgy, Prentice – Hall of India Private Limited, 2nd Edition 2006.

9. References

1 Dieter, G. E., Mechanical Metallurgy, McGraw Hill, Singapore, 2012.
2 Thomas H. Courtney, Mechanical Behaviour of Engineering Materials, McGraw Hill, Singapore, 2011.
3 William D Callister "Material Science and Engineering", John Wiley and Sons, 2010.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	40	30			20
Understand	60	70	30	60	60
Apply			70	40	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 Addressed) (Max marks in %)	II (CO3 & CO4 Addressed) (Max marks in %)
Remember		
Understand		
Apply	50	50
Analyse	50	50
Evaluate		
Create		

11. Lecture plan

S.No	Topic	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Classification of Materials, Engineering properties of materials	1	Lecture with discussions/ Seminar/ Assignment
2	Structure of Solid materials-	1	
3	BCC- FCC & HCP Structures- Atomic Packing factor	1	
4	Miller Indices, crystallographic direction, crystallographic Plane	1	
5	Solid Solution, Types of Solid Solution	1	
6	Crystal imperfection	1	
7	point defects, line defects	1	
8	Edge dislocation, Screw dislocation	1	
9	surface defects and volume defects	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
10	Introduction to Phase Diagram	1	Lecture with discussions/ Seminar/ Assignment
11	Gibbs phase Rule, Binary Equilibrium diagram	1	
12	Isomorphus system - Tie Line Rule and Lever Rule	1	
13	Iron-Iron carbide Diagram	1	
14	Effect of alloying additions on steel (Mn, Si, Cr, Mo, V Ti & W)	1	
15	Types of steel - HSLA - Maraging steels	1	
16	TRIP Steels, Tool Steels, Types Stainless Steels	1	
17	Types of Cast Irons -Copper and its alloys	1	

S.No	Topic	No. of periods	Content Delivery Method
18	Aluminum and its alloys	1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
19	Importance of Heat Treatment	1	Lecture with discussions/ Seminar/ Assignment
20	TTT- Time Temperature Transformation Diagram (Isothermal Transformation diagram)	2	
21	CCT diagram – cooling curves superimposed on I.T. diagram	1	
22	Types of Heat treatment Processes	1	
23	Annealing process, Normalizing, Quenching and Tempering of steel,	1	
24	Hardenability - Grossman's critical diameter, Jominy end quench test	1	
25	Austempering, Martempering	1	
26	Case hardening, Carburising, Nitriding, Cyaniding, Carbonitriding – Flame and Induction hardening	1	
	UT-II (CO3)		
	Unit IV	**(9)**	
27	Mechanisms of Plastic and Elastic deformations, Slip and Twinning	2	Lecture with discussions/ Seminar/ Assignment
28	Recover Recrystallization and Grain growth	1	
29	Strengthening Mechanism- Strain hardening	1	
30	Precipitation hardening, Refinement of Grain, solid solution strengthening	1	
31	Types of Fracture-, Ductile and Brittle fracture	1	
32	Griffith's theory, Creep	1	
33	Mechanisms of Creep- Creep resistant materials	1	
34	Fatigue Failure- SN curve	1	
35	Factors affecting fatigue life, prevention of fatigue failure	1	
	Unit V	**(9)**	
35	Tensile test- Stress Strain curves for Ductile and Brittle materials	1	Lecture with discussions/ Seminar/ Assignment
36	Mild steel, Copper	1	
37	Concrete, and Cast iron	1	
38	Proof Stress, Yield point phenomenon	1	
39	Compression and shear loads	1	
40	Hardness tests (Brinnel, Vicker's and Rockwell)	1	
41	Impact test- Izod and Chorpy	1	
42	Fatigue and creep test	1	
43	Fracture toughness tests	1	
	MT 2 (CO3, CO4, CO5)		
	Total	**45**	

		L	T	P	C
1152AU120	**AUTOMOTIVE COMPONENTS MANUFACTURING**	**3**	**0**	**0**	**3**

1. Preamble

This course enables the students to select suitable materials for manufacturing Automobile components and recent developments in materials and manufacturing technologies will be discussed.

2. Pre-Requisite

1151AU104 Manufacturing Technology

3. Links to Other Courses

- Strength of materials

4. Course Educational Objectives

Students undergoing this course are expected to

- Develop the knowledge for identifying and selecting the suitable materials for automotive applications.
- Understand the various types of manufacturing process.

5. Course Outcomes:

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the elastic and plastic behavior of materials	K2
CO2	Select suitable materials and explain the manufacturing process of clutch and brake components	K2
CO3	Explain the forging and extrusion process involved in manufacturing of valves, connecting rod, crank shaft, cam shaft, propeller shaft, transmission gear blanks, steering column, wheel disc and body panels.	K2
CO4	Discuss the operation involved in manufacturing of cylinder block and liners, flywheel, piston rings, bearing bushes, carburetor, front and rear axle housings through casting and machining process.	K2
CO5	Generalize the recent techniques in production of automobile components	K2

6. Correlation of COs with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	H	H	H	H	L						M		H	M
CO 2	H	H	H	H	L						M		M	M
CO 3	H	H	H	H	L						M		H	H
CO 4	H	H	H	H	L						M		M	H
CO 5	H	H	H	H	L						M		L	M

H- High; M-Medium; L-Low

7. Course Contents

UNIT I ELASTIC AND PLASTIC BEHAVIOR OF MATERIALS L- 9

Elasticity - Forms - Stress and Strain Relationship in Engineering Materials - Deformation Mechanism - Strengthening Material - Strain Hardening, Alloying, Polyphase Mixture, Martensitic Recipitation, Dispersion, Fiber and Texture Strengthening - Iron Carbon Diagram.

UNIT II POWDER METALLURGY AND PROCESSING OF PLASTICS L- 9

Powder Metallurgy Process – Sintering Process Variables, Manufacture of Friction Lining Materials for Clutches and Brakes – Plastics - Raw Material – Automobile Components –Molding – Injection, Compression and Blow – PU Foam Molding - Machining of Plastics.

UNIT III FORGING AND EXTRUSION PROCESS L- 9

Forging Materials - Process Flow Chart, Forging 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. Hydro Forming - Process, Hydro Forming of 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.

UNIT IV CASTING AND MACHINING L- 9

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 Carburetor Other Small Auto Parts. Machining of Connecting Rods – Crankshafts - 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.

UNIT V RECENT TRENDS IN MANUFACTURING OF AUTO COMPONENTS L- 9

Powder Injection Molding - Production of Aluminum MMC Liners for Engine Blocks - Plasma Spray Coated Engine Blocks and Valves - Recent Developments in Auto Body Panel Forming – Squeeze Casting of Pistons - Aluminum Composite Brake Rotors. Sinter Diffusion Bonded Idler Sprocket – Gas Injection Molding of Window Channel – Cast Con Process for Auto Parts - PVD and CVD Coatings.

8. Text Book

1. Heldt.P.M., " High Speed Combustion Engines ", Oxford Publishing Co., NewYork, 1990.

9. References

1. Haslehurst.S.E., " Manufacturing Technology ", ELBS, London, 1990.
2. Rusinoff, " Forging and Forming of metals ", D.B. Taraporevala Son & Co. PvtLtd., Mumbai, 1995.
3. Sabroff.A.M. & Others, "Forging Materials & Processes ", Reinhold BookCorporation, New York, 1988.
4. Upton, "Pressure Die Casting ", Pergamon Press, 1985.
5. High Velocity "Forming of Metals ", ASTME, prentice Hall of India (P) Ltd.,New Delhi, 1990.

10. Revised Bloom's based Assessment Pattern :

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	20	20	20	20	20
Understand	80	80	80	80	80
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 &CO2) (Max marks in %)	II (CO3&CO4) (Max marks in %)
Remember		
Understand		
Apply	10	10
Analyse	90	90
Evaluate		
Create		

11. Lecture plan

S.No	Topic	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Elasticity-forms	1	Lecture with discussions/ Seminar/ Assignment
2	Stress and strain relationship in engineering materials	1	
3	Deformation mechanism	1	
4	Strengthening material	1	
5	Strain hardening	1	
6	Alloying	1	
7	Polyphase mixture	1	
8	Martensitic recipitation, dispersion, fiber and texture strengthening	1	
9	Iron carbon diagram	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
10	Powder metallurgy process, process variables	2	Lecture with discussions/ Seminar/ Assignment
11	Manufacture of friction lining materials for clutches and brakes	2	
12	Plastics-raw material	1	
13	Automobile components –molding – injection, compression and Blow	2	
14	PU foam molding	1	
15	Machining ofplastics.	1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
16	Forging materials - process flow chart, Forging of valves, connecting rod, crank shaft, cam shaft, propeller shaft, transmission gear blanks, steering column	2	Lecture with discussions/ Seminar/ Assignment
17	Extrusions: Basic process steps, extrusion of transmission shaft, housing spindle, steering worm blanks, piston pin and valve tappets	2	
18	Hydro forming - Process, hydro forming of manifold and comparison with conventional methods	2	
19	Hydro forming of tail lamp housing – forming of wheel disc and rims	1	
20	Stretch forming - Process, stretch forming of auto body panels	1	
21	Super plastic alloys for auto body panels.	1	

S.No	Topic	No. of periods	Content Delivery Method
	UT-II (CO3)		
	Unit IV	**(9)**	
22	Sand casting of cylinder block and liners	2	Lecture with discussions/ Seminar/ Assignment
23	Centrifugal casting of flywheel, piston rings, bearing bushes, and liners, permanent mould casting of piston, pressure die-casting of carburetor other small auto parts	3	
24	Machining of connecting rods – crankshafts - cam shafts - pistons - piston pins - piston rings	2	
25	Machining of valves - front and rear axle housings - fly wheel	1	
26	Honing of cylinder bores - Copy turning and profile grinding machines.	1	
	Unit V	**(9)**	
27	Powder injection molding	1	Lecture with discussions/ Seminar/ Assignment
28	Production of aluminum MMC liners for engine blocks	1	
29	Plasma spray coated engine blocks and valves	1	
30	Recent developments in auto body panel forming	2	
31	Squeeze Casting of pistons - aluminum composite brake rotors	1	
32	Sinter diffusion bonded idler sprocket	1	
33	Gas injection molding of window channel	1	
34	Cast con process for auto parts	1	
MT 2 (CO3, CO4, CO5)			
Total		**45**	

		L	T	P	C
1152AU130	**REGULATORY MECHANISM FOR TRANSPORTATION SYSTEMS**	**3**	**0**	**0**	**3**

1. Preamble

This course imparts knowledge of regulatory mechanism for vehicle certification, control of traffic, insurance.and acts & rules for offroad and speciality vehicle.

2. Pre-requisite

NIL

3. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Explain the Motor Vehicle Act	K2
C02	Describe state motor vehicle act to certify the vehicle on the safety aspects.	K2
C03	Explain the trends in controlling traffic and procedure of insurance investigation.	K2
C04	Describe the vehicle approval procedure for certification.	K2
C05	Illustrate the acts and rules of off-road and specialty vehicles.	K2

(K2-understand, K3-Apply, K4-Analysis)

4. Correlation with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	L	H							L	L
CO2	H	H	H	M	L	H							L	L
CO3	H	H	H	M	L	H							L	L
CO4	H	H	H	M	L	H							L	L
CO5	H	H	H	M	L	H							L	L

H- Strong; M-Medium; L-Low

5. Course Content

UNIT I REGULATORY FRAMEWORK OF CMVR **L-9**

Introduction to CMVR 1989, Introduction to Licenses of Drivers of Motor Vehicles, Licensing of Drivers of Motor Vehicles - Unified Drivers Licensing Registry, Licensing - Modified Fitness, Driving Test, Refresher Training - Registration of Motor Vehicles - Unified Motor Vehicle

Registration System, Fitness of Vehicles, Suspension of Registration, Cancellation of Registration, Unique Identification Number/Registration Number, Control of Transport Vehicles - Tourist Permit and National Permit, Centralized Permit and Tax Submission System, Construction Equipment and Maintenance Of Motor Vehicles.

UNIT II INTRODUCTION TO VEHICLE CERTIFICATION L-9

Introduction to State Motor Vehicle Acts, Compliance of Motor Vehicles, Dimensions of Motor Vehicles, Tyre Requirements for the Motor Vehicles, Braking System Compliance, Steering System Compliance, Wiping System Compliance, Lights and Light Signaling Requirements Including Installation, Mirror and Horn Requirements and Installation, Exhaust Emissions and Smoke Arrangements and Requirements, Speed Limits and Speedometer, Additional Safety Components

UNIT III CONTROL OF TRAFFIC AND INSURANCE L-9

Control of Traffic, Traffic Signals and New Trends in the Control of Traffic, Requirements of Highway Police and Role of RTOs, Insurance of Motor Vehicle against Third Party, Third Party Risk, Necessity of Insurance and its Risk Coverage, Settlement if Insurance and Procedure of Investigation, Introduction to Claims Tribunal, Offence and Penalty Procedure, Provisions of Punishment and Offences, List of Offences and Penalties

UNIT IV PROCEDURE FOR VEHICLE CERTIFICATION L-9

Vehicle Approval Procedure, Bus Body Code Approval Procedure, Light and Light Signaling Device Mirror, Horn Compliance of Transport of Vehicles, Introduction of Safety Enhancement of Public Transport Vehicles, Type Approval and Conformity of Production Procedures for Safety Critical Components, Introduction to Relevant AIS and IS Pertaining to Vehicle Certification

UNIT V ACTS AND RULES L-9

Acts and Rules for Off Road Vehicles, Acts and Rules for Specialty Vehicles, Acts and Rules for Govt. Department Vehicles

Total: 45 Periods

6. Text Books

1. Peter R. White: Public Transport: Its Planning, Management and Operation (Natural and Built Environment Series, Kindle Edition, September 2008.
2. John Doke – Fleet Management, Mc Graw Hill, USA.
3. Kitchin. L.D –Bus Operation , Illiffee and sons Co, London, III edition

7. References

1. CMVR 1989
2. The Motor Vehicle Act 1988
3. Automotive Industry Standard

8. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	10	10	15
Understand	80	80	90	90	85
Apply					

Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	50	60
Analyse	50	40
Evaluate		
Create		

9. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Introduction to CMVR 1989	1	Lecture with discussions/ Seminar/ Assignment
2	Introduction to Licenses of Drivers of Motor Vehicles, Licensing of Drivers of Motor Vehicles	2	
3	Unified Drivers Licensing Registry, Licensing-Modified Fitness, Driving Test, Refresher Training; Registration of Motor Vehicles	2	
4	Unified Motor Vehicle Registration System, Fitness of Vehicles, Suspension of Registration, Cancellation of Registration, Unique Identification Number/Registration Number	2	
5	Control of Transport Vehicles- Tourist Permit and National Permit, Centralized Permit and Tax Submission System, Construction Equipment and Maintenance of Motor Vehicles.	2	
	UT-I (CO1)		
	Unit –II	**(9)**	
6	Introduction to State motor vehicle acts	1	Lecture with discussions/ Seminar/ Assignment
7	Compliance of Motor Vehicles, Dimensions of Motor Vehicles, Tyre Requirements for the Motor Vehicles	2	
8	Braking System Compliance, Steering System Compliance, Wiping System Compliance	2	
9	Lights and Light Signaling requirements including installation, mirror and horn requirements and installation,	2	
10	Exhaust emissions and smoke arrangements and requirements, Speed Limits and Speedometer, Additional safety components	2	

S.No	Topics to be covered	No. of periods	Content Delivery Method
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
11	Control of Traffic, Traffic signals and new trends in the control of traffic	2	Lecture with discussions/ Seminar/ Assignment
12	Requirements of Highway Police and role of RTOs, Insurance of Motor Vehicle against third party, Third Party Risk	2	
13	Necessity of Insurance and its risk coverage, Settlement of Insurance and procedure of investigation	1	
14	Introduction to Claims Tribunal, Offence and Penalty procedure	2	
15	Provisions of punishment and offences, List of offences and penalties	2	
	UT-II (CO3)		
	Unit IV	**(9)**	
16	Vehicle Approval Procedure, Bus Body Code Approval Procedure	1	Lecture with discussions/ Seminar/ Assignment
17	Light and Light Signaling Device mirror, horn compliance of transport of vehicles	1	
18	Introduction of safety enhancement of public transport vehicles	2	
19	Type Approval and Conformity of Production Procedures for safety critical components	2	
20	Introduction to relevant AIS and IS pertaining to vehicle certification	2	
21	Introduction to relevant AIS and IS pertaining to vehicle certification	1	
	Unit V	**(9)**	
22	Acts and Rules for Off Road Vehicles	3	Lecture with discussions/ Seminar
23	Acts and Rules for Specialty Vehicles	3	
24	Acts and Rules for Govt Department Vehicles	3	
	MT – II (CO3, CO4, CO5)		
	Total	**45**	

		L	T	P	C
1152AU131	**TRANSPORT ECONOMICS & BUSINESS MANAGEMENT**	**3**	**0**	**0**	**3**

1. Preamble

This course provides introduction to transport economics and business management. Intended to give students a working knowledge of money management and how to make economic comparisons of alternatives involving future benefits and cost

2. Pre-requisite

NIL

3. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the transport economic evaluation and demand and supply in transport sector	K2
CO2	Describe the direct and indirect cost for running a transport.	K2
CO3	Select suitable process to minimise the travel cost	K3
CO4	Describe the steps involved in transport projects	K2
CO5	Apply business management skills in order to improve the transport economics.	K3

4. Correlation with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	L	H							M	M
CO2	H	H	H	M	L	H							L	L
CO3	H	H	H	M	L	H							L	L
CO4	H	H	H	M	L	H							L	L
CO5	H	H	H	M	L	H							M	M

H- Strong; M-Medium; L-Low

5. Course content

UNIT I ECONOMIC EVALUATION **L-9**

Introduction to Transport Economics, Overview of Basic Components of Transport, Transport and Economic Development, Demand and Supply Issues in Transportation Sector, Cost of Transport, Pricing of Transport, Law of Diminishing Returns, Demand, Supply, Equilibrium, Elasticity, Consumer Surplus, Costs, Pricing and Subsidy Policies, Demand Forecasting Methods, Factors Influencing Transport Demand, Direct and Cross-Price Elasticities of Demand, Factors that Cause Shifts in Demand Function,

UNIT II TRANSPORT COSTS **L-9**

Road User Costs, Components & Factors Affecting VOC, Fuel Consumption Relations, Material Costs, Fixed Cost Management, Direct and External Costs of Transport, Concept of Generalized Costs, Social Aspects of Transport, Joint and Common Costs of Infrastructure, Short-Term and Long-Term Costs of Supply, Marginal Cost Pricing Rule, Efficient Pricing, Cost Complexities and Cost Recovery, Peak-Load Pricing, Second-Best Pricing, Transport Subsidies, Price Discrimination.

UNIT III TRAVEL COSTS & SAVINGS **L-9**

Economic Concepts of Travel Time Savings, Monetary Evaluation of Passengers Travel Time, Accident Costing, Congestion Costing, Road Pricing, Traffic Restraints, Road Space Rationing, Capacity Expansion, Methods of Economic Evaluation & Comparison.

UNIT IV TRANSPORT PROJECTS **L-9**

Feasibility and Evaluation, Cost, Impacts and Performance Levels, Evaluation of Alternatives, Analysis Techniques, Cost-Benefit Analysis, Social and Financial Benefits, Valuation of Time, Measures of Land Value and Consumer Benefits from Transportation Projects, Prioritization of Projects, Multi-Criteria Decision Assessment, Methods for Raising Funds for Maintenance, Improvement and Expansion of Transportation Networks: - Taxation and User Fee, Financing Through Loans, Bonds, PPPs and Concessions.

UNIT V BUSINESS MANAGEMENT **L-9**

HR Management, Operations Management, Financial Management, Project Management, Performance Evaluation, Change Management, Accounting Principles, Strategic Planning, Conflict Management, Cost Management, Crisis Management, Customer Relationship Management, Process Management, Project Management, Quality Management, Resource Management, Risk Management.

Total: 45 Periods

6. Text Books

1. Jill A. Hough, Crystal Bahe, Mary Lou Murphy and Jennifer Swenson: Intelligent Transportation Systems: Helping Public Transit Support Welfare To Work Initiatives
2. Peter R. White: Public Transport: Its Planning, Management and Operation (Natural and Built Environment Series, Kindle Edition, September 2008

7. References

1. CMVR 1989
2. The Motor Vehicle Act 1988
3. Automotive Industry Standard

8. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20		10	15
Understand	80	80	40	70	65

Apply			60	20	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	50	60
Analyse	50	40
Evaluate		
Create		

9. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Introduction to transport economics	1	Lecture with discussions/ Seminar/ Assignment
2	Overview of basic components of transport, transport and economic development	2	
3	Demand and supply issues in transportation sector, cost of transport, pricing of transport	2	
4	Law of diminishing returns, demand, supply, equilibrium, elasticity, consumer surplus, costs, pricing and subsidy policies	2	
5	Demand forecasting methods, factors influencing transport demand, direct and cross-price elasticities of demand, factors that cause shifts in demand function	2	
	UT-I (CO1)		
	Unit –II	**(9)**	
6	Road user costs, components & factors affecting VOC	1	Lecture with discussions/ Seminar/ Assignment
7	Fuel consumption relations, material costs, fixed cost management, direct and external costs of transport	2	
8	Concept of generalised costs, social aspects of transport, joint and common costs of infrastructure	2	
9	Short-term and long-term costs of supply, marginal cost pricing rule, efficient pricing, cost complexities and cost recovery	2	
10	Peak-load pricing, second-best pricing, transport subsidies, price discrimination.	2	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	

S.No	Topics to be covered	No. of periods	Content Delivery Method
11	Economic concepts of travel time savings	2	Lecture with discussions/ Seminar/ Assignment
12	Monetary evaluation of passengers travel time, accident costing, congestion costing,	2	
13	Road pricing, traffic restraints	1	
14	Road space rationing, capacity expansion	2	
15	Methods of economic evaluation & comparison.	2	
	UT-II (CO3)		
	Unit IV	**(9)**	
16	Feasibility and evaluation, cost, impacts and performance levels	1	Lecture with discussions/ Seminar/ Assignment
17	Evaluation of alternatives, analysis techniques	1	
18	Cost-benefit analysis, social and financial benefits, valuation of time	2	
19	Measures of land value and consumer benefits from transportation projects, prioritization of projects, multi-criteria decision assessment	2	
20	Methods for raising funds for maintenance, improvement and expansion of transportation networks: - taxation and user fee, financing through loans, bonds	2	
21	PPPs and concessions.	1	
	Unit V	**(9)**	
22	HR management.	1	Lecture with discussions/ Seminar
23	Operations management, financial management, project management, performance evaluation, change management	2	
24	Accounting principles, strategic planning, conflict management, cost management	2	
25	Crisis management, customer relationship management, process management, project management	2	
26	Quality management, resource management, risk management	2	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

		L	T	P	C
1152AU121	**AUTOMOTIVE HVAC**	**3**	**0**	**0**	**3**

1. Preamble

Students undergoing this course are expected to understand the air-conditioning systems used in automotive applications.

