Maharashtra State Board Of Technical Education, Mumbai

Learning and Assessment Scheme for Post S.S.C Diploma Courses

Programme Name	**: Diploma In Automobile Engineering.**		
Programme Code	**: AE**	**With Effect From Academic Year**	**: 2023-24**
Duration Of Programme	**: 6 Semester**	**Duration**	**: 16 WEEKS**
Semester	**: Sixth** **NCrF Entry Level : 4.0**	**Scheme**	**: K**

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme												
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL				Based on Self Learning		Total Marks
																	Practical						
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
(All Compulsory)																								
1	MANAGEMENT	MAN	AEC	315301	1	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125
2	AUTOMOBILE COMPONENT DESIGN	ACD	DSC	316346	6	4	-	2	-	6	3	3	30	70	100	40	25	10	-	-	-	-	125
3	AUTOMOBILE HYDRAULIC AND PNEUMATIC CONTROL SYSTEMS	HPC	DSC	316347	-	3	-	2	1	6	3	3	30	70	100	40	25	10	-	-	25	10	150
4	ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS	EDS	AEC	314014	-	1	-	2	1	4	2	-	-	-	-	-	50	20	25@	10	25	10	100
5	AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEM	AES	AEC	316009	-	2	-	2	-	4	2	-	-	-	-	-	25	10	50@	20	-	-	75
6	SOLID MODELLING AND ADDITIVE MANUFACTURING	SAM	SEC	316010	-	-	-	4	2	6	3	-	-	-	-	-	25	10	25#	10	25	10	75
7	CAPSTONE PROJECT	CPE	INP	316004	-	-	-	2	2	4	2	-	-	-	-	-	50	20	50#	20	50	20	150
Elective - II (Any - One)																								
8	ALTERNATIVE FUELS FOR AUTOMOBILES	AFL	DSE	316348	-	4	-	2	-	6	3	3	30	70	100	40	25	10	25#	10	-	-	150
	AUTOMOBILE AIR CONDITIONING	AAC	DSE	316349	-	4	-	2	-	6	3	3	30	70	100	40	25	10	25#	10	-	-	150
	AUTOTRONICS	ATN	DSE	316350	-	4	-	2	-	6	3	3	30	70	100	40	25	10	25#	10	-	-	150
Total					**7**	**17**		**16**	**7**		**20**		**120**	**280**	**400**		**225**		**175**		**150**		**950**

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme										
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL				Based on Self Learning		Total Marks
																	Practical						
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	

Abbreviations : CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, FA - Formative Assessment,SA -Summative Assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends : @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

Course Category : Discipline Specific Course Core (DSC) , Discipline Specific Elective (DSE) , Value Education Course (VEC) , Intern./Apprenti./Project./Community (INP) , AbilityEnhancement Course (AEC) , Skill Enhancement Course (SEC) , GenericElective (GE)

Programme Name/s	: Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Fashion & Clothing Technology/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Instrumentation & Control/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Surface Coating Technology/ Computer Science/ Textile Technology/ Electronics & Computer Engg.
Programme Code	: AA/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DC/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ FC/ HA/ IC/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ ML/ MU/ PG/ PN/ PO/ SC/ SE/ TC/ TE
Semester	: Fifth / Sixth
Course Title	: MANAGEMENT
Course Code	: 315301

I. RATIONALE

Effective management is the cornerstone of success for both organizations and individuals. It empowers diploma engineers/ professionals to accomplish their tasks with finesse and efficiency through strategic planning and thoughtful execution, projects can optimize finances, enhance safety measures, facilitate sound decision-making, foster team collaboration and cultivate a harmonious work environment. The diploma engineers require leadership and management skills with technical knowledge of the core field to carry out various tasks smoothly. This course aims to instill fundamental management techniques, empowering diploma engineers/ professionals to enhance their effectiveness in the workplace.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Apply the relevant managerial skills for achieving optimal results at workplace.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Use relevant management skills to handle work situation
- CO2 - Apply appropriate techniques of product, operations and project management
- CO3 - Use comprehensive tools of recent management practices

- CO4 - Plan suitable marketing strategy for a product / service
- CO5 - Utilize supply chain and human resource management techniques for effective management

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											Total Marks
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315301	MANAGEMENT	MAN	AEC	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125

Total IKS Hrs for Sem. : 1 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.

MANAGEMENT **Course Code : 315301**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Justify the importance of management thoughts in Indian knowledge system. TLO 1.2 Describe the importance of management in day to day life. TLO 1.3 Explain Henry Fayol's principles of management. TLO 1.4 Describe the role of each level of management in its management hierarchy. TLO 1.5 Practice the self management skills for a given situation TLO 1.6 Apply the required managerial skills for a given situation	**Unit - I Introduction to Management** 1.1 Evolution of management thoughts from ancient/medieval to modern times in India (IKS) 1.2 Management: meaning, importance, characteristics, functions & challenges. 1.3 Introduction to scientific management- Taylor's & Fayol's principles of management 1.4 Levels & functions of management at supervisory level. 1.5 Self management skills: Self awareness, self discipline, self motivation, goal setting, time management, decision making, stress management, work life balance and multitasking 1.6 Overview of Managerial Skills: negotiation skills, team management, conflict resolution, feedback, leadership	Presentations Case Study Interactive session Quiz competition Mixed Picture Puzzle
2	TLO 2.1 Identify the appropriate creativity technique for new product development TLO 2.2 Describe the new product development process for a product / service TLO 2.3 Comprehend the importance of various strategic steps Product Management TLO 2.4 Elaborate Agile product management TLO 2.5 Explain the significance of the Project Management TLO 2.6 Describe the various tools of project management	**Unit - II Product, Operations and Project Management** 2.1 Creativity and innovation management: creativity techniques - brainstorming, checklist, reverse brainstorming, morphological analysis, six thinking hats. 2.2 New product development, change management 2.3 Product Management -meaning, strategic steps for sustainable design of a product 2.4 Agile product management- concept, benefits, principles and manifesto 2.5 Project Management: importance, areas within project management,4Ps and phases 2.6 Tools of Project Management: PERT and CPM, GANTT & Chart Overview of Estimate and Budget	Presentations Case Study Video Demonstrations Presentations Role Play