2. Pre-requisite

1151AU102 Basic Engineering Thermodynamics

3. Links to Other Courses

NIL

4. Course Educational Objectives

Students undergoing this course are expect to

- To provide introduction to students the fundamentals of refrigerant, refrigeration systems and air conditioning controls to automobile applications.
- To teach students the principle of psychometry.
- To enable the students to understand heating and cooling load calculations.
- To develop the knowledge about air distribution systems.
- To introduces the general servicing of automotive air conditioning systems.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Generalize types of refrigeration systems and its applications	K2
C02	Apply the concept of psychometry to estimating the heating and cooling load for automobiles	K2
C03	Design and implement refrigeration and air conditioning systems using standards	K2
C04	Explain the air distribution system and its control	K2
C05	Diagnose and correct air-conditioning system	K2

6. Correlation of COs with ProgrammeOutcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	H	M	L		L	L		M	L	L	L
CO2	H	H	H	H	M	L		L	L		M	L	L	M
CO3	H	H	H	H	M	L		L	L		M	L	L	M

CO4	H	H	H	H	M	L		L	L		M	L	L	L
CO5	H	H	H	H	M	L		L	L		M	L	M	L

H- Strong; M-Medium; L-Low

7. Course content

UNIT I REFRIGERATION L-9

Introduction - Methods of Refrigeration - Air Refrigeration System and its Applications -Vapour Compression Refrigeration System - Vapor Absorption Refrigeration System - Applications of Refrigeration & Air Conditioning - Automobile Air Conditioning - Air Conditioning for Passengers, Isolated Vehicles and Transport Vehicles - Applications Related with Very Low Temperatures. Classification, Properties and Selection Criteria - Commonly Used Refrigerants - Alternative Refrigerants - Eco-Friendly Refrigerants - Applications of Refrigerants - Refrigerants Used in Automobile Air Conditioning

UNIT II PSYCHOMETRY L-9

Psychometric Properties, Tables, Charts - Psychometric Processes - Comfort Charts - Factor Affecting Comfort - Effective Temperature - Ventilation Requirements

UNIT III AIR CONDITIONING SYSTEMS AND LOAD ANALYSIS L-9

Classification and Layouts - Central / Unitary Air Conditioning Systems - Components Like Compressors, Evaporators, Condensers, Expansion Devices, Fan Blowers, Heating Systems Etc. Load Analysis - Outside & Inside Design Consideration - Factors Forming the Load on Refrigeration & Air Conditioning Systems - Cooling & Heating Load Calculations - Load Calculations for Automobiles - Effect of Air Conditioning Load on Engine Performance

UNIT IV AIR DISTRIBUTION SYSTEMS L-9

Distribution Duct System, Sizing, Supply / Return Ducts - Types of Grills, Diffusers, Ventilation, Air Noise Level - Layout of Duct Systems for Automobiles and their Impact on Load Calculations. Air Routine & Temperature Control - Objectives - Evaporator Care Air Flow - Through the Dash Recirculating Unit - Automatic Temperature Control - Controlling Flow - Control of Air Handling Systems

UNIT V AIR CONDITIONING SERVICE AND CONTROL L-9

Air Conditioner Maintenance & Service - Servicing Heater System - Removing & Replacing Components - Trouble Shooting of Air Conditioning System -Compressor Service, Methods of Dehydration, Charging & Testing. Air Conditioning Control - Common Control Such as Thermostats- Humidistat Us - Control Dampers - Pressure Cutouts and Relays

8. Text Books

1. Refrigeration and Air-Conditioning - W.F. Stoecker and J.W. Jones, Tata McGraw Hill Pub.
2. Paul Lung, "Automotive Air Conditioning", C.B.S. Publisher & Distributor, Delhi

9. References

1. Modern Air-Conditioning Practice - Norman C. Harris, Principles of Refrigeration -R.J. Dcssat, Wiley Eastern Pub.
2. Refrigeration and Air-Conditioning - C.P. Arora, Tata McGraw Hill Pub
3. Refrigeration and Air-Conditioning – S.S.Thipse, Jaico
4. Automotive air conditioning by Crouse
5. Harris, "Modern Air Conditioning"

10. Revised Bloom's based Assessment Pattern

10.

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	10	10	20
Understand	80	80	80	80	80
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	10	20
Analyse	90	80
Evaluate		
Create		

11. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Introduction - Methods of refrigeration - Air Refrigeration System and its applications	1	Lecture with discussions/ Seminar/ Assignment
2	Vapor compression refrigeration system - Vapor absorption refrigeration system	1	
3	Applications of refrigeration & air conditioning -Automobile air conditioning	1	
4	Air conditioning for passengers	1	
5	isolated vehicles, transport vehicles	1	
6	Applications related with very low temperatures. Classification, properties and selection criteria	2	

S.No	Topics to be covered	No. of periods	Content Delivery Method
7	Commonly used refrigerants - Alternative refrigerants - Eco-friendly refrigerants	1	
8	Applications of refrigerants -Refrigerants used in automobile air conditioning	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
9	Psychometric properties, tables, charts	2	Lecture with discussions/ Seminar/ Assignment
10	Psychometric processes - Comfort charts	3	
11	Factor affecting comfort	2	
12	Effective temperature - Ventilation requirements	2	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
13	Classification and layouts - Central / unitary air conditioning systems	1	Lecture with discussions/ Seminar/ Assignment
14	Components like compressors, evaporators, condensers, expansion devices, fan blowers, heating systems etc	1	
15	Load Analysis: Outside & inside design consideration	2	
16	Factors forming the load on refrigeration & air conditioning systems	2	
17	Cooling & heating load calculations	1	
18	Load calculations for automobiles	1	
19	Effect of air conditioning load on engine performance	1	
	UT-II (CO3)		
	Unit IV	**(9)**	
20	Distribution duct system, sizing, supply / return ducts	2	Lecture with discussions/ Seminar/ Assignment
21	Types of grills, diffusers, ventilation, air noise level	1	
22	Layout of duct systems for automobiles and their impact on load calculations	2	
23	Air Routine & Temperature Control: Objectives - evaporator care air flow - Through the dash recirculating unit	2	
24	Automatic temperature control - Controlling flow - Control of air handling systems	2	
	Unit V	**(9)**	
25	Air conditioner maintenance & service	1	Lecture with discussions/ Seminar/
26	Servicing heater system - Removing & replacing components	1	
27	Trouble shooting of air conditioning system	2	
28	Compressor service, methods of dehydration, charging & testing	2	
29	Air Conditioning Control: Common control such as thermostats- Humidity status - Control dampers - Pressure cutouts and relays	3	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

		L	T	P	C
1152AU122	**AUTOMOTIVE TESTING AND CERTIFICATION**	**3**	**0**	**0**	**3**

1. Preamble

Students undergoing this course are expected to gain knowledge on testing and certification of passenger vehicles and its component.

2. Pre-requisite

NIL

3. Links to Other Courses

NIL

4. Course Educational Objectives

Students undergoing this course are expect to

- To understand the vehicle classifications, regulations and need for certification
- To learn the various static & dynamic test to be done on vehicle
- To impart knowledge about the various tests performed on engine

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Classify the vehicle and identify the regulations governing for each vehicle type	K2
C02	Perform and analyze the Static & Dynamic test of any vehicle	K2
C03	Perform various test related to vehicle engine emissions	K2
C04	Test and analyze the performance of vehicle components	K2
C05	Perform the tests to be done on the vehicle lighting system	K2

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	H	M	L		L	L		M	L	M	H
CO2	H	H	H	H	M	L		L	L		M	L	M	M
CO3	H	H	H	H	M	L		L	L		M	L	M	H
CO4	H	H	H	H	M	L		L	L		M	L	M	H
CO5	H	H	H	H	M	L		L	L		M	L	L	H

H- Strong; M-Medium; L-Low

7. Course contents

UNIT I INTRODUCTION **L-9**

Specification & Classification of Vehicles (Including M, N And O Layout), Homologation & Its Types, Regulations Overview (EEC, ECE, FMVSS, AIS, CMVR), Type Approval Scheme, Homologation for Export, Conformity of Production, Various Parameters, Instruments and Types of Test Tracks.

UNIT II STATIC TESTING OF VEHICLE L-9

Photographs, CMVR Physical Verification, Tyre Tread Depth Test, Vehicle Weightment, Horn Installation, Rear View Mirror Installation, Tell Tales, External Projection, Wheel Guard, Arrangement of Foot Controls for M1 Vehicle, Angle & Dimensions Measurement of Vehicle, The Requirement of Temporary Cabin for Drive – Away - Chassis.

UNIT III DYNAMICS TESTING OF VEHICLE L-9

Hood Latch, Gradeability, Pass-By Noise, Interior Noise, Turning Circle Diameter & Turning Clearance Circle Diameter, Steering Effort, Constant Speed Fuel Consumption, Cooling Performance, Speedo-Meter Calibration, Range Test, Maximum Speed, Acceleration Test, Coast-Down Test, Brakes Performance ABS Test, Broad Band / Narrow Band Emi Test. Engine Power Test (Petrol & Diesel), Indian Driving Cycle, Vehicle Mass Emission, Evaporative Emission (Petrol Vehicles).

UNIT IV VEHICLE COMPONENT TESTING L-9

Horn Testing, Safety Glasses Test - Windscreen Laminated and Toughened Safety Glass, Rear View Mirror Test, Hydraulic Brakes Hoses Fuel Tank Test - Metallic & Plastic, Hinges and Latches Test, Tyre & Wheel Rim Test, Bumper Impact Test, Side Door Intrusion, Crash Test With Dummies, Demist Test, Defrost Test, Interior Fittings, Steering Impact Test (Gvw<1500 Kg), Body Block Test, Head Form Test, Driver Field of Vision, Safety Belt Assemblies, Safety Belt Anchorages, Seat Anchorages & Head Restraints Test, Airbag Test, Accelerator Control System.

UNIT V VEHICLE LIGHTING TESTING L-9

Installation Requirement for Lighting, Signaling & Reflective Devices Installation, Conspicuity & Reflective Marking, Photometry Test - Performance Requirement for Lighting, Signaling and Reflective Devices - Head Lamp, Front Lamp, Direction Indicator Lamp, Signaling Lamp and Warning Triangles.

8. Text Books

1. Vehicle Inspection Handbook by American Association of Motor Vehicle Administrators
2. Michael Plint& Anthony Martyr, “Engine Testing & Practice”, Butterworth Heinmenn, 3rd edition, 2007

9. References

1. Proceedings- Automotive Testing & Certification held on 20th to 24th July 2010 at ARAI, Pune
2. Bosch Automotive Handbook
3. Motor Vehicle Manual
4. BIS & AIS
5. ECE
6. EEC
7. FMVSS
8. CMVR

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	10	10	20
Understand	80	80	80	80	80
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	10	20
Analyse	90	80
Evaluate		
Create		

11. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Specification & Classification of Vehicles (including M, N and O layout)	2	Lecture with discussions/ Seminar/ Assignment
2	Homologation & its Types	1	
3	Regulations overview (EEC, ECE, FMVSS, AIS, CMVR)	2	
4	Type approval Scheme, Homologation for export	1	
5	Conformity of Production	2	
6	Various Parameters, Instruments and Types of test tracks	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
7	Photographs, CMVR physical verification	1	Lecture with discussions/ Seminar/ Assignment
8	Tyre Tread Depth Test, Vehicle Weightment	1	
9	Horn installation, Rear view mirror installation	2	
10	Tell Tales, External Projection, Wheel Guard	1	
11	Arrangement of Foot Controls For M1 Vehicle	1	

S.No	Topics to be covered	No. of periods	Content Delivery Method
12	Angle & Dimensions Measurement of Vehicle	1	
13	The Requirement Of Temporary Cabin For Drive – Away - Chassis	2	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
14	Hood Latch, Gradeability, Pass-by Noise, Interior Noise	1	Lecture with discussions/ Seminar/ Assignment
15	Turning Circle Diameter & Turning Clearance Circle Diameter	1	
16	Steering Effort, Constant Speed Fuel Consumption	1	
17	Cooling Performance, Speedo-meter Calibration	1	
18	Range Test, Maximum Speed, Acceleration Test, Coast-down test	1	
19	Brakes Performance ABS Test, Broad band / Narrow band EMI Test	2	
20	Engine power test (petrol & diesel), Indian driving cycle	1	
21	Vehicle mass emission, Evaporative emission (petrol vehicles)	1	
	UT-II (CO3)		
	Unit IV	**(9)**	
22	Horn Testing, Safety Glasses Test: Windscreen laminated and toughened safety glass, Rear View Mirror Test	1	Lecture with discussions/ Seminar/ Assignment
23	Hydraulic Brakes Hoses Fuel Tank Test: Metallic & Plastic, Hinges and Latches Test	2	
24	Tyre & Wheel Rim Test, Bumper Impact Test, Side Door Intrusion	1	
25	Crash test with dummies, Demist test, Defrost Test, Interior Fittings	1	
26	Steering Impact test (GVW<1500 kg), Body block test, Head form test	1	
27	Driver Field Of Vision, Safety belt assemblies, Safety belt anchorages	1	
28	Seat anchorages & head restraints test	1	
29	Airbag Test, Accelerator Control System	1	
	Unit V	**(9)**	
30	Installation requirement for lighting, signaling & reflective devices Installation,	2	Lecture with discussions/ Seminar/
31	Conspicuity & Reflective Marking,	2	
32	Photometry Test: Performance requirement for lighting, signaling and reflective devices	2	
33	Head lamp, Front lamp, direction indicator lamp, signaling lamp and Warning triangles	3	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

		L	T	P	C
1152AU123	**AUTOMOTIVE NOISE VIBRATION AND HARSHNESS**	**3**	**0**	**0**	**3**

1. Preamble

This course provides a sound knowledge in identifying, measuring and controlling strategies to control the Noise, Vibration and Harshness in automotive applications.

2. Pre-requisite

1150PH101 Engineering Physics

3. Links to Other Courses

NIL

4. Course Educational Objectives

Students undergoing this course are expect to

- Understand the role of NVH in automotive industry
- Explain the facilities and instrumentations in measuring the NVH levels in automotive applications.
- Acquire knowledge in controlling NVH levels in automobiles and improving comfort for the users.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Describe the sources and common problems in automotive industry to control NVH.	K2
C02	Explain the theory of vibration and sound measurement for the automotive applications.	K2
C03	Discuss the facilities and instrument to measure the NVH levels in automobiles.	K2
C04	Explain the signal processing analysis	K2
C05	Describe the strategies to control Noise, Vibration and Harshness for the comfort of the passengers.	K2

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	H	M	L		L	L		M	L	M	L
CO2	H	H	H	H	M	L		L	L		M	L	L	M
CO3	H	H	H	H	M	L		L	L		M	L	M	H

CO4	H	H	H	H	M	L		L	L		M	L	L	M
CO5	H	H	H	H	M	L		L	L		M	L	M	H

H- Strong; M-Medium; L-Low

7. Course content

UNIT I NVH IN THE AUTOMOTIVE INDUSTRY L-9

Sources of Noise and Vibration - Design Features - Common Problems - Marque Values - Noise Quality - Pass-By Noise Requirements. Target Vehicles and Objective Targets - Development Stages in a New Vehicle Programme and the Altering Role of NVH Engineers.

UNIT II SOUND AND VIBRATION THEORY L-9

Sound Measurement - Human Sensitivity and Weighting Factors. Combining Sound Sources - Acoustical Resonances - Properties of Acoustic Materials - Transient and Steady State Response of One Degree of Freedom System Applied to Vehicle Systems – Transmissibility - Modes of Vibration.

UNIT III TEST FACILITIES AND INSTRUMENTATION L-9

Laboratory Simulation - Rolling Roads (Dynamometers), Road Simulators, Semi-Anechoic Rooms, Wind Tunnels, Etc., Transducers, Signal Conditioning and Recording Systems - Binaural Head Recordings, Sound Intensity Technique, Acoustic Holography, Statistical Energy Analysis

UNIT IV SIGNAL PROCESSING L-9

Sampling, Aliasing and Resolution - Statistical Analysis - Frequency Analysis - Campbell's Plots, Cascade Diagrams, Coherence and Correlation Functions.

UNIT V NVH CONTROL STRATEGIES & COMFORT L-9

Source Ranking - Noise Path Analysis - Modal Analysis - Design of Experiments, Optimisation of Dynamic Characteristics - Vibration Absorbers and Helmholtz Resonators - Active Control Techniques.

8. Text Books:

1. Norton M P, Fundamental of Noise and Vibration, Cambridge University Press, 1989
2. Munjal M.L., Acoustic Ducts and Mufflers, John Wiley, 1987

9. Reference Books:

1. Baxa, Noise Control of Internal Combustion Engine, John Wiley, 1984.
2. Ewins D. J., Model Testing: Theory and Practice, John Wiley,1995.
3. Boris and Kornev, Dynamic Vibration Absorbers, John Wiley, 1993.
4. McConnell K, "Vibration Testing Theory and Practice", John Wiley, 1995.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	10	10	20
Understand	80	80	80	80	80
Apply					

Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	10	20
Analyse	90	80
Evaluate		
Create		

11. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Sources of noise and vibration	1	Lecture with discussions/ Seminar/ Assignment
2	Design features. Common problems. Marque values	2	
3	Noise quality. Pass-by noise requirements	2	
4	Target vehicles and objective targets	1	
5	Development stages in a new vehicle programme	2	
6	The altering role of NVH engineers	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
7	Sound measurement. Human sensitivity and weighting factors	2	Lecture with discussions/ Seminar/ Assignment
8	Combining sound sources. Acoustical resonances	1	
9	Properties of acoustic materials	1	
10	Transient and steady state response of one degree of freedom system applied to vehicle systems	3	
11	Transmissibility. Modes of vibration	2	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
12	Laboratory simulation: rolling roads (dynamometers)	1	Lecture with discussions/ Seminar/ Assignment
13	road simulators, semi-anechoic rooms, wind tunnels, etc	2	
14	Transducers, signal conditioning and recording systems	1	
15	Binaural head recordings., Sound Intensity technique	2	
16	Acoustic Holography	1	
17	Statistical Energy Analysis	2	
	UT-II (CO3)		
	Unit IV	**(9)**	

S.No	Topics to be covered	No. of periods	Content Delivery Method
18	Sampling, aliasing and resolution	1	Lecture with discussions/ Seminar/ Assignment
19	Statistical analysis	2	
20	Frequency analysis	2	
21	Campbell's plots, cascade diagrams	2	
22	Coherence and correlation functions	2	
	Unit V	**(9)**	
23	Source ranking. Noise path analysis	1	Lecture with discussions/ Seminar/
24	Modal analysis. Design of Experiments	2	
25	Optimisation of dynamic characteristics	2	
26	Vibration absorbers	1	
27	Helmholtz resonators	2	
28	Active control techniques	1	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

1152AU133	HYDROGEN ENGINE	L	T	P	C
		3	0	0	3

11. Preamble

This course introduces the world and Indian energy scenario, need for hydrogen, comparative properties of hydrogen with other fuels, production and storage methods of hydrogen. Further it makes the students to understand the ways and means of usage of hydrogen in SI and CI Engines and its application in fuel cell technology

12. Pre-Requisite

1151AU107 I.C Engines

13. Links to other courses

- Advanced theory of IC engines
- Fuel conservation & Alternate fuels

14. Course Educational Objective

Students undergoing this course are expected to

- To introduce about the world and Indian energy scenario, need for hydrogen and its properties.
- To create the basic knowledge about different production and storage methods of hydrogen.
- To impart technological aspects usage of hydrogen in SI and CI Engines.
- To analyze new technical challenges and create technical advancements in the generation and use of hydrogen.

15. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the need for hydrogen and its suitability to use in I.C.Engines	K2
CO2	Describe the different production, storage and distribution methods of hydrogen.	K2
CO3	Explain the concept, methods and various features related to usage of hydrogen in SI Engines.	K2
CO4	Explain the concept, methods and various features related to usage of hydrogen in CI Engines.	K2
CO5	Discuss new technical challenges and create technical advancements in the generation and use of hydrogen.	K2

16. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO 1	H	M	L	M	H	M	M			L	L		M	M
CO 2	H	M	L	M	H	M	M			L	L		M	M
CO 3	H	M	M	M	H	M	M			L	L		M	M
CO 4	H	M	M	M	H	M	M			L	L		M	M
CO 5	H	M	M	M	H	M	M			L	L		M	M

H- High; M-Medium; L-Low

17. Course Structure

UNIT – I INTRODUCTION L- 9

World and Indian Energy Scenario – Need for Hydrogen, Properties of Hydrogen, Comparison With Fossil and Other Alternate Fuels - Pollution Caused by Conventional Fuels- Emission Standards.

UNIT – II PRODUCTION AND STORAGE, SAFETY AND DISTRIBUTION L- 9

Production Methods – Electrolysis- Steam Reformation and Renewable Energy - Storage Methods - Gaseous, Liquid And Metal Hydrides- Safety Aspects and Devices - Distribution Types, Hydrogen Refueling Methods.

UNIT – III HYDROGEN IN S.I. ENGINE SYSTEM L- 9

Engine Modifications Required for Hydrogen Use in S.I. Engine, Combustion Characteristics – Dual Fueling, Direct Injection of Gaseous And Liquefied Hydrogen In S.I. Engine.

UNIT – IV HYDROGEN IN C.I. ENGINE SYSTEM L- 9

Engine modification required for hydrogen use in C.I. Engine, Combustion characteristics - Direct Injection – Gaseous and liquified Hydrogen, Dual fuel mode, Hydrogen enrichment.

UNIT – V RECENT ADVANCES L- 9

Hybrid Electric Vehicle - On Board Generation and Storage of Hydrogen - Proton Exchange Membrane Fuel Cells.

Total: 45 Periods

18. TEXT BOOKS

1. S. S. Thipse., Alternative Fuels: Concepts, Technologies and Developments, Jaico Book Distributors, 2010.
2. Richard Folkson., Alternative Fuels and Advanced Vehicle Technologies for Improved Environmental Performance, Woodhead Publishing, 2014.
3. Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers, 1997. ISBN 0-76-80-0052-1.

19. REFERENCES:

1. International Journal of Hydrogen Energy.

2. Alternative Fuels (A decade of success and Promise) edited by RedaMoh.Bata, SAE PT-48, ISBN 1-56091 – 593 – 5.
3. Osamu Hirao and Richard K. Pefley, Present and future Automotive Fuels, John Wiley and Sons, 1988.
4. Keith Owen and Trevor Eoley, Automotive Fuels Handbook, SAE Publications, 1990.
5. Richard L. Bechtold, Automotive Fuels Guide Book, SAE Publications, 1997.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember					
Understand	100	100	100	100	100
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand	70	70
Apply	30	30
Analyse		
Evaluate		
Create		

11. Lecture plan

S.No	Topic	No. of periods	Content Delivery Method
	Unit –I INTRODUCTION	**9**	
1	World and Indian energy scenario	1	
2	Need for Hydrogen	1	ICT/ Lecture with discussions/ Seminar/ Assignment
3	Properties of Hydrogen	1	
4	comparison with fossil and other alternate fuels	2	
5	Pollution caused by conventional fuels	2	
6	Emission standards	2	
	UT-I (CO1)		
	Unit –II PRODUCTION AND STORAGE, SAFETY AND DISTRIBUTION	**9**	

S.No	Topic	No. of periods	Content Delivery Method
7	Production Methods – Electrolysis, Steam Reformation	2	ICT/ Lecture with discussions/ Seminar/ Assignment
8	Production Methods –Renewable Energy	2	
9	Storage Methods - Gaseous, Liquid and Metal Hydrides	2	
10	Safety aspects and devices	2	
11	Distribution Types, Hydrogen Refueling Methods.	1	
MT-I (CO1, CO2)			
	Unit-III HYDROGEN IN S.I. ENGINE SYSTEM	**9**	
12	Engine Modifications	2	ICT/ Lecture with discussions/ Seminar/ Assignment
13	Performance and Emission Characteristics	2	
14	Combustion Characteristics	1	
15	Dual Fueling	2	
16	Direct Injection of Gaseous and Liquefied Hydrogen.	2	
	UT-II (CO3)		
	Unit IV HYDROGEN IN C.I. ENGINE SYSTEM	**9**	
17	Engine Modifications	1	ICT/ Lecture with discussions/ Seminar/ Assignment
18	Performance and Emission Characteristics	2	
19	Combustion Characteristics	1	
20	Dual Fuel Mode	2	
21	Direct Injection – Gaseous and Liquified Hydrogen	2	
22	Hydrogen Enrichment	1	
	Unit V	**9**	ICT/ Lecture with discussions/ Assignment
23	Hybrid Electric Vehicle	4	
24	On Board Generation and Storage of Hydrogen	2	
25	Proton Exchange Membrane Fuel Cells.	3	
MT 2 (CO3, CO4, CO5)			
Total		**45**	

1152AU134	HOMOGENEOUS CHARGE COMPRESSION IGNITION ENGINES	L	T	P	C
		3	0	0	3

8. **Preamble**

This course provides the fundamental concept of HCCI, comparison of HCCI with conventional diesel and gasoline engines and its benefits in IC Engines. This course also enables learners to acquire knowledge about the modifications that are required for a HCCI engine, analyses the combustion characteristics and parameters influencing the HCCI combustion.

9. **Pre-requisite**

1151AU216 Automotive Fuels, Lubricants and Coolants

1151AU107 IC Engines

10. **Links to other courses**

1152AU104	Engine Testing and Certification

11. **Course Educational Objectives**

- To achieve an understanding about the fundamentals of HCCI engine and its benefits in IC engines.
- To predict the techniques used in HCCI mode of operation in conventional gasoline engine and diesel engines
- To impart the knowledge in the HCCI fuel requirements & combustion with alternative fuels.
- To investigate the performance, emission and combustion characteristics of HCCI engine.
- To discuss the parameters influencing HCCI combustion and methods to improve combustion.

5. Course Outcomes

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Understand the concept of HCCI and extent of the challenges in methods of homogeneous charges preparation.	K2
C02	Describe the instrumentation and experimental procedures followed for HCCI mode of operation in a conventional engine.	K2
C03	Demonstrate the HCCI fuel requirements and compare the performance, combustion and emission characteristics of HCCI engine fuelled with non-conventional fuels.	K3

C04	Discuss in depth understanding of engine parameters' influence on HCCI engine combustion at different experimental aspects.	K2
C05	Examine the future trends and methods to improve in homogeneous charge compression ignition combustion.	K3

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	H	L		L				L	M	M	M
CO2	H	H	H	H	M		L				L	M	H	H
CO3	H	H	H	H	M		L				L	M	H	H
CO4	H	H	H	H	L		L				L	M	H	H
CO5	H	M	H	H	M		L				L	M	H	H

H- Strong; M-Medium; L-Low

7. Course Content

UNIT I HCCI ENGINE FUNDAMENTAL L-9

Conventional Diesel and Gasoline Combustion Process- Fundamental Fuel Properties- HCCI Fuel Specification- Fundamentals of HCCI- Combustion Chemistry- Techniques to HCCI Operation In Gasoline and Diesel Engines - Comparison of HCCI Engine With Conventional CIDI and SIDI Engines- Advantages and Disadvantages of HCCI Engine.

UNITIIINSTRUMENTATION AND EXPERIMENTAL METHODS L-9

Engine specifications- Modifications required for HCCI engine- Challenges; controlling initiation of combustion, cold-start capability, extending to high loads range- Emission regulations, emission on HCCI engine- Methods of homogeneous charges preparation. Structure of the experiments.

UNIT III COMBUSTION WITH ALTERNATIVE FUELS L-9

Fuel Additives and Fuel Modification- Studies on the Performance, Combustion and Emission Characteristics of Hydrogen/HCCI Engine, CNG/HCCI Engine, Methane/N-Butane/Air Mixtures, DME/HCCI Engine and Biofuel/HCCI Engine.

UNIT IV ENGINE PARAMETERS AND THE FACTORS INFLUENCING COMBUSTION L-9

HCCI/SI Switching- Transition Between Operating Modes (HCCI-SI-HCCI)- Parameters Influencing HCCI Combustion; Preheat Inlet Air, Intake Air Pressure, Varying Compression Ratios, Fuel Injection Pressure, Equivalence Ratio, Engine Speed And Torque Conditions- Performance And Emission Parameter Studies.

UNIT V IMPROVEMENT OF HCCI ENGINE L-9

Methods to Improve Homogenous Charge Compression Ignition Combustion – Comparison Of HCCI Engine Using Ethanol and Diethyl Ether Blends – Nano Additive Blends - Nox Reduction Techniques.

TOTAL: 45 Periods

8. Text Books

1. Hua Zhao "HCCI and CAI Engines for automotive industry" Wood Head Publishing in Mechanical Engineering, 2007.
2. B.P. Pundir, Engine Combustion and Emission, 2011, Narosa Publishing House.
3. Thipse.S.S., Alternative Fuels; Concepts, Technologies and Developments, Jaico Book Distributors, 2010

9. References:

1. John B Heywood, "Internal Combustion Engines Fundamentals", McGraw Hill International Edition, 1988.
2. Rajput R.K. Internal Combustion Engines, Laxmi Publications (P) Ltd, 2006.
3. Richard.L. Bechtold- Alternative Fuels Guide Book- SAE International Warrendale-1997.
4. Willard W. Pulkrabek, Engineering Fundamentals of the Internal Combustion Engines, 2007, Second Edition, Pearson Prentice Hall.
5. Ganesan, V, Internal Combustion Engines, Tata McGraw Hill Book Co., 2003.
6. Domkundwar V, A course in Internal Combustion Engines, DhanpatRai& Co. (P) Ltd, 2002.

10. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember					
Understand	100	40	100	20	40
Apply		60		80	60
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	60	60
Analyse	40	40
Evaluate		

Create		

10. Lecture plan

S.No	Topics to be covered	No. of periods	Content delivery method
	UNIT -I	**9**	
1	Conventional diesel and gasoline combustion process	1	Lecture with Discussion /Assignment/ Group Discussion/
2	Fundamental fuel properties	1	
3	HCCI fuel Specification	1	
4	Fundamentals of HCCI- Combustion chemistry	2	
5	Techniques to HCCI operation in gasoline and diesel engines	2	
6	Comparison of HCCI engine with conventional CIDI and SIDI engines	1	
7	Advantages and disadvantages of HCCI engine	1	
	Unit Test-I (CO1)		
	UNIT –II	**9**	
8	Engine specifications	1	Lecture with Discussion/ Demonstration/ Assignment/
9	Modifications required for HCCI engine	2	
10	Challenges; controlling initiation of combustion	2	
11	cold-start capability, extending to high loads range	1	
12	Emission regulations, emission on HCCI engine	1	
13	Methods of homogeneous charges preparation	1	
14	Structure of the experiments	1	
	Mid Term Test-I (CO1 & CO2)		
	UNIT-III	**9**	
15	Fuel additives and fuel modification	1	Lecture with Discussion/ Demonstration/ Assignment/
16	Studies on the performance, combustion and emission characteristics of hydrogen/HCCI engine	1	
17	CNG/HCCI engine	2	
18	Methane/n-butane/air mixtures	1	
19	DME/HCCI engine	2	
20	Biofuel/HCCI engine	2	
	Unit Test-II (CO3)		
	UNIT IV	**9**	
21	HCCI/SI switching	1	Lecture with Discussion/ Demonstration/
22	Transition between operating modes (HCCI-SI-HCCI)	2	
23	Parameters influencing HCCI combustion	1	
24	preheat inlet air, intake air pressure	1	
25	Varying compression ratios, fuel injection pressure	1	
26	Equivalence ratio, engine speed and torque conditions	1	

S.No	Topics to be covered	No. of periods	Content delivery method
27	Performance and emission parameter studies.	2	
	UNIT V	**9**	
28	Methods to improve homogenous charge compression ignition combustion	2	Lecture with Discussion/ Demonstration/
29	Comparison of HCCI engine using ethanol and Diethyl Ether blends	3	
30	Nano additive blends	2	
31	NOx reduction techniques	2	
	Mid Term Test II (CO3, CO4, CO5)		
	Total	**45**	

1152AU135 **DESIGN AND OPTIMIZATION OF GEARS**

L	T	P	C
3	0	0	3

7. Preamble

This course provides knowledge of designing an automotive gear drive with spur, helical, bevel and worm gears. Also it offers the importance of optimization in engineering design process.

8. Prerequisite

1151AU105 Mechanics of Machines

9. Links to other Courses

- Vehicle Design and Data Characteristics

10. Course Educational Objectives:

Students undergoing this course are expected to:

- Acquire knowledge about the Design process in engineering.
- Understand the importance of engineering optimization
- Acquire skills in designing a gear drive for the given specifications.
- Acquire knowledge about the Gear measurement methods.

11. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the fundamental concepts of engineering design process, product life cycle and fundamental concepts of optimization process.	K2
CO2	Demonstrate the terminology and design procedure for a spur and helical gear drive	K3
CO3	Demonstrate the terminology and design procedure for a Bevel gear drive	K3
CO4	Demonstrate the terminology and design procedure for a worm and worm wheel gear drive	K3
CO5	Discuss the measurement methods used for gear parameters.	K2

12. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	M	M	M	L	L				L	L	M	M
CO2	H	H	H	H	H	L	L				L	L	H	H
CO3	H	H	H	H	H	L	L				L	L	H	H
CO4	H	H	H	H	H	L	L				L	L	H	H
CO5	M	M	M	M	M	L	L				L	L	M	M

H- High; M-Medium; L-Low

8. Course Content

UNIT – I: INTRODUCTION TO DESIGN PROCESS L- 9

Need and Importance of Design - The Design Process - Morphology of Design - Product Life Cycle - Introduction to optimization - Importance and benefits – Basics of Single variable and multivariable optimization – Definition of Design Objectives, Constraints, Objective function.

UNIT – II: DESIGN OF SPUR AND HELICAL GEAR DRIVE L- 9

Gear Terminology - Speed ratios – selection of materials based on mechanical properties - Design of spur gear and helical gear - Simple design problem on spur gear and helical gear drive- Based on Lewis equation method – Based on Hertz Method

UNIT – III: DESIGN OF BEVEL DRIVE L- 9

Bevel gear: Types, Straight bevel gear - Tooth terminology - Estimating the dimensions of pair of straight bevel gears – Simple design problem on bevel gear drive – Based on Lewis equation method – Based on Hertz Method.

UNIT – IV: DESIGN OF WORM GEAR DRIVE L- 9

Worm Gear: Merits and demerits – Terminology - Heat transfer and Heat dissipated on transmission - Design of the worm and gear - Simple design problem on worm gear drive – Based on Lewis equation method – Based on Hertz Method.

UNIT – V: GEAR MEASUREMENTS L- 9

Gear Measurements – Gear Tooth measurement of gears-tooth thickness-constant chord and base tangent method - Parkinson gear tester - pitch measurement- point to point method – Run out testing – profile checking by optical projection - Gear Errors – factors to be improved.

Total : 45 Hrs

8. TEXT BOOKS:

1. Bhandari V.B., "Design of Machine Elements", Tata McGraw-Hill Publishing Company Ltd., 4th Ed, 2017
2. Jain R.K., "Engineering Metrology", Khanna Publishers, 2009.

9. REFERENCES:

1. Rao, Singaresu, S., "Engineering Optimization – Theory & Practice", New Age International (P) Limited, New Delhi, 2000.
2. Shigley J.E. and Mischke C.R., "Mechanical Engineering Design", McGraw-Hill International Editions, 1989.
3. "Design Data Book", PSG College of Technology, Coimbatore, 2000.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember					
Understand	100	20		20	20
Apply		80	100	80	80
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand	30	30
Apply	70	70
Analyse		
Evaluate		
Create		

11. Lecture plan

S.No	Topic	No. of periods	Content Delivery Method
	Unit –IINTRODUCTION TO DESIGN PROCESS	**9**	
1	Need and Importance of Design	1	ICT/ Lecture with discussions/ Seminar/ Assignment
2	The Design Process - Morphology of Design	2	
3	Product Life Cycle	1	
4	Introduction to optimization - Importance and benefits	2	
5	Basics of Single variable optimization	1	
6	Multivariable optimization	1	
7	Definition of Design Objectives, Constraints, Objective function	1	
	UT-I (CO1)		
	Unit –IIDESIGN OF SPUR AND HELICAL GEAR DRIVE	**9**	
8	Gear Terminology-Speed ratios	1	ICT/ Lecture with discussions/
9	Selection of materials based on mechanical properties	2	
10	Design of spur gear and helical gear	1	
11	Simple design problem on spur gear and helical gear drive	1	

11. Lecture plan

S.No	Topic	No. of periods	Content Delivery Method
12	Based on Lewis equation method	2	Seminar/ Assignment
13	Based on Hertz Method	2	
	MT-I (CO1, CO2)		
	Unit-IIIDESIGN OF BEVEL GEAR DRIVE	**9**	
14	Bevel gear: Types	1	ICT/ Lecture with discussions/ Seminar/ Assignment
15	Straight bevel gear - Tooth terminology	1	
16	Estimating the dimensions of pair of straight bevel gears	2	
17	Simple design problem on bevel gear drive	1	
18	Based on Lewis equation method	2	
19	Based on Hertz Method	2	
	UT-II (CO3)		
	Unit IV DESIGN OF WORM GEAR DRIVE	**9**	
20	Worm Gear: Merits and demerits	1	ICT/ Lecture with discussions/ Seminar/ Assignment
21	Worm Gear: Terminology	1	
22	Heat transfer and Heat dissipated on transmission	1	
23	Design of the worm and gear - Simple design problem on worm gear drive	2	
24	Based on Lewis equation method	2	
25	Based on Hertz Method	2	
	Unit V GEAR MEASUREMENTS	**9**	ICT/ Lecture with discussions/ Assignment
26	Introduction to Gear Measurements	2	
27	Tooth thickness-constant chord and base tangent method	1	
28	Parkinson gear tester	1	
29	Pitch measurement -Point to Point method	1	
30	Run out testing – Profile checking by optical projection	2	
31	Gear Errors – factors to be improved	2	
	MT 2 (CO3, CO4, CO5)		
	Total	**45**	

1152AU136	SUSTAINABLE FUELS FOR NONCONVENTIONAL ENGINES	L	T	P	C
		3	0	0	3

1. Preamble

This course provides an introduction to the bio mass, bio fuels, and non-conventional I.C engines and imparts knowledge about the usage of biofuels in nonconventional I.C engines and also the changes in the engine's design for handling biofuels.

2. Pre-requisite

1151AU216	Automotive Fuels, Lubricants and Coolants
1151AU107	IC Engines

3. Links to other courses

1152AU104	Engine Testing and Certification
1152AU103	Fuel conservation & Alternate fuels

4. Course Educational Objectives

Students undergoing this course are expected to

- The subject mainly deals with various engine parameters and operating conditions.
- The deals with various types of biofuels fuels and their properties, its physical and chemical properties and thermal properties.
- The subject also deals with performance, combustion and emission characteristics and the optimization technique of nonconventional engines such as HCCI, PCCI, LHR engines and dual fuel condition while using bio fuels.
- The students will learn about the gasification and the coupling of gasifier with C.I engine.
- The students will know about the process involved in pyrolysis and the optimization of the products for IC engine application.

5. Course Educational Objectives

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Illustrate the properties of various fuels and its influence on C.I engine.	**K3**
C02	Explain the basics, requirements, construction and working of LHR engines, thermal barrier coatings and material properties and its performance and emission characteristics while using biofuels.	**K2**
C03	Explain the construction details of HCCI, working principles, combustion, and fundamental study while using biofuels.	**K2**
C04	Explain the technology and modifications required to operate the engine in dual fuel condition while using biofuels.	**K2**

C05	Explain about the gasification of biomass, its product and the thermal equations about it and operating the engine using the products thus obtained.	**K2**

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	H	L						L	M	H	H
CO2	H	H	H	H	M						L	M	H	H
CO3	H	H	H	H	M						L	M	H	H
CO4	H	H	H	H	L						L	M	H	H
CO5	H	H	H	H	M						L	M	H	H

H- High; M-Medium; L-Low

7. Course Content

UNIT 1 BIOFUELS AND OPERATING CONDITIONS L- 9

Comparison of Physical and Chemical Properties of Gasoline- Diesel - Biodiesel- Vegetable Oil- Biomass - Biomass and its Products- Carbon Hydrogen and Oxygen Ratio- Operating Conditions and Performance Characteristics of C.I Engine in Bio Fuels- Influence of Injection Pressure- Injection Timing- Compression Ratio- Performance and Emission Characteristics.

UNIT 2 LHR ENGINES L- 9

Thermal Barrier Coatings and Coating Materials for IC Engines, Properties of Coating Material - Fabrication of Engine with LHR Combustion Chamber-Comparative Studies With Test Fuels With Conventional Engine and Engine with LHR Combustion Chamber- Heat Loss Characteristics.

UNIT 3 HCCI ENGINE L- 9

Fundamental Concept And Working Principles of HCCI Engine, Challenges of HCCI Combustion-Homogeneous Charge Preparation Strategies- HCCI Fuel Injection Strategies - Studies of Bioethanol, Biogas In HCCI, Domain of Operation- Cold Start, Role of Pre-Combustion Chamber in HCCI Engine- Advantages Over Compression Ignition Combustion.

UNIT 4 DUAL FUEL ENGINE L- 9

Dual Fuel Technology, Diesel Engine Modifications for Dual Fuel Condition- Alcohol–Diesel Dual Fuel Operation- Performance, Combustion and Emission Characteristics - Effect of Hydrogen on Duel Fuel Mode, Effect Induction Of Hydrogen on Volumetric Efficiency and Combustion Characteristics on Dual-Fuel Mode of Operation.

UNIT 5 GASIFICATION OF BIOMASS FOR IC ENGINE APPLICATION L- 9

Gasification Principal, Kinetics of Vegetable Oil In TGA- Arrhenius Equations-Biomass Conversion, Producer Gas From Vegetable Oil, Gasifiers, Type of Gasifiers, Characteristics of Gasifier and Its Fuel, Cleaning Producer Gas, Application of Gasification, Studies On Gasification of Vegetable Oil, Coupling The Gasifier With CI Engine.