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Understand the importance of quality management tools TLO 3.2 Explain the importance of various techniques for optimization and waste minimization TLO 3.3 State the importance of ISO quality standards TLO 3.4 Describe ERP TLO 3.5 State the importance of ISO TLO 3.6 Recognize the importance of customer satisfaction as a competitive advantage	**Unit - III Management Practices** 3.1 Quality circle, kaizen, Six Sigma, TQM 3.2 5S, Kanban card system, TPM, Lean Manufacturing: Meaning, Steps and Importance 3.3 Quality Standards and ISO: Meaning, ISO 9001:2016, ISO 14000, OSHA 2020 3.4 The overview of ERP along with example 3.5 Service quality and customer/client satisfaction, servicescape	Presentation Case study Interactive session Quiz Video Demonstration Lecture Using Chalk-Board
4	TLO 4.1 Explain the importance of marketing techniques TLO 4.2 Explain the importance of needs, wants and desires in marketing TLO 4.3 Interpret the traditional and digital marketing techniques TLO 4.4 Plan different aspects of an event management	**Unit - IV Marketing Management** 4.1 Marketing management: meaning, significance, Seven P's of Marketing 4.2 Needs, wants and demands in marketing. Customer relationship management 4.3 Types of marketing: traditional and digital marketing 4.4 Event management: types, different aspects of event management, crisis management	Case Study Interactive session based video Role Play Flipped Classroom Presentations
5	TLO 5.1 State the importance of supply chain and logistics management TLO 5.2 Explain the components of supply chain and logistics Management TLO 5.3 Describe the role of information technology in supply chain & logistics management TLO 5.4 State the significance of Human Resource Management TLO 5.5 Analyze the various methods of recruitment, selection and training for an organization TLO 5.6 List the qualities of a successful supervisor	**Unit - V Supply Chain & Human Resource Management** 5.1 The overview of Supply Chain and logistics Management 5.2 Components of Supply Chain and logistics Management 5.3 Role of information technology in supply chain & logistics management 5.4 Overview of Human Resource Management-Meaning,significance,scope and principles 5.5 Recruitment, selection and training of human resources. Chalk Circle 5.6 Qualities of a successful supervisor /team leader and types of leadership	Presentations Video Demonstrations Case Study Collaborative learning Video Demonstrations Chalk-Board

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment / Article

- Make a one page note based on a book of management you read.
- Write a short article on inventory management exploring online learning resources.
- Prepare a report on ISO standards applicable to your field. a. IATF 16949-2016 / SLA-TS 16949-2016, - Automotive Industry b. ISO 22000 — Food safety management c. ISO 50001 — Energy management d. ISO/IEC 27001 - Cyber Security e. ISO/DIS 4931-1 - Buildings and civil engineering works
- Prepare a 4 quadrant matrix of time management for managing the tasks.
- Prepare a report on any one software used for Supply Chain and Logistics Management.
- Prepare a GANTT Chart for project management related to your field.

Note Taking

- Watch a Tedx Talk Video on managerial skills and take notes in the form of keywords.

Case Study

- Prepare a case study and discuss the same on following topics a.Self Management Skills b.Six Thinking Hats c.Kaizen d.Quality Circle e.Safety Measures in different organizations related to your field
- Study the recruitment and selection process of any organization related to your field.
- Prepare a case study on management lessons based on life of Chhatrapati Shivaji Maharaj
- Conduct outbound training on managerial skills. Make a video and upload on social media.

Quizes

- Participate in online quizzes related to areas of management .

Assignment

- Workshops to be conducted for students on following topics a. creativity techniques b. time management c. stress management d. negotiation and conflict e. goal setting f. meditation new product development

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED : NOT APPLICABLE

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Management	CO1	13	8	6	4	18
2	II	Product, Operations and Project Management	CO2	8	2	4	6	12
3	III	Management Practices	CO3	8	4	4	6	14
4	IV	Marketing Management	CO4	8	2	4	6	12
5	V	Supply Chain & Human Resource Management	CO5	8	4	4	6	14
Grand Total				**45**	**20**	**22**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- MCQ Based Class Test, Self Learning Activities / Assignment

Summative Assessment (Assessment of Learning)

- Summative Assessment (Assessment of Learning) MCQ based

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	1	1	1	-	-	2	3			
CO2	1	3	3	-	1	3	3			
CO3	1	3	1	-	1	1	3			
CO4	1	2	2	-	1	2	3			
CO5	1	1	2	-	1	2	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	A. K. Gupta	Engineering Management	S. Chand, ISBN: 81-219-2812-5, 2007, 2nd Edition
2	O. P. Khanna	Industrial Engineering &management	Dhanpat Rai Publication, ISBN: 978-8189928353, 2018
3	Harold Koontz and Heinz Weinrich	Essentials of Management	Tata McGraw Hill Education ISBN: 9789353168148, 2020, 12th edition
4	E. H. McGrath	Basic Managerial Skills for All	PHI ISBN: 978-8120343146, 2011, 9th Edition
5	Andrew DuBrin	Management Concepts and Cases	Cengage Learning, ISBN: 978-8131510537, 2009, 9th edition
6	K. Dennis Chambers	How Toyota Changed the World	Jaico Books ISBN: 978-81-8495-052-6, 2009
7	Jason D. O'Grandy	How Apple changed the Wolrd	Jaico Publishing House ISBN: 978-81-8495-052-0, 2009
8	Subhash Sharma	Indian Management	New Age International Private Limited ; ISBN-978-9389802412, 2020, 1st edition
9	Chitale, Dubey	Organizational Behaviour Text and Cases	PHI LEARNING PVT. LTD., ISBN: 978-9389347067, 2019, 2nd Edition

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.debonogroup.com/services/core-programs/six-thinking-hats/	Six Thinking Hats
2	https://hbr.org/1981/09/managing-human-resources	HR Management
3	https://theproductmanager.com/topics/agile-product-management/	Agile Product Management
4	https://www.cdlogistics.ca/freight-news/the-5-components-of-supply-chain-management	Supply Chain Management
5	https://www.infosectrain.com/blog/understanding-the-concepts-of-gantt-chart-and-critical-path-methodology-cpm	PERT, CPM, GANTT Chart
6	https://www.simplilearn.com/best-management-tools-article	Management Tools
7	https://www.psychometrica.in/free-online-psychometric-tests.html	Psychometric Tests
8	https://www.investopedia.com/terms/e/erp.asp	ERP
9	https://asq.org/quality-resources/quality-management-system	QMS
10	https://testlify.com/test-library/creative-thinking/	Psychometric Tests
11	https://www.mindtools.com/	Management Skills
12	https://www.investopedia.com/terms/d/digital-marketing.asp	Digital Marketing

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

AUTOMOBILE COMPONENT DESIGN **Course Code : 316346**

Programme Name/s : **Automobile Engineering.**

Programme Code : **AE**

Semester : **Sixth**

Course Title : **AUTOMOBILE COMPONENT DESIGN**

Course Code : **316346**

I. RATIONALE

The automotive industry is a dynamic and rapidly evolving sector, driven by technological advancements, increasing performance demands, and stringent safety and environmental regulations. Consequently, the design and development of automotive components require a sophisticated and multidisciplinary approach. This course addresses the critical need for engineers who possess a strong foundation in component design principles, coupled with the ability to apply modern design methodologies and analysis techniques.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of the course is to help the students to attain the following industry identified outcome through various teaching learning experiences:

Students will be able to design automotive components using relevant design principles and methodologies.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Apply fundamental design principles and methodologies to design automotive components.
- CO2 - Determine stresses in automobile components under various loading conditions
- CO3 - Design automotive chassis components.
- CO4 - Design automotive engine components.
- CO5 - Design simple axles using available data.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
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															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316346	AUTOMOBILE COMPONENT DESIGN	ACD	DSC	4	-	2	-	6	3	3	30	70	100	40	25	10	-	-	-	-	125

AUTOMOBILE COMPONENT DESIGN **Course Code : 316346**

Total IKS Hrs for Sem. : 6 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
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7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 List the principles of modern design concepts for designing Auto component. TLO 1.2 Describe the modes of failure with relevant examples. TLO 1.3 Explain component design procedure. TLO 1.4 Describe the standards used in the design of the given automobile component. TLO 1.5 Explain effects of aesthetics and ergonomics on shape and size of an automobile component. TLO 1.6 List environmental consideration in design of automobile components.	**Unit - I Design Principles and Practices** 1.1 Component design – Concept and modern design considerations (Concurrent engineering, Design for manufacturing, Design for assembly). 1.2 Modes of failure of different automotive components. 1.3 Basic requirements of automobile components, Basic automobile component design procedure. 1.4 Use of IS codes (For material designation, Testing of materials, standard for shapes and dimensions, standards for fits, Tolerances and surface finish) and Standards in automobile component design (Introduction only), Preferred numbers series. 1.5 Ergonomic and aesthetic considerations in automobile component design (shape, size and color). 1.6 Environmental consideration in component design.	Lecture Using Chalk-Board Case Study Video Demonstrations Presentations

AUTOMOBILE COMPONENT DESIGN **Course Code : 316346**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 State different types of loads acting on automobile components. TLO 2.2 Describe stresses induced in the given components. TLO 2.3 State torsional equation for solid and hollow shafts. TLO 2.4 Describe SN curve. TLO 2.5 Illustrate suitable remedies to reduce stress concentration for the given component with justification. TLO 2.6 List criteria affecting selection of factor of safety.	**Unit - II Fundamentals of Design** 2.1 Types of loads-Static, Dynamic, Impact, Shock . 2.2 Types of stresses-Normal and Shear stresses, Crushing stress, Bearing pressure, Bending stresses (Simple numerical only). 2.3 Torsion of shafts, Modulus of rigidity, Torsional equation, (Simple numerical on solid, hollow shafts only). 2.4 Fatigue, Endurance limit, SN Curve. 2.5 Stress concentration, causes and remedies. 2.6 Working stress, factor of safety, selection of factor of safety.	Lecture Using Chalk-Board Presentations Video Demonstrations
3	TLO 3.1 Describe design procedure for threaded joint in a tie rod. TLO 3.2 Calculate friction lining dimensions of a clutch plate. TLO 3.3 Describe design procedure for a propeller shaft and universal coupling. TLO 3.4 Explain design procedure of parallel and transverse fillet welded joints for axially loaded symmetrical sections.	**Unit - III Design of chassis components** 3.1 Design of threaded joint in a tie rod. 3.2 Torque transmitted by clutch considering Uniform pressure and Uniform wear theory (No derivation), Clutch plate friction lining design for single and multi-plate clutch considering uniform wear condition. (Simple numerical only). 3.3 Design of propeller shaft, Universal coupling design (Shaft diameter, pin diameter and empirical relations). 3.4 Design of welded joints in automobile manufacturing, Design of parallel and transverse fillet welds, axially loaded symmetrical Section.	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom
4	TLO 4.1 Explain valve spring design procedure. TLO 4.2 Explain design procedure for IC engine piston and piston pin. TLO 4.3 Describe design procedure of connecting rod.	**Unit - IV Design of Engine components** 4.1 Materials for valve spring with justification, IC engine valve spring terminology, Design procedure of valve spring. 4.2 Materials for piston and piston pin with justification, IC engine piston design procedure (For strength) , Piston pin design procedure (Simple numerical only). 4.3 Materials for connecting rod with justification, Design procedure of connecting rod cross section (Simple numerical only).	Lecture Using Chalk-Board Video Demonstrations Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Describe design procedure a front axle cross section for given load condition . TLO 5.2 Describe design procedure of a full floating rear axle cross section for given load condition.	**Unit - V Design of Axles** 5.1 Material for axle with justification, Design procedure for front axle beam cross section (Simple numerical only). 5.2 Material for rear axle with justification, Design procedure for full floating rear axle cross section (solid, hollow)(Simple numerical only).	Lecture Using Chalk-Board Video Demonstrations Presentations Model Demonstration

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Find a feasible solution to resolve manufacturing and assembly issues using 'Concurrent Engineering' .	1	*Concurrent Engineering for designing automobile components.	2	CO1
LLO 2.1 Select suitable material for automobile component based on environmental aspects.	2	Environmental considerations in component design	2	CO1
LLO 3.1 Select an automobile component based on ergonomic and aesthetic considerations as per requirement. LLO 3.2 List the ergonomic and aesthetic aspects identified components under LLO 3.1. LLO 3.3 Analyze shape, size and color of selected component with respect to ergonomics and aesthetics.	3	Aesthetic and Ergonomic design considerations in automobile components.	2	CO1
LLO 4.1 Find a feasible solution to reduce stress concentration in the engine/ chassis components such as crank, connecting rod, chassis frame, leaf spring, axles, etc.	4	*Stress concentration in the automobile components.	2	CO2
LLO 5.1 Identify material used in manufacturing of automobile components such as crank, connecting rod, chassis frame, leaf spring, axles, etc. (Any four) referring design data book. LLO 5.2 Specify material properties for components given in LLO 5.1 with relevant justification.	5	*Automobile component materials.	2	CO1 CO2
LLO 6.1 Measure dimensions of given propeller shaft and Universal coupling. LLO 6.2 Select relevant materials from design data book. LLO 6.3 Select relevant design procedure. LLO 6.4 Calculate dimensions. LLO 6.5 Modify dimensions. LLO 6.6 Prepare CAD drawing.	6	*Propeller shaft and universal coupling design	6	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 7.1 Measure dimensions of given piston. LLO 7.2 Select relevant materials from design data book. LLO 7.3 Select relevant design procedure. LLO 7.4 Calculate dimensions. LLO 7.5 Modify dimensions. LLO 7.6 Prepare CAD drawing.	7	*Piston design	6	CO4
LLO 8.1 Measure dimensions of given front axle beam. LLO 8.2 Select relevant materials from design data book. LLO 8.3 Select relevant design procedure. LLO 8.4 Calculate dimensions of I section. LLO 8.5 Modify dimensions for preparation of drawing.	8	Front axle design	4	CO5
LLO 9.1 Measure dimensions of given rear axle beam. LLO 9.2 Select relevant materials from design data book. LLO 9.3 Select relevant design procedure. LLO 9.4 Calculate the dimensions of the section. LLO 9.5 Modify the dimensions for preparation of drawing.	9	*Rear axle design.	4	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Other