Total : 45 Hrs

8. References

1. Paul Degobert – Automobiles and Pollution – SAE International SBN-1-56091-563-3, 1991.
2. Ganesan .V - "IC Engines" - Tata McGraw-Hill, 2012.
3. John B. Heywood, "Internal Combustion Engine Fundamentals", McGraw-Hill Automotive technology Series ISBN 0-07-1000499-8, 1988.
4. Biomass Gasification, Pyrolysis and Torrefaction Practical Design and Theory, 2nd edition • 2013, PrabirBasu.
5. Thipse.S.S., Alternative Fuels; Concepts, Technologies and Developments, Jaico Book Distributors, 2010.
6. Richard.L. Bechtold- Alternative Fuels Guide Book- SAE International Warrendale-1997.
7. Science direct Journals

9. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember					
Understand	20	20	20	10	10
Apply	60	70	60	70	70
Analyse	20	10	20	20	20
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	60	60
Analyse	40	40
Evaluate		
Create		

10. Lecture plan

S.No	Topics to be covered	No. of periods	Content delivery method
	UNIT -I	**9**	
1	Comparison of physical and chemical properties of gasoline, diesel, biodiesel, vegetable oil	2	Lecture with Discussion /Assignment/ Seminar/ Group Discussion
2	biomass, biomass and its products, carbon hydrogen and oxygen ratio.	2	
3	Operating conditions and performance characteristics of C.I engine in bio fuels	2	
4	Influence of injection pressure, injection timing	2	
5	compression ratio on performance and emission characteristics.	1	
	Unit Test-I (CO1)		
	UNIT –II	**9**	Lecture with Discussion/ Assignment/ Group Discussion
6	Thermal barrier coatings and coating materials for IC engines	2	
7	properties of coating material	1	
8	Fabrication of engine with LHR combustion chamber	2	
9	Comparative studies with test fuels with conventional engine and engine with LHR combustion chamber	2	
10	Heat loss characteristics.	1	
	Mid Term Test-I (CO1 & CO2)		
	UNIT-III	**9**	Lecture with Discussion/ Demonstration/ Assignment/
11	Fundamental concept and working principles of HCCI engine	2	
12	challenges of HCCI combustion-Homogeneous charge preparation strategies	2	
13	HCCI fuel injection strategies	1	
14	Studies of bioethanol, Biogas in HCCI	1	
15	Domain of operation, Cold start	1	
16	Role of pre-combustion chamber in HCCI engine-	1	
17	Advantages over compression ignition combustion.	1	
	Unit Test-II (CO3)		
	UNIT IV	**9**	Lecture with Discussion/ Demonstration/ Assignment
18	Dual fuel technology	1	
19	Diesel engine modifications for dual fuel condition	2	
20	Alcohol–diesel dual fuel operation	1	
21	Performance, combustion and emission characteristics	1	
22	Effect of hydrogen on duel fuel mode	2	
23	Effect induction of hydrogen on volumetric efficiency and combustion characteristics on dual-fuel mode of operation	2	

S.No	Topics to be covered	No. of periods	Content delivery method
	UNIT V	**9**	Lecture with Discussion/ Demonstration/ Assignment
24	Gasification principal	1	
25	kinetics of vegetable oil in TGA	1	
26	Arrhenius equations	1	
	Biomass conversion, producer gas from vegetable oil	1	
27	Type of gasifiers	1	
28	characteristics of gasifier and its fuel,	1	
29	cleaning producer gas, application of gasification	1	
30	Studies on gasification of vegetable oil	1	
31	Coupling the gasifier with CI engine	1	
	Mid Term Test II (CO3, CO4, CO5)		
Total		**45**	

1153AU101 I.C.ENGINES

L	T	P	C
3	0	0	3

1. Preamble

This course make the students to understand the basic Construction, working principles of I.C. Engines, fuel systems, design of combustion chambers, supercharging techniques & cooling system

2. Pre-requisite

NIL

3. Links to other courses

- Advanced theory of IC engines
- Fuel conservation & Alternate fuels

4. Course Educational Objective

Students undergoing this course are expected to

- To create the basc knowledge of I.C. Engine working & how combustion takes places.
- Train knowledge about the fuel system used in I.C engine
- To teach the student about supercharging techiques, cooling systems & lubrication systems and its functions.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Classify the constructional and working principles of 2 stroke, 4 stroke, SI and CI Engines and demonstrate the physical features of components.	K2
CO2	Explain the basics, requirements, construction and working of fuel systems of SI and CI Engines and demonstrate the physical features of components.	K2
CO3	Illustrate the stages of combustion and its influence by different combustion chamber parameters	K3
CO4	Explain the concept, methods and various features related to super charging, turbo charging and engine testing	K2
CO5	Describe the concept, methods and various features related to Cooling and Lubrication Systems	K2

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H		H	H					L	L	
CO2	H	H		H	H					L	L	
CO3	H	H		H	H					L	L	
CO4	H	H		H	H					L	L	

CO5	H	H		H	H					L	L	

H- High; M-Medium; L-Low

7. Course Structure

UNIT I - Construction and Operation **L-9**

Constructional Details of Spark Ignition (SI) and Compression Ignition (CI) Engines. Working Principles. Two Stroke SI and CI Engines – Construction and Working. Comparison of SI and CI Engines, Four Stroke and Two Stroke Engines. Engine Classification, Firing Order.

UNIT II - Fuel Systems **L-9**

Air Fuel Ratio Requirements of SI Engines – Air Fuel Ratio and Emissions – Introduction to Carburetor & Fuel Injection Pump. Fuel System of SI and CI Engines

UNIT III - Combustion and Combustion Chambers **L-9**

Introduction to Combustion in SI and CI Engines and Stages of Combustion– Ignition Systems. Dependence of Ignition Timing on Load and Speed. Knock in SI and CI Engines. Combustion Chambers for SI and CI Engines. Direct and Indirect Injection Combustion Chambers for CI Engines. Importance of Swirl– Squish and Turbulence-Measurements. Factors Controlling Combustion Chamber Design– Introduction to Heat Release Measurements.

UNIT IV –Intake– Exhaust & Turbo Charging Systems **L-9**

Intake System– Exhaust Systems–Supercharging and Turbo Charging– Different Methods of Turbo Charging– Inter Cooling– Turbocharger Controls Including– Water Gate– Variable Geometry– Variable Nozzle Types. Dynamometers Indicated Thermal– Brake Thermal and Volumetric Efficiencies. Measurement of Friction– Cylinder Pressure Measurement. Engine Performance Maps– Thermo Controlled Cooling Fans.

UNIT V - Cooling and Lubrication Systems **L-9**

Need For Cooling– Types of Cooling Systems- Air and Liquid Cooling Systems. Thermo Psyphon and Forced Circulation and Pressurized Cooling Systems. Properties of Coolants. Requirements of Lubrication Systems. Types-Mist– Pressure Feed– Dry and Wet Sump Systems. Properties of Lubricants.

Total: 45 Periods

8. Text Books

3. Internal Combustion Engines by V. Ganesan, 2007, Tata Mc Graw Hill
4. Ramalingam K.K., "Internal Combustion Engines", Sci-Tech Publications, 2005.

9. References

6. Advanced Engine Technology by Heisler, SAE Publication.
7. Edward F. Obert Internal Combustion Engines.
8. H.N. Gupta, Fundamentals of Internal Combustion Engines by, PHI.
9. Mathur and Sharma, Internal Combustion Engines Dhanpat Rai and Sons 2002.
10. John B. Heywood, "Fundamentals of Internal Combustion Engines.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	40	10		30	10
Understand	60	80	20	60	60
Apply			80	10	30
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	50	60
Analyse	50	40
Evaluate		
Create		

11. Lecture plan

S.No	Topic	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Constructional details of spark ignition (SI) and compression ignition (CI) engines	2	Lecture with discussions/ Seminar/ Assignment
2	Working principles. Two stroke SI and CI engines – construction and working	3	
3	Comparison of SI and CI engines	2	
4	Four stroke and two stroke engines. Engine classification, firing order	2	
	UT-1 (CO1)		
	Unit –II	**(9)**	
5	Air fuel ratio requirements of SI engines	2	Lecture with discussions/ Seminar/ Assignment
6	Air fuel ratio and emissions	2	
7	Introduction to Carburettor & fuel injection pump	3	
8	Fuel system of SI and CI engines	2	

11. Lecture plan

S.No	Topic	No. of periods	Content Delivery Method
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
9	Introduction to combustion in SI and CI engines	1	Lecture with discussions/ Seminar/ Assignment
10	Stages of combustion, ignition systems	1	
11	Dependence of ignition timing on load and speed	1	
12	Knock in SI and CI engines	1	
13	Combustion chambers for SI and CI engines. Direct and indirect injection combustion chambers for CI engines	2	
14	Importance of Swirl, squish and turbulence-measurements	1	
15	Factors controlling combustion chamber design	1	
16	Introduction to heat release measurements	1	
	UT-II (CO3)		
	Unit IV	**(9)**	
17	Intake system, Exhaust systems	1	Lecture with discussions/ Seminar/ Assignment
18	Supercharging and Turbo charging, Different methods of turbo charging	2	
19	Inter cooling, Turbocharger controls including, water gate, variable geometry and variable nozzle types	1	
20	Dynamometers Indicated thermal, brake thermal and volumetric efficiencies	2	
21	Measurement of friction	1	
22	Cylinder pressure measurement	1	
23	Engine performance maps, Thermo controlled cooling fans	1	
	Unit V	**(9)**	
24	Need for cooling, types of cooling systems- air and liquid cooling systems.	2	Lecture with discussions/ Assignment
25	Thermo psyphon and forced circulation and Properties of lubricants	2	
26	Pressurized cooling systems	1	
27	Properties of coolants.	1	
28	Requirements of lubrication systems. Types-mist lubrication systems	1	
29	Pressure feed, dry and wet sump systems.	2	
	MT 2 (CO3, CO4, CO5)		
	Total	**45**	

1153AU102 AUTOMOTIVE TRANSMISSION

L	T	P	C
3	0	0	3

12. Preamble

This course provides an introduction to the Transmission like gearbox, clutch, fluid couplings, torque converters and electrical drives.

13. Pre-requisite

NIL

14. Links to other courses

- Vehicle Body Engineering
- Automotive chassis

15. Course Educational Objectives

Students undergoing this course are expected to

- To develop the basic knowledge of the students in mechanics, torque conversion areas.
- To develop the skills of the students in the areas of alternative drives and concepts.
- To serve as a pre-requisite course for other courses in UG and PG programs specialized studies and research.

16. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Understand the concept of gear motions, drive line positions.	K2
C02	Study about different types of gearboxes.	K3
C03	Know about the multi stage and polyphase torque converters, performance characteristics	K3
C04	Study about Automatic transmission	K3
C05	Learn about the different drive systems	K3

(K2-understand, K3-Apply, K4-Analysis)

17. Correlation of COs with Programme Outcomes :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H			H	H					L	L	
CO2	H			H	H					L	L	
CO3	H			H	H					L	L	
CO4	H			H	H					L	L	
CO5	H			H	H					L	L	

H- High; M-Medium; L-Low

18. Course Content

UNIT I Clutch and Gear Box **L-9**

Different Types of Clutches - Principle - Construction and Torque Capacity. Determination of Gear Ratios for Vehicles. Different Types of Gearboxes Such as Sliding Mesh Gearbox - Constant Mesh Gearbox and Synchromesh Gearbox Fluid Coupling: Advantages and Limitations - Construction Details - Torque Capacity - Slip in Fluid Coupling - Performance Characteristics. Means Used to Reduce Drag Torque in Fluid Coupling

UNIT II Hydrodynamic Drive **L-9**

All Spur and internal Gear Type Planetary Gearboxes - Ford T-Model - Cotal and Wilson Gear Box - Determination of Gear Ratios - Automatic Overdrives

UNIT III Torque Convertors **L-9**

Principal of Torque Conversion - Single - Multi Stage and Polyphase Torque Converters - Performance Characteristics - Constructional and Operational Details of Typical Hydraulic Transmission Drives (E.G.) Leyland - White Hydro Torque Drives

UNIT IV Automatic Transmission **L-9**

Automatic Transmission: Relative Merits and Demerits When Compared to Conventional Transmission - Automatic Control of Gears -AMT - Study of Typical Automatic Transmissions - Epicyclic Gear Train and Automatic Control of Gear Box - Clutch less Transmission -CVT - Transmission Control System

UNIT V Hydrostatic and Electric Drive **L-9**

Hydrostatic Drives: Advantages and Disadvantages - Principles of Hydrostatic Drive Systems - Construction and Working of Typical Hydrostatic Drives - Janney Hydrostatic Drive. Electrical Drives: Advantages and Limitations - Principles of Ward Leonard System of Control Modern Electric Drive for Buses and Performance Characteristics.

Total: 45 Periods

19. Text Books

2. Heldt. P. M., Torque converters, Chilton Book Co., 1992

20. References

4. Newton and Steeds, The Motor vehicle, llliffe Publishers, 1985.
5. Judge. A.W., Modern Transmission systems, Chapman and Hall Ltd., 1990.SAE Transactions 900550 & 930910.
6. Crouse. W.H., Anglin. D.L, Automotive Transmission and Power Trains construction, McGraw Hill,1976.

21. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	10	10	20
Understand	80	80	80	80	80
Apply					
Analyse					
Evaluate					

Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	40	40
Analyse	60	60
Evaluate		
Create		

22. Lecture plan:

S.No	Topic	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Introduction	1	Lecture with discussions/ Seminar/ Assignment
2	Gear Box: method of calculation of gear ratios for vehicles	1	
3	performance characteristics in different speeds	1	
4	different types of gear boxes	1	
5	speed synchronizing devices, gear materials, lubrication.	1	
6	Fluid coupling: advantages and limitations	1	
7	construction details, torque capacity	1	
8	slip in fluid coupling	1	
9	Means used to reduce drag torque in fluid coupling.	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
10	All spur calculation	1	Lecture with discussions/ Seminar/ Assignment
11	All spur calculation	1	
12	internal gear type	1	
13	planetary gearboxes	1	
14	Ford T-model	1	
15	Cotal and Wilson Gear box	1	
16	Cotal and Wilson Gear box	1	
17	determination of gear ratios	1	
18	automatic overdrives	1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
19	Principal of torque conversion	1	

S.No	Topic	No. of periods	Content Delivery Method
20	Single torque converters	2	Lecture with discussions/ Seminar/ Assignment
21	multi stage torque converters	1	
22	Polyphase torque converters	1	
23	performance characteristics	1	
24	and operational details of typical hydraulic transmission drives	1	
25	Leyland torque drives	1	
26	White Hydro torque drives, Case study about drives	1	
	UT-II (CO3)		
	Unit IV	**(9)**	
27	Introduction Automatic transmission	1	Lecture with discussions/ Seminar/ Assignment
28	relative merits and demerits	1	
29	conventional transmission	1	
30	automatic control of gears	1	
31	study of typical automatic transmissions	1	
32	Ford drive	1	
33	Chevrolet drive	1	
34	automatic control of gear box	1	
35	automatic control of gear box	1	
	Unit V	**(9)**	
35	Hydrostatic drives	1	Lecture with discussions/ Seminar/ Assignment
36	advantages and disadvantages	1	
37	principles of hydrostatic drive systems	1	
38	construction and working of typical hydrostatic drives	1	
39	Janney Hydrostatic drive	1	
40	Electrical drives	1	
41	advantages and limitations	1	
42	principles of Ward Leonard system	1	
43	Ward Leonard system of control Modern electric drive for buses and performance characteristics	1	
	MT 2 (CO3, CO4, CO5)		
	Total	**45**	

1153AU103 AUTOMOTIVE ELECTRICAL AND ELECTRONICS

L	T	P	C
3	0	0	3

1. Preamble

This course makes the students to know the functions, working principles of various automotive electrical & electronics components.

2. Pre-requisite

NIL

3. Links to other courses

- Automotive Safety
- Engine Electronics Management Systems

4. Course Educational Objectives

Students undergoing this course are expected

- To know the concepts and develop basic skills necessary to diagnose automotive electrical problems
- To know Starting, and charging, lighting systems, advanced automotive electrical systems, to include body electrical accessories and basic computer control.
- To explore practically about the components present in an Automotive electrical and electronics system.

5. Course Outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Enumerate the construction, characteristics and maintanance of battery, lighting system and different accessories in a typical automobile after careful inspection.	K2
CO2	Explain the construction, characteristics and maintenance of starting and ignition system and diagnose the ignition system fault of any vehicle.	K2
CO3	List out the principles and characteristics of charging system components and demonstrate their working with suitable tools.	K2
CO4	Describe the principles and architecture of electronics systems and its components present in an automobile related to instrumentation, control, security and warning systems.	K2
CO5	Enumerate the principles, application, construction and specification of different sensors and actuators usable in typical automobile by suitable testing.	K2

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	H	H	M	L			L			
CO2	M	H	H	H	M	L			L			
CO3	M	H	H	H	M	L			L			
CO4	M	H	H	H	M	L			L			
CO5	M	H	H	H	M	L			L			

7. Course content

UNIT I Electrical Systems **L-9**

Principle and Construction of Lead Acid and Lithium-Ion Battery - Characteristics of Battery - Rating Capacity and Efficiency of Batteries - Various Tests on Batteries - Maintenance and Charging. Lighting System and Photometry: insulated and Earth Return System - Details of Head Light and Side Light - LED Lighting System - Head Light Dazzling and Preventive Methods – Horns - Wiper System and Trafficator.

UNIT II Starting and Ignition System **L-9**

Condition at Starting - Behavior of Starter During Starting - Series Motor and Its Characteristics - Principle and Construction of Starter Motor - Over Running Clutch Working of Different Starter Drive Units - Care and Maintenances of Starter Motor - Starter Switches. Spark Plugs. Advance Mechanisms. Different Types of Ignition Systems.

UNIT III Charging System **L-9**

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.

UNIT IV Sensors and Actuators **L-9**

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.

UNIT V Electronics Systems **L-9**

Current Trends in Automotive Electronic Engine Management System - Types of EMS - Electromagnetic interference Suppression - Electromagnetic Compatibility - Electronic Dashboard instruments - Onboard Diagnostic System - Security - Warning System - infotainment and Telematics.

45 periods

8. Text Books

4. Young A.P. & Griffiths. L. “Automotive Electrical Equipment”, ELBS & New Press-1999.
5. William B.Ribbens “Understanding Automotive Electronics”, 5th edition - Butter worth Heinemann Woburn, 1998.

6. Ganesan .V- "Internal Combustion Engines"- Tata McGraw-Hill Co- 2003.

9. References

7. Bechhold "Understanding Automotive Electronics", SAE, 1998.
8. Crouse, W.H "Automobile Electrical Equipment", McGraw-Hill Book Co., Inc., New York, 3rd edition, 1986.
9. Judge A.W "Modern Electrical Equipment of Automobiles", Chapman & Hall, London, 1992.
10. Kholi.P.L "Automotive Electrical Equipment", Tata McGraw-Hill Co., Ltd., New Delhi, 1975.
11. Robert Bosch "Automotive Hand Book", SAE (5th Edition), 2000.
12. Ganesan.V. "Internal Combustion Engines", Tata McGraw-Hill Publishing Co., New Delhi, 2003.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	20	20	20	20	20
Understand	80	80	80	80	80
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (Max marks in %)	2 (CO3&CO4) (Max marks in %)
Remember		
Understand		
Apply	70	80
Analyze	30	20
Evaluate		
Create		

11. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Principle and construction of lead acid battery	1	Lecture with discussions/ Seminar/ Assignment
2	Characteristics of battery	1	
3	Rating capacity and efficiency of batteries	1	
4	Various tests on batteries, maintenance and charging	1	
5	Lighting system: insulated and earth return system	1	
6	Details of head light and side light	1	
7	LED lighting system	1	
8	Head light dazzling and preventive methods	1	
9	Horn, wiper system and trafficator	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
10	Condition At starting	1	Lecture with discussions/ Seminar/ Assignment
11	Behavior of starter during starting	1	
12	Series motor and its characteristics	1	
13		1	
14	Principle and construction of starter motor	1	
15		1	
16	Working of different starter drive units,	1	
17	Care and maintenances of starter motor, starter switches	1	
18		1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
19	Generation of direct current, shunt generator characteristics	1	Lecture with discussions/ Seminar/ Case Studies/ Assignment
20	Armature reaction	1	
21	Third brush regulation	1	
22	Cutout, Voltage and current regulators	1	
23	Compensated voltage regulator	1	
24	Alternators principle and construction	2	
25	Bridge rectifiers	1	
26	New developments	1	
	UT-II (CO3)		
	Unit - IV	**(9)**	
27	Current trends in automotive electronic engine management system	2	Lecture with discussions/ Seminar/ Case Studies/ Assignment
28	Electromagnetic interference suppression	1	
29	Electromagnetic compatibility	1	
30	Electronic dashboard instruments	1	
31	Electronic dashboard instruments	1	
32	Onboard diagnostic system	2	
33	Security and warning system	1	

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit -V	**(9)**	
34	Types of sensors	1	Lecture with discussions/ Seminar/ Lecture with demonstration
35	Sensor for speed	1	
36	Throttle position	1	
37	Exhaust oxygen level	1	
38	Manifold pressure, crankshaft position	1	
39	Coolant temperature, exhaust temperature	2	
40	Air mass flow for engine application	1	
41	Solenoids, stepper motors, relay	1	
	MT-II (CO3, CO4, CO5)		
Total		**45**	

1153AU104 ENGINE ELECTRONICS AND MANAGEMENT SYSTEMS

L	T	P	C
3	0	0	3

11. Preamble

This course imparts knowledge about the sensors and electronic components used in an automobile and the engine control system.

12. Prerequisite

NIL

13. Links to other courses

- IC Engines
- Automotive chassis

14. Course Educational Objectives

Students undergoing this course are expected to:

- Gain knowledge about the construction and working of electronic components in an engine management system.
- Gain knowledge about how the combustion and pollution can be varied by sensors.

15. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the basic electronic components and controls used in sensors	K2
CO2	Explain the different types of sensors used in an automobile engine	K2
CO3	Describe the ignition and injection methods used in an SI engine	K3
CO4	Describe the fuel injection systems in a diesel engine and the emission control systems	K3
CO5	Explain the electronic systems used in the fuel control system and the dash board unit.	K2

(K2 – Understand; K3 – Apply)

16. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	L	M	L					L	
CO2	H	H	M	L	M	L					L	
CO3	H	H	M	L	M	L					L	
CO4	H	H	M	L	M	L					L	
CO5	H	H	M	L	M	L					L	

H- High; M-Medium; L-Low

17. Course Content

UNIT I Fundamentals of Automotive Electronics L-9

Components for Electronic Engine Management System- Open and Closed Loop Control Strategies- PID Control- Look Up Tables- Introduction to Modern Control Strategies Like Fuzzy Logic and Adaptive Control. Switches- Active Resistors- Transistors- Current Mirrors/Amplifiers- Voltage and Current References- Comparator- Multiplier. Amplifier- Filters- A/D and D/A Converters.

UNIT II Sensors and Actuators L-9

Inductive- Hall Effect- Thermistor- Piezo Electric- Piezoresistive- Based Sensors. Throttle Position- Mass Air Flow- Crank Shaft Position- Cam Position- Engine Speed Sensor- Exhaust Oxygen Level (Two Step- Linear Lambda and Wideband)- Knock- Manifold Temperature and Pressure Sensors. Solenoid- Relay (Four and Five Pin)- Stepper Motor

UNIT III SI Engine Management L-9

Layout and Working of SI Engine Management Systems. Group and Sequential Injection Techniques. MPFI- GDI- Advantages of Electronic Ignition Systems. Types of Solid State Ignition Systems and Their Principle of Operation- Contactless (BREAKERLESS) Electronic Ignition System- Electronic Spark Timing Control

UNIT IV CI Engine Management L-9

Fuel Injection System Parameters Affecting Combustion- Noise and Emissions in CI Engines. Electronically Controlled Unit Injection System. Common Rail Fuel Injection System. Working of Components Like Fuel Injector- Fuel Pump- Rail Pressure Limiter- Flow Limiter- EGR Valve.

UNIT V Digital Engine Control System L-9

Cold Start and Warm Up Phases- Idle Speed Control- Acceleration and Full Load Enrichment- Deceleration Fuel Cut-off. Fuel Control Maps- Open Loop and Closed Loop Control – Integrated Engine Control System- Electromagnetic Compatibility – EMI Suppression Techniques – Electronic Dash Board Instruments – Onboard Diagnosis System.

Total: 45 periods

8. Text Books:

3. Understanding Automotive Electronics William B Ribbens, SAE 1998
4. Automobile Electronics by Eric Chowanietz SAE

9. References:

3. Diesel Engine Management by Robert Bosch, SAE Publications, 3rd Edition, 2004
4. Gasoline Engine Management by Robert Bosch, SAE Publications, 2nd Edition, 2004

10. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	20	20			10
Understand	80	80	20	30	50
Apply			80	70	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 &CO2) (Max marks in %)	II (CO3&CO4) (Max marks in %)
Remember		
Understand		
Apply	**60**	**40**
Analyse	**40**	**60**
Evaluate		
Create		

11. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Components for electronic engine management system	1	Lecture with discussions/ Seminar/ Assignment
2	Open and closed loop control strategies	1	
3	PID control	1	
4	Look up tables	1	
5	Introduction to modern control strategies like Fuzzy logic and adaptive control	1	
6	Switches, active resistors, Transistors, Current mirrors/amplifiers	1	
7	Voltage and current references, Comparator, Multiplier	1	
8	Amplifier, filters	1	
9	A/D and D/A converters.	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
10	Inductive, Hall Effect, thermistor, piezo electric, piezoresistive, based sensors.	1	Lecture with discussions/ Seminar/ Assignment
11	Throttle position sensor	1	
12	Mass air flow sensor	1	

S.No	Topics to be covered	No. of periods	Content Delivery Method
13	Crank shaft position, cam position sensor	1	
14	Engine speed sensor	1	
15	Exhaust oxygen level (two step, linear lambda and wideband)sensor	1	
16	Knocksensor	1	
17	Manifold temperature and pressure sensors.	1	
18	Solenoid, relay(four and five pin), stepper motor.	1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
19	Layout and working of SI engine management systems	2	Lecture with discussions/ Seminar/ Case Studies/ Assignment
20	Group and sequential injection techniques	1	
21	Electronic ignition systems and advantages	2	
22	Types of solid state ignition systems and their principle of operation	1	
23	Contactless (BREAKERLESS) electronic ignition system	2	
24	Electronic spark timing control.	1	
	UT-II (CO3)		
	Unit IV	**(9)**	
25	Fuel injection system parameters affecting combustion, noise and emissions in CI engines.	3	Lecture with discussions/ Seminar/ Case Studies/ Assignment
26	Electronically controlled Unit Injection system	2	
27	Common rail fuel injection system	1	
28	Working of components like fuel injector	1	
29	Fuel pump, rail pressure limiter, flow limiter	1	
30	EGR valve	1	
	Unit V	**(9)**	
31	Cold start and warm up phases	1	Lecture with discussions/ Seminar/ Lecture with demonstration
32	Idle speed control	1	
33	Acceleration and full load enrichment	1	
34	Deceleration fuel cutoff	1	
35	Fuel control maps	1	
36	Open loop and closed loop control	1	
37	Integrated engine control system	1	
38	Electromagnetic compatibility – EMI Suppression techniques	1	
39	Electronic dash board instruments – Onboard diagnosis system	1	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

1153AU105 ADVANCED THEORY OF I.C. ENGINES

L	T	P	C
3	0	0	3

11. Preamble

This course imparts knowledge in the advanced developments in automobiles, engines and various emission controlling technologies.

12. Pre-requisite

NIL

13. Links to other courses

NIL

14. Course Educational Objectives

Students undergoing this course are expected to:

- Gain knowledge about the advanced theory and working of I.C engines.
- Express the phenomena of combustion and modelling.

15. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the various working cycles of engine.	K2
CO2	Describe the various types of combustion in IC engines.	K2
CO3	Illustrate the engine combustion parameters.	K3
CO4	Describe the different types of modern engines.	K2
CO5	Explain the modern electronic engine management system (EMS) of IC engines.	K2

(K2 – Understand; **K3** – Apply)

16. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	M	M	L	L	M	L	L	L
CO2	H	H	H	M	M	M	L		M	L	L	L
CO3	H	H	H	M	M	M	H		M	L	L	L
CO4	H	H	H	M	M	M	H		M	L	L	L
CO5	H	H	H	M	M	M	H		M	L	L	L

H- High; M-Medium; L-Low

17. Course Content

UNIT I Combustion of Fuels **L-9**

Chemical Composition and Molecular Structure of Hydrocarbon Fuels. Combustion Stoichiometry of Hydrocarbon Fuels – Chemical Energy and Heat of Reaction Calculations – Chemical Equilibrium and Adiabatic Flame Temperature Calculation. Theory of SI and CI Engine Combustion – Flame Velocity and Area of Flame Front. Fuel Spray Characteristics – Droplet Size-Depth of Penetration and Atomization.

UNIT II Engine Cycle Analysis **L-9**

Ideal Air- Fuel Air Cycle and Actual Cycle Analysis. Progressive Combustion Analysis in SI Engines. Parametric Studies on Work Output- Efficiency and other Engine Performance.

UNIT III Combustion Modelling L-9

Basic Concepts of Engine Simulation – Governing Equations- Classification of Engine Models- Thermodynamic Models For intake and Exhaust Flow Process – Quasi Steady Flow - Filling and Emptying - Gas Dynamic Models. Thermodynamic Based in Cylinder Models for SI Engine and CI Engines.

UNIT IV – Nonconventional IC Engines L-9

LHR Engines- Surface Ignition Concept and Multi Fuel Engines- Stratified Charge and Lean Burn Engines- Performance and Emission Characteristics- Merits and Demerits- GDI-RCCI-GDCI-CRDI-Lean Burn Engines

UNIT V-Electronic Engine Management L-9

Computer Control of SI & CI Engines for Better Performance and Low Emissions- Closed Loop Control of Engine Parameters of Fuel injection and Ignition.

Total: 45 Periods

18. Text Books:

4. Ganesan .V - "IC Engines" - Tata McGraw-Hill, 2012.
5. John B. Heywood, "Internal Combustion Engine Fundamentals", McGraw-Hill Automotive Technology Series ISBN 0-07-1000499-8, 1988.
6. B.P.Pundir, "IC Engines-Combustion and Emissions", 1st ed., Narosa Publishing House, New Delhi

19. References:

3. Richard Stone – "Introduction to IC Engines" – 2nd edition – Macmillan – 1992.
4. BOSCH hand book, edition: 2012

20. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20		20	20
Understand	80	80	30	60	50
Apply			70	20	30
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	50	50
Analyse	50	50
Evaluate		
Create		

21. Lecture plan:

S.NO	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Chemical composition and molecular structure of hydrocarbon fuels	1	Lecture with discussions/ Seminar/ Assignment
2	Combustion Stoichiometry of hydrocarbon fuels	1	
3	Chemical energy and heat of reaction calculations	1	
4	Chemical equilibrium and adiabatic flame temperature calculation	2	
5	Theory of SI and CI engine combustion	1	
6	Flame velocity and area of flame front	1	
7	Fuel spray characteristics	1	
8	Droplet size, depth of penetration and atomization	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
9	Ideal air, fuel air cycle and actual cycle analysis	2	Lecture with discussions/ Seminar/ Assignment
10	Progressive combustion analysis in SI engines	2	
11	Parametric studies on work output	1	
12	Parametric studies on efficiency	2	
13	Other engine performance	2	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
14	Basic concepts of engine simulation	1	Lecture with discussions/ Seminar/ Assignment
15	Governing equations	1	
16	Classification of engine models-Thermodynamic models for Intake and exhaust flow process	2	
17	Quasi steady flow	1	
18	Filling and emptying, Gas dynamic Models	2	
19	Thermodynamic based in cylinder models for SI engine and CI engines	2	
	UT-II (CO3)		

S.NO	Topics to be covered	No. of periods	Content Delivery Method
	Unit IV	**(9)**	
20	LHR engines, surface ignition concept and multi fuel engines	2	Lecture with discussions/ Seminar/ Assignment
21	Stratified charge and lean burn engines	2	
22	Performance and emission characteristics, merits and demerits.of HCCI, GDI	2	
23	Performance and emission characteristics, merits and demerits of RCCI,GDCI,CRDI	2	
24	Lean burn engines	1	
	Unit V	**(9)**	
25	Computer control of SI engines for better performance and low emissions	3	Lecture with discussions/ Seminar
26	Computer control of CI engines for better performance and low emissions	3	
27	closed loop control of engine parameters of fuel injection and ignition	3	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

1153AU106 AUTOMOBILE ENGINEERING

L	T	P	C
3	0	0	3

1. Preamble

This course provides an introduction to vehicle structure, engine, power transmission system, steering system, brakes and suspension; it also provides an introduction to engine emissions and their control and offers various alternative fuels that can be used in automobiles

2. Pre-requisite

NIL

3. Link to other courses

Automotive Engines, Automotive Chassis, Automotive Transmission,

4. Course Educational Objective

Students undergoing this course are expected

- Describe the concept of chassis and various subsystems of automobile.
- Explain about fundamental principles, construction and working of different subsystems of engines used in automobiles
- Analyse various types of emissions and suggest ways to reduce them

5. Course Outcome

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the vehicle construction and engines in automobiles.	K2
CO2	Understand the fuel injection, ignition systems and starting systems.	K2
CO3	Describe the transmission and cooling systems.	K2
CO4	Illustrate the steering systems, braking systems and suspension systems.	K2
CO5	Describe the IC engine emissions and alternative fuels and their conversion kits used in automobile.	K2

6. Correlation of COs with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H			H	H		H				M	
CO2	H			H	H		H				M	
CO3	H			H	H		H				M	
CO4	H			H	H		H				M	
CO5	H			H	H		H				M	

H- Strong; M-Medium; L-Low

18. Course Contents

UNIT I Vehicle Structure and Engines L-9

Introduction: General Classification of Automobiles, Layout of Chassis, Types of Drives of Automobile. Chassis and Body – Body Parts, Functions, Material and Vehicle Construction. Engines – Types of Engines, Components, Functions and Materials, Working Principle, Comparison of Four Stroke and Two Stroke Engines.

UNIT II Engine Auxiliary Systems L-9

Carburetor–Working Principle- Electronic Fuel injection System – Mono-Point and Multi - Point injection Systems – Battery Coil and Magneto Ignition Systems, Electronic Ignition Systems. Construction, Operation and Maintenance of Lead Acid Battery - Principle and Construction of Starter Motor, Working of Different Starter Drive Units. Supercharging and Turbo Charging.

UNIT III Transmission and Cooling Systems L-9

Clutch – Types and Construction – Gear Boxes, Manual and Automatic –Flywheel-Torque Converters– Propeller Shaft – Slip Joint – Universal Joints – Differential and Rear Axle – Hotchkiss Drive. Need for Cooling System, Types of Cooling System: Air Cooling System, Liquid Cooling System, Forced Circulation System, Pressure Cooling System.

UNIT IV Steering, Brakes and Suspension L-9

Wheels and Tyres - Steering Geometry – Power Steering – Types of Front Axle – Classification of Brakes, Drum Brakes and Disc Brakes, Constructional Details, Theory of Braking, Parking Brake, Braking Material, Hydraulic System, Vacuum Assisted System, Air Brake System, Antilock Braking System. 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.

UNIT V Emission, Emission Control and Alternative Fuels L-9

Mechanism of HC, NOx and CO Formation in Four Stroke and Two Stroke SI Engines, Smoke and Particulate Emissions in CI Engines, NOx Formation and Control. Noise Pollution from Automobiles, Measurement and Standards. Design of Engine, Optimum Selection of Operating Variables for Control of Emissions, Catalytic Converters, Catalysts. Fuel Modifications -Use of Natural Gas, LPG, Biodiesel, Gasohol and Hydrogen in Automobiles - Electric and Hybrid Vehicles, Fuel Cells.

TOTAL = 45 periods

8. Text Books

1. Ganesan, V., Internal Combustion Engines, Tata McGraw-Hill, New Delhi, 2012.
2. Kirpal Singh, Automobile Engineering- Vol. I and II, Standard Publishers, New Delhi, 2011.
3. Ramalingam. K .K, Automobile Engineering, Scitech publications,2011.

9. References

1. Kamaraju Ramakrishna, Automobile Engineering, PHI Learning pvt. Ltd., New delhi-2012.
2. Mathur M.L. and Sharma. ‘A Course in Internal Combustion Engines’, R.P. Dhanpat Rai Publications, 2009.
3. K. M. Gupta, Automobile Engineering- Vol I and II, Umesh Publications, 2007

4. G B S Narang, Automobile Engineering, Khanna publishers, New Delhi, 2005.
5. Crouse, W.H., and Anglin, D.L., Automotive Mechanics, Tata McGraw Hill, New Delhi, 2005.

10. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember	20	20	20	20	20
Understand	80	80	80	80	80
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (COs addressed) (Max marks in %)	II (COs addressed) (Max marks in %)
Remember		
Understand		
Apply	**50**	**50**
Analyse	**50**	**50**
Evaluate		
Create		

11. Lecture plan:

S.No.	Topics to be covered	No. of periods	Content delivery method
	Unit–I	**(9)**	
1	General classification of automobiles and layout of chassis	1	Lecture with discussion, Assignment
2	Types of drives of automobile	1	
3	Chassis Body parts, functions and their materials	1	
4	Vehicle construction	1	
5	Components of Engine and their functions and materials	1	
6	Introduction to Engines and Types of Engines	1	
7	Working principle of four stroke petrol and four stroke diesel engine	1	
8	Working principle of two stroke petrol and two stroke diesel engine	1	
9	Comparison of four stroke and two stroke engine	1	
Unit Test I (CO 1)			

S.No.	Topics to be covered	No. of periods	Content delivery method
Unit–II		**(9)**	
10	Carburetor and its working principle	1	Lecture with discussion, Assignment
11	Electronic fuel injection system	1	
12	Mono-point and multi - point Injection Systems	1	
13	Battery coil and magneto ignition systems	1	
14	Electronic ignition systems	1	
15	Construction, Operation and Maintenance of Lead Acid Battery	1	
16	Principle and construction of starter motor And Working of different starter drive units	1	
17	Supercharging	1	
18	Turbo charging	1	
Midterm Test 1 (CO1, CO2)			
Unit-III		**(9)**	
19	Clutch and Types of clutches	1	Lecture with discussion, Assignment
20	Manual gear box	1	
21	Automatic gearbox	1	
22	Fluid flywheel and Torque converter	1	
23	Propeller shaft ,Slip Joint and Universal Joints	1	
24	Differential and Rear Axle Hotchkiss Drive	1	
25	Need for cooling system and Types of cooling system	1	
26	Air cooling system and liquid cooling system	1	
27	Forced circulation system and pressure cooling system.	1	
Unit Test 2 (CO 3)			
Unit-IV		**(9)**	
28	Wheels and Tyres	1	Lecture with discussion, Assignment
29	Steering Geometry and Power Steering	1	
30	Types of Front Axle ,Classification of brakes, drum brakes and disc brakes	1	
31	Constructional details, theory of braking, parking brake, braking material.	1	
32	Hydraulic braking system and Vacuum assisted system,	1	
33	Air brake system and antilock braking system(ABS)	1	
34	Need of suspension system, types of suspension, suspension springs	1	
35	Constructional details and characteristics of leaf, coil and torsion bar springs	1	
36	Independent suspension, rubber suspension, pneumatic suspension and shock absorbers	1	
Unit -V		**(9)**	
37	Mechanism of HC, NOx and CO formation in four stroke and two stroke SI engines	1	Lecture with discussion
38	Smoke and particulate emissions in CI engines, NO_x formation and control.	1	

S.No.	Topics to be covered	No. of periods	Content delivery method
39	Noise pollution from automobiles, measurement and standards	1	
40	Design of engine, optimum selection of operating variables for control of emissions	1	
41	Catalytic converters and catalysts	1	
42	Fuel modifications, Use of Natural Gas, LPG and Biodiesel.	1	
43	Use of Gasohol and Hydrogen in Automobiles	1	
44	Electric and Hybrid Vehicles	1	
45	Fuel Cells	1	
Midterm Test 2 (CO3, CO4, CO5)			
Total		**45**	

1153AU107 VEHICLE DYNAMICS

L	T	P	C
3	0	0	3

1. Preamble

This course enriches knowledge of the learners in analysing forces and moments exerted in vehicle under different loads, speed and road conditions in order to improve the comfort for the passengers and life of the various components of the vehicle.

2. Pre-Requisite

NIL

3. Links to Other Courses

- Finite element analysis

4. Course Educational Objectives

- To develop the basic knowledge of the students in automotive field in the areas of vehicle vibrations.
- To develop the skills of the students in stability of vehicles and their effects, related with longitudinal, vertical & lateral dynamics.

5. Course Outcomes

On successful completion of this course students will be able to:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the basics of vibration, when the vehicle is at dynamic condition.	K2
CO2	Understand the tyre dynamics with respect to force & moments.	K2
CO3	Derive the effective cornering stiffness when considering the elastic elements in the wheel suspension and be able to analyse it's effect on the dynamic characteristics of the vehicle	K3
CO4	Understand the aerodynamic forces & moments, load distribution in the various vehicles.	K2
CO5	Test the effective steering geometry, vehicle handling & directional control of vehicle	K3

6. Correlation of COs with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	H	L	L						L
CO2	H	M	H	H	L	L						
CO3	H	M	H	H	L	L				L	L	
CO4	H	M	H	H	L	L						
CO5	H	M	H	H	L	L				H	H	

H- High; M-Medium; L-Low

7. Course Content

UNIT I Concept of Vibration **L-9**

Definitions- Modelling and Simulation- Global and Vehicle Coordinate System- Free- Forced- Undamped and Damped Vibration- Response Analysis of Single DOF- Two DOF- Multi DOF- Magnification Factor- Transmissibility- Vibration Absorber- Vibration Measuring instruments- torsional Vibration- Critical Speed.

UNIT II Tire Dynamics **L-9**

Tire Forces and Moments- Tire Structure- Longitudinal and Lateral Force at Various Slip Angles- Rolling Resistance- Tractive and Cornering Property of Tire. Performance of Tire on Wet Surface. Ride Property of Tires. Magic Formulae Tire Model- Estimation of Tire Road Friction. Test on Various Road Surfaces. Tire Vibration.

UNIT III Vertical Dynamics **L-9**

Human Response to Vibration- Sources of Vibration. Design and Analysis of Passive- Semi-Active and Active Suspension Using Quarter Car- Half Car and Full Car Model. influence of Suspension Stiffness- Suspension Damping- and Tire Stiffness. Control Law For LQR- H-Infinite- Skyhook Damping. Air Suspension System and Their Properties.

UNIT IV Longitudinal Dynamics **L-9**

Aerodynamic Forces and Moments. Equation of Motion. Resistance- Rolling Resistance-Load Distribution for Three-Wheeler and Four-Wheeler. Calculation of Maximum Acceleration- Reaction Forces for Different Drives. Braking and Driving torque. Prediction of Vehicle Performance.

UNIT V Lateral Dynamics **L-9**

Steady State Handling Characteristics. Steady State Response to Steering input. Testing of Handling Characteristics. Transient Response Characteristics- Direction Control of Vehicles. Roll Centre- Roll Axis- Vehicle Under Side Forces. Stability of Vehicle Running on Slope- Banked Road and During Turn. Effect of Suspension on Cornering- Latest Trends in Vehicle Dynamic Testing Like Four Poster- Multi Axis Simulator- Etc.