- NOT APPLICABLE

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Computer system (Core i5 or equivalent, RAM- 4GB or more, Monitor 20" or more) with internet connectivity (More than 2 mbps)	1
2	Computer system (Core i5 or equivalent, RAM- 4GB or more, Monitor 20" or more) with internet connectivity (More than 2 mbps)	2
3	Chassis model of old vehicle with major chassis components (Chassis frame, leaf spring, engine mounted on frame, propeller shaft, Axles).	3
4	Chassis model of old vehicle with major chassis components (Chassis frame, leaf spring, engine mounted on frame, propeller shaft, Axles). Crankshaft, piston, connecting rod, valves, etc.	4
5	Design data book and Chassis model of old vehicle with major chassis components (Chassis frame, leaf spring, engine mounted on frame, propeller shaft, Axles). Crankshaft, piston, connecting rod, valves, etc.	5
6	Single piece propeller shaft with hollow cross section and slip joint, universal coupling at ends for any commercially vehicle.	6
7	Petrol/Diesel engine working model, specifications of the engine, Vernier caliper, Design data book and piston connecting rod assembly model.	7
8	Dead type front axle (I cross section) with chassis component mounted on frame, Design data book.	8
9	fully floating rear axle used in light/heavy commercial motor vehicle with vehicle specifications (Engine torque, gear box ratio, differential ratio).	9

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Design Principles and Practices	CO1	12	4	8	4	16
2	II	Fundamentals of Design	CO2	10	2	8	2	12
3	III	Design of chassis components	CO3	14	4	4	8	16
4	IV	Design of Engine components	CO4	16	2	4	8	14
5	V	Design of Axles	CO5	8	2	8	2	12
Grand Total				**60**	**14**	**32**	**24**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Continuous assessment based on process and product related performance indicators

Summative Assessment (Assessment of Learning)

- End semester examination

XI. SUGGESTED COS - POS MATRIX FORM

AUTOMOBILE COMPONENT DESIGN **Course Code : 316346**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	3	2	2	2	-	2			
CO2	3	3	2	2	-	-	2			
CO3	3	3	3	2	-	-	2			
CO4	3	3	3	2	-	-	2			
CO5	3	3	2	2	-	-	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Bhandari, V.B.	Design of Machine Elements	McGraw Hill Education New Delhi, 3rd Edition 2012 ISBN (13 digit) 9780070681798
2	Khurmi, R.S., Gupta J.K.	A Textbook of Machine Design	S Chand Publishing New Delhi 2010, ISBN (13 Digit) 9788121925372
3	Giri, N.K.	Automobile Technology	Khanna Publisher, Delhi 110006, 2012, ISBN (13 Digit) 9788174091789
4	--	Design Data Book	PSG College of Technology Coimbatore, 2014 ISBN 13-9788192735504
5	Aggarwal K.M.	Auto Design Problems	Satya Prakashan New Delhi 2012 ISBN:8176842079

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3283358	Environment consideration in Auto component design
2	https://www.youtube.com/watch?v=9_R7M49Atz4	Aesthetics and Ergonomics in Design
3	https://www.youtube.com/watch?v=-hLwyhDRcJM	Design of fillet welds
4	https://www.youtube.com/watch?v=LhUclxBUV_E	Fatigue testing procedure
5	https://www.youtube.com/watch?v=ZwqBia_gRGo&list=PLg9TnucUbzBW3tt1AtCBxcz6Hr1YqQYwQ&index=1	Design of piston in IC engine
6	https://www.youtube.com/watch?v=Pvlm35eiI78	Use of Design data book
7	https://www.youtube.com/watch?v=-FG9AVYqF0U	Modes of failure
8	https://www.youtube.com/watch?v=yQGiwsHQab8	Methods of reducing stress concentration

AUTOMOBILE COMPONENT DESIGN **Course Code : 316346**

Sr.No	Link / Portal	Description

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MSBTE Approval Dt. 04/09/2025 **Semester - 6, K Scheme**

AUTOMOBILE HYDRAULIC AND PNEUMATIC CONTROL SYSTEMS **Course Code : 316347**

Programme Name/s : **Automobile Engineering.**
Programme Code : **AE**
Semester : **Sixth**
Course Title : **AUTOMOBILE HYDRAULIC AND PNEUMATIC CONTROL SYSTEMS**
Course Code : **316347**

I. RATIONALE

Hydraulic and pneumatic control systems are extensively used in both the automotive and manufacturing industries due to their versatility and adaptability in automation. Automobile technocrats must be proficient in maintaining these systems. This course is designed to provide students with the knowledge and skills essential to effectively maintain and manage various hydraulic and pneumatic systems in industrial settings.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Maintain automotive hydraulic and pneumatic systems efficiently.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Apply principles of fluid mechanics for energy conservation.
- CO2 - Select suitable hydraulic pumps for the given applications.
- CO3 - Maintain hydraulic and pneumatic components used in automobile systems.
- CO4 - Select appropriate accessories for a given fluid-operated systems.
- CO5 - Maintain hydraulic, pneumatic and hydro-pneumatic circuits and systems.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316347	AUTOMOBILE HYDRAULIC AND PNEUMATIC CONTROL SYSTEMS	HPC	DSC	3	-	2	1	6	3	3	30	70	100	40	25	10	-	-	25	10	150

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Define different properties of fluids. TLO 1.2 Classify different fluid flows. TLO 1.3 Classify different pressures. TLO 1.4 List different device for measurement of pressure. TLO 1.5 Determine different parameters by using Bernoulli 's theorem. TLO 1.6 Calculate different Hydraulic Coefficients.	**Unit - I Overview of Fluid Mechanics** 1.1 Fluid Fundamentals: Classification of fluids, properties of fluids: specific weight, specific gravity, viscosity. Specifications of hydraulic oil, Pascal 's law, Types of fluid flow- steady, unsteady, laminar, turbulent, one, two and three dimensional flow, uniform and non-uniform flow. 1.2 Pressure Measurement: Concept of Intensity of pressure and pressure head. Concept of atmospheric pressure, gauge pressure, vacuum and absolute pressure. Pressure gauges - Piezometer tube, simple and differential manometer. Bourdon's tube pressure gauge 1.3 Hydrodynamics: Basic principles of fluid flow, Law of continuity and its applications. Energy possessed by the liquid in motion. Bernoulli's theorem and its applications such as Venturi meter, orifice-meter and Pitot tube. Hydraulic Coefficients: Coefficient of Contraction, Coefficient of Velocity, Coefficient of Discharge and Coefficient of Resistance. Relation between hydraulic coefficients.	Lecture Using Chalk-Board Presentations Video Demonstrations Model Demonstration

AUTOMOBILE HYDRAULIC AND PNEUMATIC CONTROL SYSTEMS **Course Code : 316347**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Explain construction and working of different pumps. TLO 2.2 State significance of NPSH. TLO 2.3 Select pumps on the basis of pressure, discharge, field of application and economy. TLO 2.4 Differentiate the given Positive Displacement pumps.	**Unit - II Hydraulic Machinery** 2.1 Centrifugal Pump: Working principle of centrifugal pump and types of casing. Need of priming, Heads, losses and efficiencies of centrifugal pump, Cavitation and Net Positive Suction Head (NPSH), Fault finding and remedies, Pump selection. 2.2 Reciprocating Pump: Construction and working of single and double acting reciprocating pump, Coefficient of discharge, positive and negative slip, Air vessels (Functions and Advantages) 2.3 2.3 Submersible Pump:Construction, working and application 2.4 2.4 Positive Displacement Pumps: Gear type, vane type , plunger type (axial, radial, swash plate and bent axis), Comparison of above pumps for various characteristics and their applications.	Lecture Using Chalk-Board Presentations Video Demonstrations Model Demonstration
3	TLO 3.1 Draw layout of automobile hydraulic and pneumatic system. TLO 3.2 Explain the constructional and working of the given hydraulic and pneumatic actuator with neat sketch. TLO 3.3 Explain hydraulic and pneumatic valves with neat sketch. TLO 3.4 Classify different valves.	**Unit - III Basic Components of Hydraulic and Pneumatic Systems** 3.1 General layout of oil hydraulics and pneumatics system. 3.2 Hydraulic Actuators-hydraulic cylinders (Single, double and telescopic)-Construction and working, hydraulic motors (gear and piston type)-construction and working. 3.3 Pneumatic Actuators-Pneumatic cylinders (single and double acting)-construction and working, air motors (vane and piston type)-construction and working. 3.4 Classification of Control valves. Pressure control valves- relief, unloading, sequence, counter balance, pressure reducing valves. Direction control valves- Check valve,2/2, 3/2, 4/2, 4/3, 5/2, 5/3 D.C. Valves used in Hydraulics and Pneumatics. Standard centre positions, Methods of valve actuation. Flow control valves- Non-compensated, Pressure and temperature compensated.	Lecture Using Chalk-Board Presentations Video Demonstrations Model Demonstration
4	TLO 4.1 Explain with sketch the functions of the given accessory for hydraulic systems. TLO 4.2 Compare the given accessories of pneumatic/hydraulic systems . TLO 4.3 Select accessories based on Material Compatibility, type of sealing (Static/ dynamic), Shape and Design.	**Unit - IV Accessories of hydraulic and Pneumatic systems** 4.1 Hydraulic filters and strainers- Full flow and proportional types, function and working, difference between filters and strainers. 4.2 Pneumatic Filters-Screen type and mechanical type, function and working, FRL unit. 4.3 Hoses and connectors for Hydraulic and Pneumatic systems- Types, construction and application. 4.4 Seal and gasket for hydraulic and pneumatic systems- Types, function and construction of commonly use seals and gasket materials. 4.5 Concept of Intensifiers and accumulators.	Lecture Using Chalk-Board Presentations Video Demonstrations Model Demonstration

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Draw ISO symbols (ISO 1219-1:2012) used in Pneumatic Hydraulic circuits. TLO 5.2 Draw simple hydraulic and pneumatic circuits. TLO 5.3 Draw specified circuit using the given components for the given application. TLO 5.4 Name different components of Hydro-pneumatic systems. TLO 5.5 Write procedure for Maintenance of Hydraulic, Pneumatic and hydro-pneumatic systems. TLO 5.6 Diagnose different faults in hydraulic and pneumatics systems.	**Unit - V Hydraulic and Pneumatic Circuits and systems** 5.1 ISO symbols (ISO 1219-1:2012) used in Pneumatic Hydraulic circuits. 5.2 Simple Hydraulic circuits: Single and Double Acting Hydraulic cylinders, motors. Speed control circuits: Meter in, Meter out, bleed off, Sequencing circuits Applications of hydraulics circuits-Hydraulic power steering, hydraulic brakes, milling machine, hydraulic press. Electro-hydraulics- concept, principles and applications. 5.3 Simple pneumatic circuits: Single and Double Acting Hydraulic cylinders, motors. Speed control circuit, Sequencing circuit and time delay circuit, Application of pneumatic circuits-air brake, low-cost automation in industries, pneumatic power tools (drill, nut runner, hammer and grinder). 5.4 Simple hydro-pneumatic circuits and system-Hydro-pneumatic rams, Brake booster of truck/bus, Pin lift of pneumatic mounding machines. 5.5 Maintenance of Hydraulic, Pneumatic and hydro-pneumatic systems. 5.6 Troubleshooting of hydraulic and pneumatics systems.	Lecture Using Chalk-Board Presentations Video Demonstrations Model Demonstration

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify various components of available hydraulic brake. LLO 1.2 Check the condition of various components of hydraulic brake. LLO 1.3 Do the necessary remedial action based on condition observed.	1	Hydraulic circuit and components of automobile hydraulic brakes relevant to Pascal's law.	2	CO1
LLO 2.1 Calculate total energy available at different sections of a pipe layout. LLO 2.2 Verify Bernoulli’s theorem.	2	*Measurement of total energy available at different sections of a pipe layout to verify Bernoulli’s theorem	2	CO1
LLO 3.1 Measure the manometric head (Hm) at different flow rates LLO 3.2 Calculate overall efficiency of centrifugal pump LLO 3.3 Plot performance characteristics based on the results	3	*Determination of overall efficiency of Centrifugal pump using Centrifugal pump test rig	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 4.1 Identify various components of centrifugal pump LLO 4.2 Check the condition of various components of centrifugal pump LLO 4.3 Do the necessary remedial action based on condition observed.	4	Assembly and dismantling of the centrifugal pump to prepare a troubleshooting chart.	2	CO2
LLO 5.1 Calculate overall efficiency of reciprocating pump LLO 5.2 Calculate percentage slip of reciprocating pump	5	*Determination of overall efficiency and percentage slip of Reciprocating pump using Reciprocating pump test rig	2	CO2
LLO 6.1 Identify various components of available reciprocating pump. LLO 6.2 Check the condition of various components of reciprocating pump. LLO 6.3 Do the necessary remedial action based on condition observed.	6	Assembly and dismantling of the reciprocating pump to prepare a troubleshooting chart.	2	CO2
LLO 7.1 Identify various components of available lubricating oil pump. LLO 7.2 Check the condition of various components of lubricating oil pump. LLO 7.3 Do the necessary remedial action based on condition observed.	7	Assembly and dismantling of the lubricating oil pump of car.	2	CO2
LLO 8.1 Identify various components of air motor. LLO 8.2 Check the condition of various components of air motor. LLO 8.3 Do the necessary remedial action based on condition observed.	8	Assembly and dismantling of the air motor.	2	CO3
LLO 9.1 Identify various components of used valve. LLO 9.2 Check the condition of various components of used valve. LLO 9.3 Do the necessary remedial action based on condition observed.	9	*Assembly and dismantling of the hydraulic and pneumatic system valves.	2	CO3
LLO 10.1 Inspect hydraulic and pneumatic filters used in the system. LLO 10.2 Clean hydraulic and pneumatic filters used in the system. LLO 10.3 Replace hydraulic and pneumatic filters used in the system if needed.	10	Service and replacement of the hydraulic and pneumatic filters.	2	CO4
LLO 11.1 Identify and select leak detection tests. LLO 11.2 Check the effectiveness of seals and gaskets by identifying leaks. LLO 11.3 Do the necessary remedial action based on condition observed.	11	*Leak detection test to verify the effectiveness of installed seals and gaskets.	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 12.1 List ISO symbols used in Pneumatic Hydraulic circuits. LLO 12.2 Draw ISO symbols used in Pneumatic Hydraulic circuits.	12	Drawing of the ISO symbols used in pneumatic hydraulic circuits.	2	CO5
LLO 13.1 Draw Meter-in and Meter-Out Hydraulic circuits. LLO 13.2 Choose different components for Meter-in and Meter-Out Hydraulic circuits. LLO 13.3 Connect and Test the circuit for the correct operation.	13	*Construction and actuatuation of the Meter-in and Meter-Out hydraulic circuits.	2	CO5
LLO 14.1 Draw Sequencing Hydraulic circuits. LLO 14.2 Choose different components for Sequencing Hydraulic circuits. LLO 14.3 Connect and Test the circuit for the correct operation.	14	*Developement of any suitable sequencing hydraulic circuit	2	CO5
LLO 15.1 Draw Sequencing Pilot Control Pneumatic circuits. LLO 15.2 Choose different components for Pilot Control Pneumatic circuit. LLO 15.3 Connect and Test the circuit for the correct operation.	15	Construction and actuatuation of the pilot control pneumatic circuit.	2	CO5
LLO 16.1 Select a Hydraulic and Pneumatic simulation software. LLO 16.2 Represent the Hydraulic and Pneumatic circuit using the software's graphical interface and connecting the components. LLO 16.3 Execute the simulation to observe the circuit's behavior.	16	*Construction of the Hydraulic and Pneumatic circuit using simulation software.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Visit a hydroelectric power plant and prepare a report on layout of plant, components of plant.
- Power Point Presentation on accessories used in hydraulics and pneumatics by group of two/three students. (Duration: 10 minutes)
- Prepare journal based on practical performance in Industrial fluid power laboratory.
- Power Point Presentation on hydraulic and Pneumatic brakes by group of two/three students. (Duration: 10 minutes)
- Power Point Presentation on accessories used in hydraulics and pneumatics by group of two/three students. (Duration: 10 minutes)

- Power Point Presentation on accessories used in hydraulics and pneumatics by group of two/three students. (Duration: 10 minutes)
- Prepare Seminar/presentation on types of oil filters by group of two/three students.(Duration: 10 minutes)

Micro project

- Prepare report of market survey of suppliers for fluid powered Earth moving equipment's like JCB, Mahindra Earth master by group of four students.
- Prepare chart on full imperial drawing sheet for ISO Symbols used in hydraulic and pneumatic system by group of two students.
- Prepare display chart on types of seals and gaskets (actual/ used samples) used in hydraulics.
- Prepare visit report of any automobile service station to observe use of pneumatic hand tools.
- Prepare visit report of construction sites to observe use of earth moving equipment /Other hydraulic /pneumatic equipment's for automation.
- Prepare case study report on maintenance of hydraulic brake, air brake, hydraulic jack, and hydraulic power steering.
- Prepare a detailed report based on the range of products, manufacturer and technical specifications of Centrifugal/ reciprocating/ multistage pumps/ submersible pumps/any other pump from the local market or internet.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Hydraulic trainer kit consisting of power pack (motor, pump, tank, filter, breather, pressure relief valve and pressure gauge), Basic components-valves-direction control valve, flow control valve, sequencing valve, bleed off valve, pressure gauge, actuators, accumulators, rigid pipes, hoses and connectors.	13,14
2	Compressor (Two stage -Two-cylinder air cooled, with intercooler and after cooler, receiver mounted,30 to 40 m3/hr,3.5 KW with pressure switch, pressure gauge and safety valve mounted).	15,16
3	Pneumatic trainer kit consisting of compressor, basic components-FRL unit, valves-direction control valve, flow control valve, safety valve, sequence valve, connectors and hoses.	15,16
4	Venturimeter Test-Rig (Venturimeter-Cast iron/Brass/PVC) 25 mm and 50 mm.	2
5	Practical; Set-up of Bernoulli's Theorem (apparatus for verification of Bernoulli's theorem complete with tank).	2
6	Measuring Equipments (Pressure gauges, Stopwatch, etc)	2,4,6

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
7	Centrifugal pump test rig (Constant Speed-Centrifugal pump, with electric motor, vacuum gauge at suction and pressure gauge on discharge pipe, gate valve on discharge). Motor suitable for main and operating characteristics.	3
8	Centrifugal Pump-1/2 HP (370 W),1400 rpm.	4
9	Maintenance kit (Maintenance tool kit for hydraulic and pneumatic system)	4,6,7,8
10	Hydraulics and Pneumatics Maintenance Tool Kit	4,6,7,8,9,10,11
11	Reciprocating pump test rig (Re-circulating type unit with reciprocating pump and vacuum gauge, pressure gauge at discharge) three speed drive arrangement pulley.	5
12	Reciprocating pump-Max.Flow rate: upto 3728 L/Hr Max. Pressure: upto 150	6
13	Gear pump of lubrication system of a vehicle.	7
14	Hydraulic and Pneumatic Valves- Direction control valves: Operating pressure min 10 bar Operating pressure max 50 bar, Nominal flow 80 L/min. Flow control valve: Valve size ¼" to 2", Pressure 500 bar. Pressure relief valve: flow rate (60 L/min). Material-Brass, Pressure-35 bar.	9

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Overview of Fluid Mechanics	CO1	8	2	4	6	12
2	II	Hydraulic Machinery	CO2	10	4	4	8	16
3	III	Basic Components of Hydraulic and Pneumatic Systems	CO3	12	4	6	8	18
4	IV	Accessories of hydraulic and Pneumatic systems	CO4	6	2	2	4	8
5	V	Hydraulic and Pneumatic Circuits and systems	CO5	9	2	6	8	16
Grand Total				**45**	**14**	**22**	**34**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two-unit tests of 30 marks and average of two-unit tests.
- For laboratory learning 25 Marks
- For Self Learning 25 Marks

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks.

XI. SUGGESTED COS - POS MATRIX FORM

AUTOMOBILE HYDRAULIC AND PNEUMATIC CONTROL SYSTEMS **Course Code : 316347**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	2	3	3	3	3	-			
CO2	3	3	-	3	2	3	3			
CO3	3	3	-	-	-	3	2			
CO4	3	-	-	-	-	3	2			
CO5	3	3	3	3	2	3	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Er. R.K. Rajput	A Textbook of Fluid Mechanics and Hydraulic Machines	S. Chand and Company Pvt. Ltd., New Delhi, 1 January 2016 ISBN: 9789385401374
2	Dr. R.K. Bansal	Fluid Mechanics and Hydraulic Machines	Laxmi Publications Pvt. Ltd., New Delhi, 1 January 2019 ISBN: 9788131808153
3	Dr. P.N. Modi, Dr. S.M. Seth	Hydraulics and Fluid Mechanics including Hydraulic Machines	Standard Book House, New Delhi, 1 January 2019 ISBN: 13: 9788189401269
4	R.S. Khurmi, N. Khurmi	A Textbook of Hydraulics, Fluid Mechanics and Hydraulic Machines	S. Chand and Company Pvt. Ltd., New Delhi, 15th Edition, ISBN: 9788121901628
5	Modi P.N.; Seth S.M.	Hydraulic and fluid Mechanics	Standard Book House,Delhi,2017 ISBN-13:978-8189401269
6	Pippenger, Hicks	Industrial Hydraulics	McGraw Hill Int.Mumbai,3rd Edition ISBN-13:978-0070501409
7	Ilango.S. Soundararajan V	Introduction to Hydraulics and Pneumatics	PHI Learning Private Limited, New Delhi, 11 March 2012 ISBN: 978-8120344068
8	Esposito Anthony	Fluid Power with Applications	PEARSON Education, Noida, Delhi, 1 January 2013, ISBN-13:978-8177585803
9	Sundaram S.K.	Hydraulic and Pneumatic Controls	S. Chand, Pune,2006.1 December 2006 ISBN-13:978-8121926355
10	Vickers	Industrial Hydraulics Manuel	Vickers system international Ltd. Pimpri, Pune-411018,1999. ISBN-13:978-0963416209

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=_bfcdRhY7Rw	Working Principle of Venturimeter
2	https://www.youtube.com/watch?v=iRdJHPFVHwM	Orifice Meter Working Principle
3	https://www.youtube.com/watch?v=3zEdtkuNYLU	Pitot Tube Working Animation
4	https://www.youtube.com/watch?v=IiE8skW8btE	Centrifugal Pump

AUTOMOBILE HYDRAULIC AND PNEUMATIC CONTROL SYSTEMS **Course Code : 316347**

Sr.No	Link / Portal	Description
5	https://www.youtube.com/watch?v=41vb6T42_Tk	Reciprocating Pump animation
6	https://www.youtube.com/watch?v=ri5QydTx3AQ	Reciprocating Pump animation
7	https://www.youtube.com/watch?v=Dim0fLFlFOg&list=PLIMdd_mE4yZGWJ32cgnK2-bs44Gpj81xi	Introduction to Oil Hydraulics and Pneumatics
8	https://www.youtube.com/watch?v=9cO78SgZkXc	Single Acting Cylinder/Actuator Animation
9	https://www.youtube.com/watch?v=mDLf7pe_Zug	Telescopic Cylinder/Actuator Animation
10	https://www.youtube.com/watch?v=sTrEGXXSLSA	Hydraulic Motors Summary of Features
11	https://www.youtube.com/watch?v=2UoDHqlMGB8	Types Of Pneumatic Actuators
12	https://www.youtube.com/watch?v=jbOdnEwUYOw	Flow Control Valves in Hydraulics
13	https://www.youtube.com/watch?v=LfWTyn8UT5M	Pressure Control Valves
14	https://www.youtube.com/watch?v=JlYbKgsgrxY	Directional Control Valves
15	https://www.youtube.com/watch?v=VGWua73ArFs	Types of hydraulic Filters
16	https://www.youtube.com/watch?v=4BoGenyK45w	Hydraulic accumulators, Classifications, Applications
17	https://www.youtube.com/watch?v=_EbJvm2T_OU	Industrial Hydraulic Circuit
18	https://www.youtube.com/watch?v=kbLyD-ATOZ8	Oil Hydraulic Circuits
19	https://www.youtube.com/watch?v=JnFOFa7J-Ms	Pneumatic Circuits

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEM **Course Code : 316009**

Programme Name/s : **Automobile Engineering.**
Programme Code : **AE**
Semester : **Sixth**
Course Title : **AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEM**
Course Code : **316009**

I. RATIONALE

Modern vehicles are equipped with a variety of electrical, electronic, and computer-controlled systems that play a crucial role in enhancing performance, drivability, and safety. These systems are managed by multiple control units to ensure optimal efficiency and functionality. Diploma holders in automobile engineering are expected to identify electrical, electronic and computer controlled system components and demonstrate diagnosis thereof. This course is designed to provide students with the essential skills needed to maintain and troubleshoot these advanced systems, preparing them for the demands of automobile industry.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Maintain automotive electrical and electronic systems efficiently and safely.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Test components of automotive electrical and electronic circuits.
- CO2 - Test automotive batteries and charging system.
- CO3 - Test cranking system and ignition system.
- CO4 - Troubleshoot automotive transducers and OBD-II systems.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316009	AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEM	AES	AEC	2	-	2	-	4	2	-	-	-	-	-	25	10	50@	20	-	-	75

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 State the function of electrical components in the given circuit. TLO 1.2 Describe the operation of the given circuit protection device. TLO 1.3 Describe the test procedure of the given circuit. TLO 1.4 Describe the impact of integrating a smart wiring harness with Flexible Data-rate Controller Area Network (CAN-FD) on modern vehicles.	**Unit - I Electrical Components, Circuit Protection Devices, and Smart Wiring Systems** 1.1 Purpose and operation of electrical components and circuit protection devices. a)Switches: Single Pole Single Throw (SPST), Single Pole Double Throw (SPDT), Ganged switch. b)Relays, Solenoids, Buzzers, Resistors. c)Fuses, Maxi fuses, Fusible links, Smart fuses and circuit breakers with self-resetting capabilities. 1.2 Testing of circuit defects: Open circuit, short circuit, short to ground, voltage drop. 1.3 Smart Wiring Harness & Flexible Data-rate Controller Area Network (CAN-FD) – Evolution from traditional wiring harness to high-speed communication networks. 1.4 Wiring diagrams: Headlight, turn indicators, Horn, Windshield wiper, Stop light.	Lecture Using Chalk-Board Video Demonstrations Model Demonstration

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Describe working of the given type of battery. TLO 2.2 List the causes of battery failure based on given symptoms. TLO 2.3 Explain working of Computer/ ECM -controlled alternator. TLO 2.4 Explain working of the computer controlled charging system.	**Unit - II Automotive Batteries and Charging System** 2.1 Battery: Types of Battery, Construction and Working of following types: Lead acid battery, Maintenance free battery, Hybrid Battery, Lithium-ion battery, Battery rating and specifications. 2.2 Standard procedure of battery charging. 2.3 Battery failure: Types and causes 2.4 Charging system: Charging system circuit, Alternator – Principle of working, Construction and working, Computer/ Electronic Control Module (ECM) controlled alternator.	Lecture Using Chalk-Board Video Demonstrations Model Demonstration
3	TLO 3.1 Describe working of the given cranking system aggregates. TLO 3.2 State remedial measures for starting system trouble with justification. TLO 3.3 Explain working of the computer-controlled ignition system.	**Unit - III Cranking and Ignition System** 3.1 Cranking system: solenoid-operated starter circuit, components and their functions. 3.2 Types of starter drive: overrunning clutch and Integrated Starter Generator (ISG) system. Stop-Start System: components and working. 3.3 Computer-controlled cranking system. 3.4 Starter motor components, working principle. 3.5 Cranking system: Symptoms and troubleshooting. 3.6 Computer controlled ignition system: operation with block diagram.	Lecture Using Chalk-Board Video Demonstrations Model Demonstration
4	TLO 4.1 Describe working of the given transducer on engine. TLO 4.2 Describe testing procedure of the given transducer. TLO 4.3 Describe diagnosis procedure of the given sensors using scan tool.	**Unit - IV Automotive Transducers and On Board Diagnostics (OBD) -II System** 4.1 Transducers - construction, working: Camshaft position sensor, Coolant temperature sensor, Throttle position sensor, Oxygen sensor, Manifold absolute pressure sensor, Mass air flow sensor, electronic fuel injector, idle air control valve. 4.2 OBD II procedure for body computer and relevant transducers: Function, diagnosis and procedure to erase fault code.	Video Demonstrations Demonstration Site/Industry Visit Flipped Classroom

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Inspect given electrical/ electronic component using multi meter. LLO 1.2 Inspect given circuit protection device.	1	*Electrical components and circuit protection devices.	2	CO1
LLO 2.1 Diagnose given parallel/ series circuit fault using service manual standard procedure. LLO 2.2 Troubleshoot fault in wiring harness.	2	Troubleshooting of the faults in automobile circuit/ wiring harness.	2	CO1

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 3.1 Perform battery specific gravity test. LLO 3.2 Perform battery terminal test.	3	*Battery specific gravity test and battery terminal test.	2	CO2
LLO 4.1 Perform battery load test. LLO 4.2 Perform battery drain test.	4	Battery load test and battery drain test.	2	CO2
LLO 5.1 Inspect the battery visually. LLO 5.2 Test the battery terminals and clamps. LLO 5.3 Test the battery voltage. LLO 5.4 Perform battery charging.	5	*Regular maintenance of battery.	2	CO2
LLO 6.1 Dismantle the given alternator. LLO 6.2 Examine the internal components of alternator. LLO 6.3 Assemble the given alternator. LLO 6.4 Measure alternator drive belt tension.	6	*Dismantle and assemble the alternator.	2	CO2
LLO 7.1 Test the Continuity of the stator windings. LLO 7.2 Test the Continuity of rotor winding. LLO 7.3 Inspect the diode rectifier.	7	Continuity test of alternator stator and rotor windings.	2	CO2
LLO 8.1 Perform the Current Output Test. LLO 8.2 Perform the Field Current Draw Test.	8	Current Output Test and Field Current Draw Test on alternator.	2	CO2
LLO 9.1 Perform the Regulator Output Test. LLO 9.2 Perform the Charging Circuit Resistance Test.	9	*Regulator Output Test and Charging Circuit Resistance Test on alternator.	2	CO2
LLO 10.1 Dismantle the given starter motor. LLO 10.2 Identify the components of starter motor. LLO 10.3 Assemble the starter motor.	10	*Dismantle and assemble the starter motor.	2	CO3
LLO 11.1 Perform the Current Draw Test. LLO 11.2 Perform the Insulated Circuit Resistance Test.	11	Current Draw Test, Insulated Circuit Resistance Test on starter motor.	2	CO3
LLO 12.1 Perform the Ground Circuit Test. LLO 12.2 Perform the No-Crank Test. LLO 12.3 Perform the Free Speed Test.	12	*Ground Circuit Test, No Crank Test and Free Speed Test on starter motor.	2	CO3
LLO 13.1 Interpret timing marks on the crankshaft pulley or flywheel. LLO 13.2 Make use of a stroboscope for measuring ignition timing. LLO 13.3 Modify ignition timing or Electronic Control Unit (ECU) settings.	13	Ignition timing inspection of a multi-cylinder engine with Stroboscope.	2	CO3
LLO 14.1 Test the given transducer.	14	Test the sensor and fuel injector.	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 15.1 Make use of a diagnostic scan tool. LLO 15.2 Diagnose faults in body control functions. LLO 15.3 Interpret Diagnostic Trouble Codes (DTCs) related to the Body Control Unit (BCU).	15	*Fault diagnosis of the body control unit using a scan tool.	2	CO4

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Not Applicable

Assignment

- Not Applicable

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Wiring harness of two and four wheeled vehicle.	1,2
2	Digital Multimeter: LCD Display, 0 to 50ºC Operating Temperature, DCvoltage-200mV to 1000 V DC, 2 to 1000 V Alternating Current, Current:2mA to 20 A DC, Diode Test, Continuity Test- Audible buzzer, Resistance: 200 ohm to 200 mega ohm; Accessories: Test leads, Current Clamp 300 A, Current Clamp Adapter.	1,2,3,4,5,6,7,8,9,11,12,14
3	Trainer electrical circuits of two and four wheeled vehicle.	1,2,3,9,11,12
4	Starter Motor – 12V, 0.7KW. Over running clutch type.	10,11,12

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
5	Stroboscope/ Timing gun: Ignition Advance: 0 to 45º, 12V DC system, Reverse polarity protection, Bright flash for daylight use.	13
6	Multiport Fuel Injection engine with sensors, actuators and Electronic Control Module, Exhaust Gas Regulation valve and Positive Crankcase Ventilation valve; Power: 25 KW @ 5000 rpm to 55KW@ 5000 rpm, Cubic Capacity: 800 CC to 2000 CC.	13,