TOTAL: 45 Periods

8. Text Books

1. Singiresu S. Rao, "Mechanical Vibrations", 5 th Edition, Prentice Hall, 2010
2. Wong. J. Y., "Theory of Ground Vehicles", 3rd Edition, Wiley-Interscience, 2001
3. Rajesh Rajamani, "Vehicle Dynamics and Control", 1st edition, Springer, 2005
4. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", Society of Automotive Engineers Inc, 1992

9. References

5. Dean Karnopp, "Vehicle Stability", 1st edition, Marcel Dekker, 2004

6. Nakhaie Jazar. G., "Vehicle Dynamics: Theory and Application", 1st edition, Springer, 2008 3. Michael Blundell & Damian Harty, "The Multibody Systems Approach to Vehicle Dynamics", Elsevier Limited 2004
7. Hans B Pacejka, "Tire and Vehicle Dynamics", 2nd edition, SAE International, 2005 65
8. John C. Dixon," Tires, Suspension, and Handling", 2nd edition, Society of Automotive Engineers Inc, 1996 6. Jan Zuijdijk, 'Vehicle dynamics and damping", Author House, 2009

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20		20	10
Understand	80	80	10	50	50
Apply			90	30	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	40	50
Analyse	60	50
Evaluate		
Create		

11. Lecture plan:

S.No.	Topic	No. of periods	Content delivery method
	Unit –I	**(9)**	Lecture with Discussion/ Assignment/ Seminar
1	Single degree of freedom, two degree of freedom	2	
2	Free, forced and damped vibrations, modelling and simulation studies	2	
3	Model of an automobile, magnification.	2	
4	Factor, transmissibility, vibration absorber	3	
	UT-I (CO1)		
	Unit –II	**(9)**	

S.No.	Topic	No. of periods	Content delivery method
5	Requirements of suspension system.	1	Lecture with Discussion/ Assignment
6	Spring mass frequency, wheel hop, Wheel wobble, wheel shimmy	1	
7	Choice of suspension spring rate. Calculation of effective spring rate	1	
8	Vehicle suspension in fore and aft & roll axis. Human response to vibration, vehicle ride model.	2	
9	Tire forces and moments, rolling resistance of tires, relationship between tractive effort and longitudinal slip of tyres	2	
10	Cornering properties of tyres, ride properties of tyre	2	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
11	Load distribution, and, and reactions for different drives.	3	Lecture with Discussion
12	stability on a curved track slope	3	
13	banked road calculation of tractive effort	3	
	UT-II (CO3)		
	Unit IV	**(9)**	
14	Equation of motion and maximum tractive effort. Aerodynamics forces and moments	2	Lecture with Discussion/ Assignment/ Seminar / Tutorial
15	Power plant and transmission characteristics. Prediction of vehicle performance.	2	
16	Braking performance. Steering geometry. Steady state handling characteristics.	2	
17	Steady state response to steering input. Transient response characteristics.	2	
18	Directional stability of vehicle.	1	
	Unit V	**(9)**	
19	Objects — Vehicle types of drag. Various types of forces and moments.	2	Lecture with Discussion
20	Effects of forces and moments. Various body optimization techniques for minimum drag.	3	
21	Principle of wind tunnel technology. Flow visualization techniques.	2	
22	Test with scale models.	3	
	MT-II (CO3, CO4, CO5)		
	Total	**60**	

1153AU108 AUTOMOTIVE EMISSIONAND CONTROL

L	T	P	C
3	0	0	3

11. Preamble

This course provides an introduction to the vehicle population growth, types of emission, formation of pollutant in SI and CI engine, effect of pollutant on human health, environment, measurement and control.

12. Pre-requisite

NIL

13. Links to other courses

- Fuel conservation & Alternate fuels
- I.C.Engines

14. Course Educational Objectives

Students undergoing this course are expected to

- To develop the basic knowledge of the students in automobile engines pollution formation & control techniques, Measurement techniques.
- Know the social, cultural, global and environmental responsibilities of the professional engineer, and the principles of sustainable design and development.

15. Course Outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the emission and its effect on human health and environment.	**K2**
CO2	Identify the formation of pollutant in SI engine.	**K2**
CO3	Identify the formation of pollutant in CI engine	**K2**
CO4	Describe the Emission control techniques.	**K2**
CO5	Describe the Emission measurement techniques, Emission Standards and various test procedure	**K2**

16. Correlation of COs with Programme Outcomes :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**H**	**H**	**L**					**H**			
CO2	**H**	**H**	**M**	**L**					**H**			
CO3	**H**	**H**	**H**	**L**					**H**			

CO4	**H**	**H**	**H**	**L**					**H**			
CO5	**H**	**H**	**H**	**L**					**H**			

17. Course content

UNIT I Introduction **L-9**

Vehicle Population Assessment in Metropolitan Cities and Contribution to Pollution- Effects on Human Health and Environment- Global Warming- Types of Emission (Controlled and Uncontrolled Emissions)- Transient Operational Effects on Pollution.

UNIT II Pollutant Formation in SI Engines **L-9**

Pollutant Formation in SI Engines- Mechanism of HC and Co Formation in Four Stroke and Two Stroke SI Engines- NOx Formation in SI Engines- Effects of Design and Operating Variables on Emission Formation- Evaporative Emission. Two Stroke Engine Pollution.

UNIT III Pollutant Formation in CI Engines **L-9**

Pollutant Formation in CI Engines- Smoke and Particulate Emissions in CI Engines- Effects of Design and Operating Variables on CI Engine Emissions. NOx Formation

UNIT IV Control of Emissions from SI and CI Engines **L-9**

Design of Engine- Optimum Selection of Operating Variables for Control of Emissions- EGR- Catalytic Converters- Catalysts- Fuel Modifications- Two Stroke Engine Pollution Controls. SCR- Lean NOx Trap and DPF- PCV- Fuel Charcoal Canister.

UNIT V Measurement Techniques Emission Standards and Test Procedure **L-9**

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.

TOTAL: 45 periods

18. Text Books

4. Paul Degobert – Automobiles and Pollution – SAE International SBN-1-56091-563-3, 1991.
5. G.P.Springer ad D.J.Patterson, Engine Emissions, Pollutant formation, Plenum Press, New York,1986.
6. D.J.Patterson and N.A.Henin, ‘Emission from Combustion Engine and their control’, Anna Arbor Science Publication,1985.

19. References

5. SAE Transactions- “Vehicle Emission”- 1982 (3 volumes).
6. Obert.E.F.- “Internal Combustion Engines”- 1988
7. Marco Nute- “ Emissions from two stroke engines, SAE Publication – 1998
8. Ganesan .V- “Internal Combustion Engines”- Tata McGraw-Hill Co- 2003.

20. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	20	20	20	20	20
Understand	80	80	80	80	80
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	**80**	**70**
Analyse	**20**	**30**
Evaluate		
Create		

21. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Vehicle population assessment in metropolitan cities and contribution to pollution	2	Lecture with discussions/ Seminar/ Assignment
2	Effects on human health and environment	2	
3	Global warming	1	
4	Types of emission (controlled and uncontrolled emissions)	2	
5	Transient operational effects on pollution	2	
	UT-I (CO1)		
	Unit –II	**(9)**	
6	Pollutant formation in SI Engines	1	Lecture with discussions/ Seminar/ Assignment
7	Mechanism of HC and CO formation in four stroke and two stroke SI engines	2	
8	NOx formation in SI engines	1	
9	Effects of design and operating variables on emission formation	2	

S.No	Topics to be covered	No. of periods	Content Delivery Method
10	Evaporative emission	1	
11	Two stroke engine pollution	2	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
12	Pollutant formation in CI engines	2	Lecture with discussions/ Seminar/ Assignment
13	Smoke and particulate emissions in CI engines	2	
14	Effects of design and operating variables on CI engine emissions	3	
15	NOx formation	2	
	UT-II (CO3)		
	Unit - IV	**(9)**	
16	Design of engine, optimum selection of operating variables for control of emissions	2	Lecture with discussions/ Seminar/ Case Studies/ Assignment
17	EGR, catalytic converters	1	
18	Catalysts, fuel modifications	1	
19	Two stroke engine pollution controls	2	
20	SCR, lean NOx trap	1	
21	DPF, PCV	1	
22	Fuel charcoal canister	1	
	Unit -V	**(9)**	
23	NDIR, FID,	1	Lecture with discussions/ Seminar/ Lecture with demonstration
24	Chemiluminescent analyzers, Gas Chromatograph	1	
25	smoke meters, emission standards	2	
26	Driving cycles – USA, Japan, Euro and India	2	
27	Test procedures – ECE, FTP Tests	1	
28	SHED Test – chassis dynamometers	1	
29	dilution tunnels	1	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

1153AU109 FUEL CONSERVATION AND ALTERNATE FUELS

L	T	P	C
3	0	0	3

4. **Preamble**

This course enables learners to acquire knowledge in fuel conservation, fuel economy, alternate fuels and the changes in the engine design for handling them and understand various energy systems for use in the automobiles.

5. **Pre-requisite**

NIL

6. **Links to other courses**

- Automotive Emission & Control
- Automotive Electrical & Electronics

7. **Course Educational Objectives**

Students undergoing this course are expect to

- The subject mainly deals with the fuel conservation and various sources of energy, various types of alternative fuels and their properties.
- The air fuel properties have a defined behavior corresponding to the compression ratio of the engine
- Understand the types of fuels and its physical and chemical properties.
- Will learn to distinguish between the Petrol and Diesel fuels with their properties and will the effect of these on to combustion.
- The subject also deals with combustion in SI and CI engines, dual fuel and multi fuel engines and their performance.
- In this course pupil will learn in depth the various stages and performance and emission characteristics of liquid fuels (alcohols, bio diesels), gaseous fuels (H2, CNG, LPG) and electric and hybrid vehicles.

8. **Course Outcomes**

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Understand the fuel economy, the fuel conservation and the air fuel ratio, carburettors and various types of fuel injection system	**K2**
C02	Know the properties, performance and emission characteristics of liquid fuels like gasoline , alcohol , vegetable oils in both SI and CI engines	**K4**
C03	Know the properties, performance and emission characteristics of gaseous fuels like LPG, CNG, and HYDROGEN.	**K4**

C04	Know the modification of SI and CI engines for various alternative fuels.	**K3**
C05	Familiarize the electric , hybrid and solar powered vehicle	**K4**

9. **Correlation of COs with Programme Outcomes**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	L	H	H			M		L	L
CO2	H	H	M	L	H	M			M		L	L
CO3	H	H	M	L	H	M			M		L	
CO4	H	H	H	L	H	H			M		L	L
CO5	H	H	H	L	H	H			M		L	L

H- Strong; M-Medium; L-Low

10. **Course Content**

UNIT I Fuel Economy **L-9**

Introduction- Air-Fuel Mixtures and Mixture Requirements- Analysis of Single Jet Carburetor- Exact Analysis of A Carburetor- Fuel Requirements of S.I. Engines- Devices To Meet The Requirements of An Ideal Carburetor- Petrol Injection System- Electronic Fuel Injection System- and Rotary Gate Meters Fuel in Injection System Requirements of A Diesel Injection System- Heat Release Pattern and Fuel Injection- Fuel Spray Patterns- S/V Ratio of Combustion Chamber- and Surface Profile of Combustion Chamber.

UNIT II Alcohols as Fuels **L-9**

Alternative Fuels. Availability of Different Alternative Fuels for Engines. Alcohols – Properties- Production Methods and Usage in Engines. Blending- Dual Fuel Operation- Surface Ignition- Spark Ignition and Oxygenated Additives. Modification Required for SI and CI Engines. Performance- Combustion and Emission Characteristics in Engines. Issues & Limitation in Alcohols.

UNIT III Vegetable Oils as Fuels **L-9**

Vegetable Oils and Their Important Properties. Methods of Using Vegetable Oils – Blending- Preheating- Transesterification and Emulsification – Performance- Combustion and Emission Characteristics in Diesel Engines. Modification Required for SI and CI Engines. Issues & Limitation in Vegetable Oils

UNIT IV Hydrogen as Engine Fuel **L- 9**

Hydrogen – Properties- Problems- Production Methods- Storage and Safety Aspects. Issues &Limitation in Hydrogen. Methods of Using Hydrogen in Engines. Modification Required for SI and CI Engines. Performance- Combustion and Emission Characteristics in Engines.

UNIT V Biogas- Natural Gas and LPG As Fuels **L-9**

Biogas- Natural Gas and LPG – Properties and Production Methods. Co2 and H2s Scrubbing in Biogas- Modifications Required for Use in Engines- Performance- Combustion and Emission Characteristics in Engines. Issues & Limitation in Gaseous Fuels.

TOTAL= 45 Periods

8. Text Book

4. Richard.L. Bechtold- Alternative Fuels Guide Book- SAE International Warrendale-1997.
5. Thipse.S.S., Alternative Fuels; Concepts, Technologies and Developments, Jaico Book Distributors, 2010
6. Gajendra Babu, M. K. and Subhramanian, K. A., Alternative Transportation Fuels, CRC Press, 2013

9. References

1. MaheswarDayal- Energy today & Tomorrow-I&B Horishr India_1982.
2. Nagpal-Power plant engineering- Khanna Pulisher-1991
3. SAE Paper No.840367,841333,841334,841156, Transactions,SAE, USA

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20				
Understand	80	30		10	30
Apply			20	40	20
Analyse		70	80	50	50
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	60	60
Analyse	40	40
Evaluate		
Create		

11. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Introduction, air-fuel mixtures and mixture requirements	1	Lecture with discussions/ Seminar/ Assignment
2	Analysis of single jet carburetor, exact analysis of a carburetor	2	
3	Fuel requirements of S.I. engines	1	
4	Devices to meet the requirements of an ideal carburetor, petrol injection system	1	

S.No	Topics to be covered	No. of periods	Content Delivery Method
5	Electronic fuel injection system, and rotary gate meters fuel in injection system	2	
6	Requirements of a diesel injection system, Heat release pattern and fuel injection, fuel spray patterns	1	
7	S/V ratio of combustion chamber, and surface profile of combustion chamber	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
8	Alternative fuels. Availability of different alternative fuels for engines	1	Lecture with discussions/ Seminar/ Assignment
9	Alcohols – Properties, Production methods and usage in engines	2	
10	Blending, dual fuel operation, surface ignition	1	
11	Spark ignition and oxygenated additives	1	
12	Modificatation required for SI and CI Engines	1	
13	Performance, combustion and emission Characteristics in engines	2	
14	Issues & limitation in alcohols	1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
15	Vegetable oils and their important properties	1	Lecture with discussions/ Seminar/ Case Studies/ Assignment
16	Methods of using vegetable oils – Blending, preheating	2	
17	Transesterification and emulsification	1	
18	Performance, combustion and emission Characteristics in diesel engines	2	
19	Modificatation required for SI and CI Engines	2	
20	Issues & limitation in Vegetable Oils	1	
	UT-II (CO3)		
	Unit IV	**(9)**	
21	Hydrogen – Properties, problems, Production methods	2	Lecture with discussions/ Seminar/ Case Studies/ Assignment
22	Storage and safety aspects	1	
23	Issues & limitation in Hydrogen	1	
24	Methods of using hydrogen in engines	2	
25	Modificatation required for SI and CI Engines	1	
26	Performance, combustion and emission Characteristics in engines	2	
	Unit V	**(9)**	
27	Biogas, Natural gas and LPG – Properties and production methods	2	Lecture with discussions/ Seminar
28	CO2 and H2S scrubbing in Biogas	2	
29	Modifications required for use in Engines	2	
30	Performance, combustion and emission Characteristics in engines	2	
31	Issues & limitation in Gaseous fuels	1	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

1153AU110 ELECTRIC AND HYBRID VEHICLES

L	T	P	C
3	0	0	3

12. Preamble

This course is intended for learning the Fundamentals of Automobile Hybrid vehicles. This course is gives the brief ideas of Hybrid vehicles propulsion methods- Hybrid architecture- Hybrid power plant specifications- Fuel cell technology - and Non electric Hybrid propulsion systems.

13. Pre-requisite

NIL

14. Links to other courses

- Automotive Electrical and Electronics.
- Automotive Transmission

15. Course Educational Objectives

Students undergoing this course are expectedto

- To develop the basic knowledge of the students in electric and hybrid vehicles.
- To develop the skills of the students in the area of working and types of electric motors.
- To develop the detailed knowledge about batteries.

16. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Illustrate the concept of electric vehicles and its propulsion systems.	**K2**
C02	State the concept of hybrid architecture and power plant	**K2**
C03	List the energy storage systems.	**K2**
C04	Explain about the fuel cells.	**K2**
C05	Illustrate the non electric hybrid propulsion systems.	**K2**

17. Correlation of COs with ProgrammeOutcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**H**	**H**		**M**						**L**	
CO2	**H**	**H**	**H**		**M**						**L**	
CO3	**H**	**H**	**H**		**M**						**L**	
CO4	**H**	**H**	**H**		**M**						**L**	
CO5	**H**	**H**	**H**		**M**						**L**	

H- Strong; M-Medium; L-Low

18. Course Content:

UNIT I Introduction to Road Vehicles and Propulsion System L-9

Hybrid Vehicles: Performance Characteristics of Road Vehicles; Calculation of Road Load- Predicting Fuel Economy- Grid Connected Hybrids.

Propulsion Methods: DC Motors Series Wound- Shunt Wound- Compound Wound and Separately Excited Motors AC Motors Induction- Synchronous- Brushless DC Motor- Switched Reluctance Motors.

UNIT II Hybrid Architecture and Power Plant Specifications L-9

Hybrid Architecture: Series - Parallel and Series Parallel Configuration Locomotive Drives- Switching- Load Tracking Architecture. Pre-transmission Parallel and Combined Configurations Mild Hybrid- Power Assist- Dual Mode- Power Split- Power Split with Shift- Continuously Variable Transmission (CVT) - Wheel Motors.

Hybrid Power Plant Specifications: Grade and Cruise Targets- Launching and Boosting- Braking and Energy Recuperation- Drive Cycle Implications- Engine Friction Reduction - Engine Downsizing and Range and Performance- Usage Requirements.

UNIT III Drive System and Energy Storage Technology L-9

Sizing the Drive System - Matching Electric Drive and ICE - Sizing the Propulsion Motor - Power Electronics. Energy Storage Technology - Battery Basics - Lead Acid Battery - Different Types of Batteries - Battery Parameters.

UNIT IV Fuel Cells L-9

Fuel Cell Characteristics- Fuel Cell Types – Alkaline Fuel Cell- Proton Exchange Membrane; Direct Methanol Fuel Cell- Phosphoric Acid Fuel Cell- Molten Carbonate Fuel Cell- Solid Oxide fuel Cell- Hydrogen Storage Systems- Reformers- Fuel Cell EV- Super and Ultra Capacitors- Flywheels.

UNIT V Non-Electric Hybrid Propulsion Systems L-9

Nonelectric Hybrid Propulsion Systems: Short Term Storage Systems Flywheel Accumulators. Continuously Variable Transmissions Hydraulic Accumulators Hydraulic Pumps/Motors- Pneumatic Hybrid Engine Systems Operation Modes

TOTAL: 45 periods

19. Text Books

3. Hybrid and Alternative Fuel Vehicles (2nd Edition) (Professional Technician) by James D. Halderman and Tony Martin (Feb 7, 2010)
4. How Your Car Works: Your Guide to the Components & Systems of Modern Cars, Including Hybrid & Electric Vehicles (Rac Handbook) by ArvidLinde (Oct 15, 2011)

20. References

3. Electric and Hybrid Vehicles by Iqbal Husain (Jul 16, 2011)
4. Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives by Chris Mi, M. AbulMasrur and David WenzhongGao (Jul 5, 2011)

21. **Revised Bloom's based Assessment Pattern :**

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	30	40	40	40	40
Understand	70	60	60	60	60
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	60	60
Analyse	40	40
Evaluate		
Create		

22. Lecture plan:

S.No.	Topic	No. of periods	Content Delivery methods
	Unit-I	**(9)**	
1	Hybrid Vehicles: Performance characteristics of road vehicles	2	Lecture with discussion/ Assignment/ Seminar/ Case studies
2	Calculation of road load- predicting fuel economy- grid connected hybrids.	2	
3	Propulsion methods: DC motors series wound- shunt wound- compound wound and separately excited motors AC motors	2	
4	Induction- synchronous- brushless DC motor- switched reluctance motors.	2	
5	Seminar	1	
	UT-I (CO1)		
	Unit–II	**(9)**	
6	Hybrid architecture: Series configuration locomotive drives- series parallel switching- load tracking architecture.	2	Lecture with discussion/ Assignment/
7	Pre transmission parallel and combined configurations	1	

S.No.	Topic	No. of periods	Content Delivery methods
8	Mild hybrid- power assist- dual mode- power split- power split with shift	1	Seminar
9	Continuously Variable transmission (CVT) - wheel motors.	2	
10	Hybrid power plant specifications: Grade and cruise targets- launching and boosting- braking and energy recuperation-	2	
11	Drive cycle implications- engine fraction engine downsizing and range and performance- usage requirements.	1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
12	Drive system, Matching electric drive and ICE,	3	Lecture with discussion/ Assignment/ Seminar
13	Sizing the propulsion motor, sizing power electronics.	3	
14	Energy storage technology, Battery basics, leads acid battery	2	
15	different types of batteries, battery parameters	1	
	UT-II (CO3)		
	Unit IV	**(9)**	
16	Fuel cell characteristics- fuel cell types – alkaline fuel cell- proton exchange Membrane.	2	Lecture with discussion/ Assignment/ Seminar/ Case studies
17	direct methanol fuel cell- phosphoric acid fuel cell	2	
18	molten carbonate fuel cell	3	
19	solid oxidefuel cell- hydrogen storage systems- reformers-	3	
20	fuel cell EV- super and ultra capacitors- flywheels	2	
	Unit V	**(9)**	
21	Nonelectric Hybrid Propulsion Systems: Short Term Storage Systems	3	Lecture with discussion/ Assignment/ Seminar/ Case studies/ Group discussion
22	Flywheel Accumulators. Modes	2	
23	Continuously Variable Transmissions Hydraulic	2	
24	Hydraulic Pumps/Motors- Pneumatic Hybrid Engine Systems Operation	1	
25	Revision	1	
26	Seminar	1	
	MT – II (CO3, CO4, CO5)		
	Total	**45**	

1153AU201	ELECTRIC TWO WHEELER TECHNOLOGY	L	T	P	C
		3	0	6	6

Course Category: Allied Elective

1. Preamble

This course is intended for learning and practicing technology on electric two wheeler. This course gives the elaborate ideas on construction of two wheeler frames, energy storage devices, controllers and electric drives used in electric two wheelers.

2. Pre-requisite

NIL

3. Links to other courses

- Electric and Hybrid Vehicles

4. Course Educational Objective

Students undergoing this course are expected to,

- To develop the basic knowledge of the students in electric vehicles.
- To develop the skills of the students in the area of working and types of electric motors.
- To develop the detailed knowledge about controller and batteries.
- Students were able to design, fabricate an Electric bicycle.

5. Course Outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe about working principle of electric vehicles, norms and government policies.	K2
CO2	Describe the different types two wheeler frames, suspension and brake system.	K2
CO3	Demonstrate the construction and working principle of lead acid battery and battery rating, testing and selection of battery	K3
CO4	Understand about controller for EVs, converter, charging methods for EVs	K2
CO5	Demonstrate the construction and working principle of various motors used in electric vehicles.	K3

Unit I : Introduction of Electric Vehicle **L 9 P 6**

Introduction to Electric Vehicle - Need - Types – Electric and Hybrid vehicles - Layouts - Electric Vehicle Technology in Two wheelers – Power Transmission Layout of Electric Two Wheelers- Electric Vehicle norms and Government Policies – Infrastructure requirement.

List of Demonstrations

1. Demo on components required for the fabrication of Electric bicycle.
2. Case study on electric two wheelers in India.

Unit II : Frames and Suspension **L 9 P 6**

Two Wheeler's Mainframe and its types - Backbone frame - Single cradle frame - Double cradle frame - Perimeter frame - Suspension - Front and Rear Forks - Springs for Suspension - Telescopic Suspension – Mono shock Suspension - Hydraulic Shock Absorber - Brake - Drum Brakes - Disc Brakes.

List of Demonstration:

1. Practical Study on Electric two wheeler frame and suspension.

Unit III : Storage Devices **L 9 P 6**

Energy storage technology - Battery basics - different types of batteries - lead acid battery – construction- working principle - Lithium ion and Lithium polymer batteries - Battery parameters - Battery rating and battery testing - basic calculation of battery capacity , range for an electric vehicle – Environmental concerns – recycling of batteries.

List of Demonstrations:

1. Demo on lead acid battery construction and testing.
2. Design calculation and selection of Battery required for Electric two wheeler.

Unit IV : Electric Drives **L 9 P 6**

Electric motors – types – DC Motors series wound- shunt wound- compound wound and brushless DC motor- Principle, Construction, Control - Hub motors - Construction and uses -Electric Drive Trains - basic calculation of torque and speed for electric vehicle.

List of Demonstration:

1. Design calculation and selection of electric drive required for the fabrication of Electric two wheeler.

Unit V : Electric vehicle Control System **L 9 P 6**

Electric vehicle controller – Need - Types – Controller components - DC to DC converter- Alternator - Requirements of the Charging System - Charging System Principles - Charging methods - Regenerative power generation methods – Electric two wheeler wiring circuit.

List of Demonstration:

1. Practical Study on Electric two wheeler controller.
2. Demonstration on Electric two wheeler wiring.

DESIGN, IMPLEMENT and OPERATE (DIO) – PROJECT P – 60

Total Hr: 45 + 90 = 135

Reference Books:

1. K. Newton, W. Steeds and T. K. Garrett, 'Motor Vehicle' Butterworth, Heinemann, 13th Edition, 2000.
2. P E Irving, 'Motorcycle Engineering', Veloce Enterprises, Inc, 2017.
3. Dr.Kirpal Singh, 'Automobile Engineering'- Vol. I and II, Standard Publishers, New Delhi, 2011.
4. Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes publication, 2001.

Guidelines to select and carry out the project:	
Step 1(Identify):	Conceive/identify a need or an innovative idea for the modification on Bicycle/Two wheeler for Electrification.
Step 2(Design):	Design and Selection of components required for Electric Bicycle as per the technical requirements.
Step 3(Implement):	Fabricate and Assemble components as per the requirement of Electric Bicycle.
Step 4(Operate):	Test run the Electric Bicycle.

DESIGN, IMPLEMENT and OPERATE (DIO) – PROJECT

1. Design and Development of Electric Bicycle using Hub motor.
2. Design and Development of Electric Bicycle using BLDC electric motor.
3. Regeneration of power through alternator on Electric Bicycle.

1154AU101 AUTOMOTIVE SAFETY

L	T	P	C
3	0	0	3

1. Preamble

This course imparts understanding of role of safety systems in automobiles through technology.

2. Pre-Requisite

NIL

3. Links to Other Courses

- Vehicle Body Engineering
- Automotive chassis

4. Course Educational Objectives

Students undergoing this course are expected to

- Gain knowledge about the vehicles structural crashworthiness and crash testing
- Gain knowledge about the working of vehicle vision safety systems

5. Course Outcomes:

On successful completion of this course students will be able to:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Identity different safety systems and vehicle structural crashworthiness	K2
CO2	Analyse and simulate vehicle in barrier impacts	K2
CO3	Design vehicle safety systems	K3
CO4	Determine the fundamentals of light ,vision and colour	K2
CO5	Analyse pedestrian safety by use of light measurement and testing	K3

6. Correlation of COs with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	L	H		L	L					
CO2	H	H	L	H		L	L					
CO3	H	H	L	H		L	L					
CO4	H	H	L	H		L	L					
CO5	H	H	L	H		L	L					

H- High; M-Medium; L-Low

7. Course Content

UNIT I Introduction Vehicle Safety- Structural Crashworthiness and Crash Testing L-9

Automotive Safety-Active and Passive Safety- Driver Assistance Systems in Automobiles-Definitions and Terminology. Balance of Stiffness and toughness Characteristics and Energy Absorption Characteristics of Vehicle Structures- Design of Crash Crumple Zones- Modeling and Simulation Studies- Optimization of Vehicle Structures for Crash Worthiness- Types of Impacts-and Impact with Rebound- Movable Barrier Tests- Analysis and Simulation of Vehicle in Barrier Impacts- Roll Over Crash Tests- Behavior of Specific Body Structures in Crash Testing-Photographic Analysis of Impact Tests

UNIT II Ergonomics and Human Response to Impact L-9

Importance of Ergonomics in Automotive Safety- Locations of Controls- Anthropometry- Human Impact tolerance Determination of injury Thresholds- Severity index- Study of Comparative tolerance- Application of Trauma for Analysis of Crash injuries. injury Criteria's and Relation with Crash and Modeling and Simulation Studies in Dummy

UNIT III Vehicle Safety Systems L-9

Survival Space Requirements- Restraints Systems Used Automobiles- Types of Safety Belts- Head Restraints- Air Bags Used in Automobiles- Use of Energy Absorbing Systems in Automobiles-Impact Protection from Steering Controls- Design of Seats for Safety- Types of Seats Used in Automobiles. Importance of Bumpers in Automobiles- Damageability Criteria in Bumper Designs. introduction to the Types of Safety Glass and Their Requirements and Rearward Field of Vision in Automobiles- Types of Rear-View Mirrors and Their Assessment. Warning Devices- Hinges and Latches Etc. Active Safety

UNIT IV Fundamentals of Light- Vision and Color L-9

Electromagnetic Radiation and Light- Propagation of Light- Spectral Sensitivity of Light-Measures of Radiation and Light- Standard Elements for Optical Control. Illuminant Calculations-Derivation of Luminous Flux from Luminous intensity- Flux Transfer and inter Reflection-Luminance Calculations- Discomfort Glare- Eyes as an Optical System Visual Processing-Lighting for Results- Modes of Appearance- Pointers for Lighting Devices. Nature of The Color Tri-Chromatic Colorimetry- Surface Color- Color Spaces and Color Solids-- Color Rendering.

UNIT V Light Measurements- Testing Equipment- Calibration and Photometric Practice L-9

Basics of Standards and Detectors- Spectral Measurements and Colorimetry- Illuminant Meters and Luminance Meters- Colorimeters. Fundamentals of Equipment Used for Light Measurement in Automotive Field; Gonio- Photometer- Reflecto-Meter- Colorimeter- integrating Sphere-Types- Application- Coordinates System- Types of Sensors and Working Principle- Construction-Characteristics Etc. Used in Different Equipment. National and international Regulations- Test Requirements and Testing Procedure

Total: 45 Periods

8. Text Books:

6. Watts, A. J., et al "Low speed Automobile Accidents" Lawyers and Judges 1996
7. Jullian Happian-Smith 'An Introduction to Modern Vehicle Design' SAE, 2002
8. Johnson, W., and Mamalis, A.G., "Crashworthiness of Vehicles, MEP, London, 1995
9. Edward .A, Lamps and Lighting, Hodder & Stoughton, London, 1993.
10. Bosch –automotive -handbook ,edition 5-SAE Publication-2000

9. References:

9. Keitz H. A. E, Light calculations and Measurements, Macmillan, 1971.
10. Olson L. P, Forensic aspects of driver perception and response, Lawyers and Judges 1996.
11. Pantazis. M, Visual instrumentation: Optical design & engineering Principles, McGraw - Hill 1999.
12. Matthew Huang, "Vehicle Crash Mechanics".
13. David C. Viano, "Role of the Seat in Rear Crash Safety".
14. Jeffrey A. Pike, "Neck Injury".
15. Ching-Yao Chan, "Fundamentals of Crash Sensing in Automotive Air Bag Systems".
16. Rollover Prevention, Crash Avoidance, Crashworthiness, Ergonomics and Human Factors", SAE Special Publication, November 2003.

10. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	40	20			10
Understand	60	80	20	40	50
Apply			80	60	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 &CO2) (Max marks in %)	II (CO3&CO4) (Max marks in %)
Remember		
Understand		
Apply	20	20
Analyse	80	80
Evaluate		
Create		

11. Lecture plan

S.No.	Topics to be covered	No. of periods	Content delivery method
	Unit –I	**(9)**	
1	Design of the body for safety, energy equation, engine location	3	Lecture with discussion/ Assignment/ Seminar
2	Deceleration of vehicle inside passenger compartment	3	
3	Deceleration on impact with stationary and movable obstacle	3	
4	Concept of crumble zone	3	
	UT-I (CO1)		
	Unit –II	**(9)**	
5	Active safety: driving safety, conditional safety, perceptibility safety,	2	Lecture with discussion/ Assignment/ Seminar
6	Operating safety passive safety: exterior safety	2	
7	Interior safety	2	
8	Deformation behavior of vehicle body,	1	
9	Speed and acceleration characteristics of passenger compartment on impact.	1	
10	Speed and acceleration characteristics of passenger compartment on impact.	1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
11	Airbags, electronic system for activating air bags	1	Lecture/ Lecture with discussion/ Assignment/ Seminar
12	Seat belt, regulations, automatic seat belt tightener system	2	
13	Collapsible & tiltable steering column, bumper design for safety. Collision warning systems, child lock	2	
14	Antilock braking systems	1	
15	Electronic stability control system/traction control system.	1	
16	Vision enhancement, road recognition system, Anti theft technologies	1	
17	Smart card system, number plate coding, central locking system	1	
	UT-II (CO3)		
	Unit IV	**(9)**	
18	Active suspension systems, requirement and characteristics,	2	Lecture/ Lecture with discussion/ Assignment
19	Different types, Vehicle Handling and Ride characteristics of f road vehicle, pitch, yaw, bounce control,	2	
20	Power windows, thermal management system, adaptive noise control.	2	
21	Steering and mirror adjustment, central locking system ,	1	
22	Garage door opening system, tyre pressure control system	1	
23	Rain sensor system, environment information system	1	
	Unit V	**(9)**	
24	Traffic routing system - Automated highway systems	2	Lecture/ Lecture with
25	Lane warning system – Driver Information System, driver assistance systems	2	

S.No.	Topics to be covered	No. of periods	Content delivery method
26	Data communication within the car, Driver conditioning warning	2	discussion/ Assignment
27	Route Guidance and Navigation Systems – vision enhancement system	2	
28	In-Vehicle Computing – Vehicle Diagnostics system – Hybrid / Electric and Future Cars – Case studies	1	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

1154AU102 AUTOMOTIVE ELECTRICAL AND ELECTRONICS

L	T	P	C
3	0	0	3

1. Preamble

This course makes the students to know the functions, working principles of various automotive electrical & electronics components.

2. Pre-requisite

NIL

3. Links to other courses

- Automotive Safety
- Engine Electronics Management Systems

4. Course Educational Objectives

Students undergoing this course are expected

- To know the concepts and develop basic skills necessary to diagnose automotive electrical problems
- To know Starting, and charging, lighting systems, advanced automotive electrical systems, to include body electrical accessories and basic computer control.
- To explore practically about the components present in an Automotive electrical and electronics system.

5. Course Outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Enumerate the construction, characteristics and maintanance of battery, lighting system and different accessories in a typical automobile after careful inspection.	K2
CO2	Explain the construction, characteristics and maintenance of starting and ignition system and diagnose the ignition system fault of any vehicle.	K2
CO3	List out the principles and characteristics of charging system components and demonstrate their working with suitable tools.	K2
CO4	Describe the principles and architecture of electronics systems and its components present in an automobile related to instrumentation, control, security and warning systems.	K2
CO5	Enumerate the principles, application, construction and specification of different sensors and actuators usable in typical automobile by suitable testing.	K2

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	H	H	M	L			L			
CO2	M	H	H	H	M	L			L			
CO3	M	H	H	H	M	L			L			
CO4	M	H	H	H	M	L			L			
CO5	M	H	H	H	M	L			L			

7. Course content

UNIT I Electrical Systems **L-9**

Principle and Construction of Lead Acid and Lithium-Ion Battery- Characteristics of Battery- Rating Capacity and Efficiency of Batteries- Various Tests on Batteries- Maintenance and Charging. Lighting System and Photometry: insulated and Earth Return System- Details of Head Light and Side Light- LED Lighting System- Head Light Dazzling and Preventive Methods – Horns- Wiper System and Trafficator.

UNIT II Starting and Ignition System **L-9**

Condition at Starting- Behavior of Starter During Starting- Series Motor and Its Characteristics- Principle and Construction of Starter Motor- Over Running Clutch Working of Different Starter Drive Units- Care and Maintenances of Starter Motor- Starter Switches. Spark Plugs. Advance Mechanisms. Different Types of Ignition Systems.

UNIT III Charging System **L-9**

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.

UNIT IV Sensors and Actuators **L-9**

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.

UNIT V Electronics Systems **L-9**

Current Trends in Automotive Electronic Engine Management System- Types of EMS- Electromagnetic interference Suppression- Electromagnetic Compatibility- Electronic Dashboard Instruments- Onboard Diagnostic System- Security - Warning System- infotainment and Telematics.

45 periods

8. Text Books

1. Young A.P. & Griffiths. L. “Automotive Electrical Equipment”, ELBS & New Press- 1999.
2. William B.Ribbens “Understanding Automotive Electronics”, 5th edition - Butter worth Heinemann Woburn, 1998.
3. Ganesan .V- “Internal Combustion Engines”- Tata McGraw-Hill Co- 2003.

9. References

1. Bechhold "Understanding Automotive Electronics", SAE, 1998.
2. Crouse, W.H "Automobile Electrical Equipment", McGraw-Hill Book Co., Inc., New York, 3rd edition, 1986.
3. Judge A.W "Modern Electrical Equipment of Automobiles", Chapman & Hall, London, 1992.
4. Kholi.P.L "Automotive Electrical Equipment", Tata McGraw-Hill Co., Ltd., New Delhi, 1975.
5. Robert Bosch "Automotive Hand Book", SAE (5th Edition), 2000.
6. Ganesan.V. "Internal Combustion Engines", Tata McGraw-Hill Publishing Co., New Delhi, 2003.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	10	10	20
Understand	80	80	90	90	80
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand	40	40
Apply	60	60
Analyse		
Evaluate		
Create		

11. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Principle and construction of lead acid battery	1	Lecture with discussions/ Seminar/ Assignment
2	Characteristics of battery	1	
3	Rating capacity and efficiency of batteries	1	
4	Various tests on batteries, maintenance and charging	1	
5	Lighting system: insulated and earth return system	1	
6	Details of head light and side light	1	
7	LED lighting system	1	
8	Head light dazzling and preventive methods	1	
9	Horn, wiper system and trafficator	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
10	Condition At starting	1	Lecture with discussions/ Seminar/ Assignment
11	Behavior of starter during starting	1	
12	Series motor and its characteristics	1	
13		1	
14	Principle and construction of starter motor	1	
15		1	
16	Working of different starter drive units,	1	
17	Care and maintenances of starter motor, starter switches	1	
18		1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
19	Generation of direct current, shunt generator characteristics	1	Lecture with discussions/ Seminar/ Case Studies/ Assignment
20	Armature reaction	1	
21	Third brush regulation	1	
22	Cutout, Voltage and current regulators	1	
23	Compensated voltage regulator	1	
24	Alternators principle and construction	2	
25	Bridge rectifiers	1	
26	New developments	1	
	UT-II (CO3)		
	Unit - IV	**(9)**	
27	Current trends in automotive electronic engine management system	2	Lecture with discussions/ Seminar/ Case Studies/ Assignment
28	Electromagnetic interference suppression	1	
29	Electromagnetic compatibility	1	
30	Electronic dashboard instruments	1	
31	Electronic dashboard instruments	1	
32	Onboard diagnostic system	2	
33	Security and warning system	1	

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit -V	**(9)**	
34	Types of sensors	1	Lecture with discussions/ Seminar/ Lecture with demonstration
35	Sensor for speed	1	
36	Throttle position	1	
37	Exhaust oxygen level	1	
38	Manifold pressure, crankshaft position	1	
39	Coolant temperature, exhaust temperature	2	
40	Air mass flow for engine application	1	
41	Solenoids, stepper motors, relay	1	
	MT-II (CO3, CO4, CO5)		
Total		**45**	

1154AU103 AUTOMOTIVE ECU DESIGN AND WIRING HARNESS

L	T	P	C
3	0	0	3

8. Preamble

This course provides the fundamentals of basic hardware components to the sophistication of digital control systems algorithms. It will start with a review of automotive sensors and actuators technologies and progress with the fundamental notions of digital signal processing and digital control system design which are necessary to the engineer who works with computer-controlled systems

9. Pre Requisite

NIL

10. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the principles of basic electronic components related with automobiles.	K2
CO2	Understand the basic principles of control system and embedded system in automobile	K2
CO 3	Study about the working of operating system in automobile	K2
CO4	Study about components of electronic control unit	K2
CO5	Understand the wiring harness in automobile	K2

11. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M		M	M					L	L
CO2	L	H	M		M	M					L	L
CO3	M	H	M		M	M					L	L
CO4	L	H	M		M	M					L	L
CO5	L	H	M		M	M					L	L

12. Course Content

UNIT-1 Fundamentals of Automotive Electronics **L-9**

Semiconductor Devices- Diodes- Rectifier Circuit- Transistors- Transistor Amplifiers- Operational Amplifiers- Logic Gates- Flip-Flops. ADC and Its Types- DAC and Its Types. Manufacturing of Semiconductor Components and Circuits.

UNIT-2 Control Systems and Embedded Systems **L-9**

Open-Loop and Closed-Loop Control Systems: Modeling- Block Diagrams-Discrete Systems- Time-Discrete Systems- Value-Discrete Systems and Signals- Time- and Value-Discrete Systems and Signals- State Machines. Embedded Systems: Microcontroller Construction- Memory Technologies: Read/Write Memory- Non-Erasable-Read-Only Memory- Reprogrammable Nonvolatile Memory- Microcontroller Programming- Program Version and Data Version- Functional Principles of Microcontrollers -Principal Microcontroller Operations- Microprocessor Architecture and instruction Set- I/O Module Architecture.

UNIT-3 Automotive Software **L-9**

Real-Time Systems- Distributed and Networked Systems- System Reliability- Safety- Monitoring- and Diagnostics.

UNIT-4 Electronic Control Unit **L-9**

Operating Conditions- Design- Data Processing- Digital Modules in the Control Unit.

UNIT-5 Wiring Harness **L-9**

Wiring Harness and Cables- Wiring System interfaces- Circuit Protection- Circuit Diagrams.

45 periods

13. Text book

3. Jörg Schäuffele Thomas Zurawka, Automotive Software Engineering: Principles, Processes, Methods, and Tools, SAE International, Fachverlage GmbH, Wiesbaden, Germany, 2003, ISBN 3-528-01040-1
4. William B. Ribbens, Understanding Automotive Electronics, Fifth Edition, Butterworth–Heinemann publications, 1998.

14. References

3. Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive, 5th Edition, Robert Bosch GmbH, 2007.
4. Najamuz Zaman, Automotive Electronics Design Fundamentals, Springer International Publishing Switzerland 2015

Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	10	10	20
Understand	80	80	90	90	80
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand	40	40
Apply	60	60
Analyse		
Evaluate		
Create		

11. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Semicnductor devices, diodes, rectifier circuit	2	Lecture with discussions/ Seminar/ Assignment
2	Transistors, transistor amplifiers, operational amplifiers,	2	
3	Logic gates, flip-flops.	2	
4	ADC and its types, DAC and its types.	2	
5	Manufacturing of semiconductor components and circuits	1	
	UT-I (CO1)		
	Unit –II	**(9)**	
6	Open-Loop and Closed-Loop Control Systems: Modeling, Block Diagrams.	1	Lecture with discussions/ Seminar/ Assignment
7	Discrete Systems, Time-Discrete Systems, Value-Discrete Systems and Signals.	1	
8	Time- and Value-Discrete Systems and Signals, State Machines	1	
9	Embedded Systems: Microcontroller Construction, Memory Technologies: Read/Write Memory, Non-Erasable.	2	
10	Read-Only Memory,Reprogrammable Nonvolatile Memory	1	
11	Microcontroller Programming, Program Version and Data Version	1	
12	Functional Principles of Microcontrollers ,Principal Microcontroller Operations.	1	

S.No	Topics to be covered	No. of periods	Content Delivery Method
13	Microprocessor Architecture and Instruction Set, I/O Module Architecture	1	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
14	Real-Time Systems	3	Lecture with discussions/ Seminar/ Assignment
15	Distributed and Networked Systems	2	
16	System Reliability	2	
17	Safety, Monitoring, and Diagnostics	2	
	UT-II (CO3)		
	Unit - IV	**(9)**	
18	Operating conditions	3	Lecture with discussions/ Assignment
19	Design, Data processing	3	
20	Digital modules in the control unit	3	
	Unit -V	**(9)**	
21	Wiring harness and cables	2	Lecture with discussions/ Lecture with demonstration
22	Wiring system interfaces	3	
23	Circuit Protection	2	
24	Circuit Diagrams	2	
	MT-II (CO3, CO4, CO5)		
	Total	**45**	

1154AU104 AUTOMOBILE ENGINEERING

L	T	P	C
3	0	0	3

1. Preamble

This course provides an introduction to vehicle structure, engine, power transmission system, steering system, brakes and suspension; it also provides an introduction to engine emissions and their control and offers various alternative fuels that can be used in automobiles

2. Pre-requisite

NIL

3. Link to other courses

Automotive Engines, Automotive Chassis, Automotive Transmission,

4. Course Educational Objective

Students undergoing this course are expected

- Describe the concept of chassis and various subsystems of automobile.
- Explain about fundamental principles, construction and working of different subsystems of engines used in automobiles
- Analyse various types of emissions and suggest ways to reduce them

5. Course Outcome

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the vehicle construction and engines in automobiles.	K2
CO2	Understand the fuel injection, ignition systems and starting systems.	K2
CO3	Describe the transmission and cooling systems.	K2
CO4	Illustrate the steering systems, braking systems and suspension systems.	K2
CO5	Describe the IC engine emissions and alternative fuels and their conversion kits used in automobile.	K2

6. Correlation of COs with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H			H	H		H				M	
CO2	H			H	H		H				M	
CO3	H			H	H		H				M	
CO4	H			H	H		H				M	
CO5	H			H	H		H				M	

H- Strong; M-Medium; L-Low

15. Course Contents

UNIT I Vehicle Structure and Engines L-9

Introduction: General Classification of Automobiles- Layout of Chassis- Types of Drives of Automobile. Chassis and Body – Body Parts- Functions- Material and Vehicle Construction. Engines – Types of Engines- Components- Functions and Materials- Working Principle- Comparison of Four Stroke and Two Stroke Engines.

UNIT II Engine Auxiliary Systems L-9

Carburetor–Working Principle- Electronic Fuel injection System – Mono-Point and Multi - Point injection Systems – Battery Coil and Magneto Ignition Systems- Electronic Ignition Systems. Construction- Operation and Maintenance of Lead Acid Battery - Principle and Construction of Starter Motor- Working of Different Starter Drive Units. Supercharging and Turbo Charging.

UNIT III Transmission and Cooling Systems L-9

Clutch – Types and Construction – Gear Boxes- Manual and Automatic –Flywheel-Torque Converters– Propeller Shaft – Slip Joint – Universal Joints – Differential and Rear Axle – Hotchkiss Drive. Need for Cooling System- Types of Cooling System: Air Cooling System- Liquid Cooling System- Forced Circulation System- Pressure Cooling System.

UNIT IV Steering- Brakes and Suspension L-9

Wheels and Tyres - Steering Geometry – Power Steering – Types of Front Axle – Classification of Brakes- Drum Brakes and Disc Brakes- Constructional Details- theory of Braking- Parking Brake- Braking Material- Hydraulic System- Vacuum Assisted System- Air Brake System- Antilock Braking System. 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.

UNIT V Emission- Emission Control and Alternative Fuels L-9

Mechanism of HC- NOx and CO Formation in Four Stroke and Two Stroke SI Engines- Smoke and Particulate Emissions in CI Engines- NOx Formation and Control. Noise Pollution from Automobiles- Measurement and Standards. Design of Engine- Optimum Selection of Operating Variables for Control of Emissions- Catalytic Converters- Catalysts. Fuel Modifications -Use of Natural Gas- LPG- Biodiesel- Gasohol and Hydrogen in Automobiles - Electric and Hybrid Vehicles- Fuel Cells.

TOTAL = 45 periods

8. Text Books

1. Ganesan, V., Internal Combustion Engines, Tata McGraw-Hill, New Delhi, 2012.
2. Kirpal Singh, Automobile Engineering- Vol. I and II, Standard Publishers, New Delhi, 2011.
3. Ramalingam. K .K, Automobile Engineering, Scitech publications,2011.

9. References

1. Kamaraju Ramakrishna, Automobile Engineering, PHI Learning pvt. Ltd., New delhi-2012.

2. Mathur M.L. and Sharma. 'A Course in Internal Combustion Engines', R.P. Dhanpat Rai Publications, 2009.
3. K. M. Gupta, Automobile Engineering- Vol I and II, Umesh Publications, 2007
4. G B S Narang, Automobile Engineering, Khanna publishers, New Delhi, 2005.
5. Crouse, W.H., and Anglin, D.L., Automotive Mechanics, Tata McGraw Hill, New Delhi, 2005.

10. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember	20	20	20	20	20
Understand	80	80	80	80	80
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (COs addressed) (Max marks in %)	II (COs addressed) (Max marks in %)
Remember		
Understand		
Apply	**50**	**50**
Analyse	**50**	**50**
Evaluate		
Create		

11. Lecture plan:

S.No.	Topics to be covered	No. of periods	Content delivery method
	Unit–I	**(9)**	
1	General classification of automobiles and layout of chassis	1	Lecture with discussion, Assignment
2	Types of drives of automobile	1	
3	Chassis Body parts, functions and their materials	1	
4	Vehicle construction	1	
5	Components of Engine and their functions and materials	1	
6	Introduction to Engines and Types of Engines	1	
7	Working principle of four stroke petrol and four stroke diesel engine	1	

S.No.	Topics to be covered	No. of periods	Content delivery method
8	Working principle of two stroke petrol and two stroke diesel engine	1	
9	Comparison of four stroke and two stroke engine	1	
Unit Test I (CO 1)			
Unit–II		**(9)**	
10	Carburetor and its working principle	1	Lecture with discussion, Assignment
11	Electronic fuel injection system	1	
12	Mono-point and multi - point Injection Systems	1	
13	Battery coil and magneto ignition systems	1	
14	Electronic ignition systems	1	
15	Construction, Operation and Maintenance of Lead Acid Battery	1	
16	Principle and construction of starter motor And Working of different starter drive units	1	
17	Supercharging	1	
18	Turbo charging	1	
Midterm Test 1 (CO1, CO2)			
Unit-III		**(9)**	
19	Clutch and Types of clutches	1	Lecture with discussion, Assignment
20	Manual gear box	1	
21	Automatic gearbox	1	
22	Fluid flywheel and Torque converter	1	
23	Propeller shaft ,Slip Joint and Universal Joints	1	
24	Differential and Rear Axle Hotchkiss Drive	1	
25	Need for cooling system and Types of cooling system	1	
26	Air cooling system and liquid cooling system	1	
27	Forced circulation system and pressure cooling system.	1	
Unit Test 2 (CO 3)			
Unit-IV		**(9)**	
28	Wheels and Tyres	1	Lecture with discussion, Assignment
29	Steering Geometry and Power Steering	1	
30	Types of Front Axle ,Classification of brakes, drum brakes and disc brakes	1	
31	Constructional details, theory of braking, parking brake, braking material.	1	
32	Hydraulic braking system and Vacuum assisted system,	1	
33	Air brake system and antilock braking system(ABS)	1	
34	Need of suspension system, types of suspension, suspension springs	1	
35	Constructional details and characteristics of leaf, coil and torsion bar springs	1	
36	Independent suspension, rubber suspension, pneumatic suspension and shock absorbers	1	
Unit -V		**(9)**	

S.No.	Topics to be covered	No. of periods	Content delivery method
37	Mechanism of HC, NOx and CO formation in four stroke and two stroke SI engines	1	Lecture with discussion
38	Smoke and particulate emissions in CI engines, NO_x formation and control.	1	
39	Noise pollution from automobiles, measurement and standards	1	
40	Design of engine, optimum selection of operating variables for control of emissions	1	
41	Catalytic converters and catalysts	1	
42	Fuel modifications, Use of Natural Gas, LPG and Biodiesel.	1	
43	Use of Gasohol and Hydrogen in Automobiles	1	
44	Electric and Hybrid Vehicles	1	
45	Fuel Cells	1	
Midterm Test 2 (CO3, CO4, CO5)			
Total		**45**	

1154AU105 AUTOMOTIVE EMISSIONAND CONTROL

L	T	P	C
3	0	0	3

1. Preamble

This course provides an introduction to the vehicle population growth, types of emission, formation of pollutant in SI and CI engine, effect of pollutant on human health, environment, measurement and control.

2. Pre-requisite

NIL

3. Links to other courses

- Fuel conservation & Alternate fuels
- I.C.Engines

4. Course Educational Objectives

Students undergoing this course are expected to

- To develop the basic knowledge of the students in automobile engines pollution formation & control techniques, Measurement techniques.
- Know the social, cultural, global and environmental responsibilities of the professional engineer, and the principles of sustainable design and development.

5. Course Outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the emission and its effect on human health and environment.	**K2**
CO2	Identify the formation of pollutant in SI engine.	**K2**
CO3	Identify the formation of pollutant in CI engine	**K2**
CO4	Describe the Emission control techniques.	**K2**
CO5	Describe the Emission measurement techniques, Emission Standards and various test procedure	**K2**

6. Correlation of COs with Programme Outcomes :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**H**	**H**	**L**					**H**			
CO2	**H**	**H**	**M**	**L**					**H**			
CO3	**H**	**H**	**H**	**L**					**H**			
CO4	**H**	**H**	**H**	**L**					**H**			

CO5	**H**	**H**	**H**	**L**					**H**			

7. Course content

UNIT I Introduction **L-9**

Vehicle Population Assessment in Metropolitan Cities and Contribution to Pollution- Effects on Human Health and Environment- Global Warming- Types of Emission (Controlled and Uncontrolled Emissions)- Transient Operational Effects on Pollution.

UNIT II Pollutant Formation in Si Engines **L-9**

Pollutant Formation in SI Engines- Mechanism of HC and CO Formation in Four Stroke and Two Stroke SI Engines- NOx Formation in SI Engines- Effects of Design and Operating Variables on Emission Formation- Evaporative Emission. Two Stroke Engine Pollution.

UNIT III Pollutant Formation in Ci Engines **L-9**

Pollutant Formation in CI Engines- Smoke and Particulate Emissions in CI Engines- Effects of Design and Operating Variables on CI Engine Emissions. NOx Formation

UNIT IV Control of Emissions from Si and Ci Engines **L-9**

Design of Engine- Optimum Selection of Operating Variables for Control of Emissions- EGR- Catalytic Converters- Catalysts- Fuel Modifications- Two Stroke Engine Pollution Controls. SCR- Lean NOx Trap and DPF- PCV- Fuel Charcoal Canister.

UNIT V Measurement Techniques Emission Standards and Test Procedure **L-9**

NDIR- Fid- Chemiluminescent Analyzers- Gas Chromatograph- Smoke Meters- Emission Standards- Bs-Vi Norms- Driving Cycles – USA- Japan- Euro and India. Test Procedures – ECE- FTP tests. Shed test – Chassis Dynamometers- Dilution Tunnels.

TOTAL: 45 periods

8. Text Books

1. Paul Degobert – Automobiles and Pollution – SAE International SBN-1-56091-563-3, 1991.
2. G.P.Springer ad D.J.Patterson, Engine Emissions, Pollutant formation, Plenum Press, New York,1986.
3. D.J.Patterson and N.A.Henin, ‘Emission from Combustion Engine and their control’, Anna Arbor Science Publication,1985.

9. References

1. SAE Transactions- “Vehicle Emission”- 1982 (3 volumes).
2. Obert.E.F.- “Internal Combustion Engines”- 1988
3. Marco Nute- “ Emissions from two stroke engines, SAE Publication – 1998
4. Ganesan .V- “Internal Combustion Engines”- Tata McGraw-Hill Co- 2003.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	20	20	20	20	20
Understand	80	80	80	80	80
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	**80**	**70**
Analyse	**20**	**30**
Evaluate		
Create		

11. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	**(9)**	
1	Vehicle population assessment in metropolitan cities and contribution to pollution	2	Lecture with discussions/ Seminar/ Assignment
2	Effects on human health and environment	2	
3	Global warming	1	
4	Types of emission (controlled and uncontrolled emissions)	2	
5	Transient operational effects on pollution	2	
	UT-I (CO1)		
	Unit –II	**(9)**	
6	Pollutant formation in SI Engines	1	Lecture with discussions/ Seminar/ Assignment
7	Mechanism of HC and CO formation in four stroke and two stroke SI engines	2	
8	NOx formation in SI engines	1	
9	Effects of design and operating variables on emission formation	2	

S.No	Topics to be covered	No. of periods	Content Delivery Method
10	Evaporative emission	1	
11	Two stroke engine pollution	2	
	MT-I (CO1, CO2)		
	Unit-III	**(9)**	
12	Pollutant formation in CI engines	2	Lecture with discussions/ Seminar/ Assignment
13	Smoke and particulate emissions in CI engines	2	
14	Effects of design and operating variables on CI engine emissions	3	
15	NOx formation	2	
	UT-II (CO3)		
	Unit - IV	**(9)**	
16	Design of engine, optimum selection of operating variables for control of emissions	2	Lecture with discussions/ Seminar/ Case Studies/ Assignment
17	EGR, catalytic converters	1	
18	Catalysts, fuel modifications	1	
19	Two stroke engine pollution controls	2	
20	SCR, lean NOx trap	1	
21	DPF, PCV	1	
22	Fuel charcoal canister	1	
	Unit -V	**(9)**	
23	NDIR, FID,	1	Lecture with discussions/ Seminar/ Lecture with demonstration
24	Chemiluminescent analyzers, Gas Chromatograph	1	
25	smoke meters, emission standards	2	
26	Driving cycles – USA, Japan, Euro and India	2	
27	Test procedures – ECE, FTP Tests	1	
28	SHED Test – chassis dynamometers	1	
29	dilution tunnels	1	
	MT – II (CO3, CO4, CO5)		
Total		**45**	

1154AU301 TWO WHEELER MAINTENANCE LABORATORY

L	T	P	C
0	0	2	1

1. Preamble

Course includes the development of skills in basic two wheeler maintenance. Students are introduced to diagnosis of systems and concerns, causes and correction of problems.

2. Prerequisite

NIL

3. Links to other courses

NIL

4. Course Educational Objectives

Students undergoing this course are expected to:

- Know the requirement of tools & equipment used in service station.
- Know about the different service station equipment construction and working
- Learn general procedures for servicing and maintenance of motor vehicle

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Perform facult diagnostic of a two wheeler	K3,S3
CO2	Demonstrate the gear box in different views	K4,S3
CO3	Demonstrate the transmission in different views	K3, S3
CO4	Describe the Clutch and brake adjustment	K3, S3

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	M	M		L				H		H
CO2	L	M	L	H		M				H		H
CO3	M	M	H	H		H				L		H
CO4	L	M	L	H		L				H		H

H- High; M-Medium; L-Low

7. List of Experiments

1. Carburetor Tuning in Idle Condition
2. Two-Wheeler Tyre Removal and Vulcanize
3. Play Adjustment of Clutch and Brake
4. Spark Plug Cleaning
5. Assembling and Dismantling of Two-Wheeler Gearbox
6. Assembling and Dismantling of Two-Wheeler Engines and Checking Lube Oil
7. Checking Chain Tension
8. Two-Wheeler Battery Maintenance
9. Two-Wheeler Electrical System – Horn, Light
10. Cylinder Reboring
11. Overall Maintenance and Service Check List
12. Shock Absorber

TOTAL = 30 periods

9. Assessment Pattern

Rubrics for Internal Assessment

Performance	**Excellent (5)**	**Very good (4)**	**Good (3)**	**Average (2)**	**Low (1)**
Observation (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

9. Rubrics for Model/ University Examination:

Performance Indicator	**Excellent (100 %)**	**Very good (80 %)**	**Good (60 %)**	**Average (40%)**	**Low (20%)**
Identify the tools & Equipment (10)	Identify all the tools & Equipment required	Able to Identify most of the tools & Equipment required	Able to Identify some important tools & Equipment required	Able to Identify few tools & Equipment required	Not able to Identify all the tools & Equipment required
Conducting experiment as per procedure/order & readings (20)	Able to conduct the experiment completely as per procedure with the specified/	Able to conduct the experiment completely as per procedure	Able to conduct the experiment partially as per procedure	Able to conduct the experiment partially as per procedure with wrong reading	unable to conduct the experiment completely as per procedure

	required reading	with few readings	with few readings		
Formulae & Calculations (40)	Able to write all the formulae and complete the calculations correctly	Able to write all the formulae and complete the calculations partially	Able to write some formulae and complete the calculations partially with mistake in units	Able to write some formulae and unable to complete the calculations	Unable to write all the formulae and complete the calculations
Tabulation & Result (20)	Able to formulate the tabulation completely with correct units and arrive the exact results	Able to formulate the tabulation completely with correct units and arrive the results with deviations	Able to formulate the tabulation completely with incorrect units and arrive the results with deviations	Able to formulate the tabulation partially with incorrect units and arrive the results with much deviations	Unable to formulate the tabulation completely.
Viva- voce (10)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer

1154AU302 ENGINE COMPONENTS LABORATORY

L	T	P	C
0	0	2	1

1. Preamble

The main objective of this course is to understand the Understand the complete operation of 2 stroke and 4 stroke I.C engines and its subcomponents.

2. Prerequisite

NIL

3. Links to other courses

NIL

4. Course Educational Objectives

Students undergoing this course are expected to

- Understand internal combustion engine parts and their functionality.
- To teach the procedure involved to dismantle and assemble various engine components

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Distinguish the various types of engine	K3,S3
C02	Develop skills in dismantling & assembling of running system	K3,S3

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	H			H		H			L		
CO2	L	H			H		H			L		

H- Strong; M-Medium; L-Low

7. List of Experiments

Dismantling, Assembling, study & drawing (dimensions)

1. Multi-cylinder Petrol Engine
2. Multi-cylinder Diesel Engine
3. Petrol Engine Fuel System
4. Diesel Engine Fuel System
5. Cooling System
6. Lubrication system

8. Assessment Pattern

Rubrics for Internal Assessment

Performance	Excellent (5)	Very good (4)	Good (3)	Average (2)	Low (1)
Observation (10)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Attendance(5)	90% and above	80% to 89%	75% to 79%	-	-

Rubrics for Model/ University Examination

Performance Indicator	Excellent (100 %)	Very good (80 %)	Good (60 %)	Average (40%)	Low (20%)
Identify the appropriate tools and equipments (10)	Identify all tools/equipment without any guidance	Identify maximum tools/equipment without any guidance	Identify important tools/equipment without any guidance	Identify minimum tools/equipment without any guidance	Cannot Identify tools/equipment without guidance
Conduct experiment as per procedure/order (20)	Conduct experiments as per the procedure/order without any guidance	Conduct experiment as per the procedure/ order with minimum guidance	Conduct experiment as per the procedure/ order with few important guidance	Conduct experiments as per the procedure/ order with maximum guidance	Cannot conduct experiment without any guidance
Tabulation/calculation/ formula used (20)	Tabulate / calculate without any error	Tabulate / calculate without minimum error	Tabulate / calculate without maximum error	Tabulate / calculate with minimum guidance	Cannot Tabulate / calculate without guidance
Diagram (20)	Neat diagram with proper label without error	Neat diagram with label with minimum error	Neat diagram with label with Maximum error	diagram without label with error	Poor diagram without label with maximum error

Results and discussions (20)	Accurate result	Good result with minimum deviation	Result with average deviation	Result with maximum deviation	Poor result
Viva- voce (10 %)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer

1154AU303 FUELS TESTING LABORATORY

L	T	P	C
0	0	2	1

1. Preamble

This course automotive fuels and lubricants enable learners to understand the properties of fuels and lubricants for the design and operation of the I.C engines.

2. Pre-requisite

NIL

3. Links to other courses

NIL

4. Course Educational Objectives

Students undergoing this course are expected to

- Understand the manufacturing of fuels and lubricants
- Understand the detailed working of fuels and lubricants
- Develop their knowledge in methods involved in testing of fuels and lubricants

5. Course outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the manufacturing and refining process of fuels and lubricants	S2
CO2	List the requirements, types and classification of lubricating oils, grease and solid lubricants used in automobiles.	S2
CO3	Describe the different properties and testing procedures of fuels used in automobiles.	S2

List of Experiments

13. Study of Refining Process of Fuels and Lubricants.
14. Study of Classification of Fuels.
15. Temperature Dependence of Viscosity of Lubrication Oil by Redwood Viscometer.
16. Flash and Fire Points of Fuels/Lubricants.
17. ASME Distillation Test of Gasoline.
18. Drop Point of Grease and Mechanical Penetration in Grease.
19. Aniline Distillation Test of Gasoline.

20. Calorific Value of Liquid Fuel Using Bomb Calorimeter.
21. Reid Vapor Pressure Test.
22. Carbon Residue Test.
23. Copper Corrosion Test.
24. Cloud and Pour Point Test.

Total: 30 periods

13. Rubrics for Lab Experiments

Performance Indicator	Excellent (100 %)	Very good (80 %)	Good (60 %)	Average (40%)	Low (20%)
Identify the Equipment (10)	Identify all Equipment required	Able to Identify most of the Equipment required	Able to Identify some important Equipment required	Able to Identify few Equipment required	Not able to Identify all Equipment required
Conducting experiment as per procedure/order & readings (20)	Able to conduct the experiment completely as per procedure with the specified/ required reading	Able to conduct the experiment completely as per procedure with few readings	Able to conduct the experiment partially as per procedure with few readings	Able to conduct the experiment partially as per procedure with wrong reading	unable to conduct the experiment completely as per procedure
Formulae & Calculations (40)	Able to write all the formulae and complete the calculations correctly	Able to write all the formulae and complete the calculations partially	Able to write some formulae and complete the calculations partially with mistake in units	Able to write some formulae and unable to complete the calculations	Unable to write all the formulae and complete the calculations
Tabulation & Result (20)	Able to formulate the tabulation completely with correct units and arrive the exact results	Able to formulate the tabulation completely with correct units and arrive the results with deviations	Able to formulate the tabulation completely with incorrect units and arrive the results with deviations	Able to formulate the tabulation partially with incorrect units and arrive the results with much deviations	Unable to formulate the tabulation completely.
Viva- voce (10)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer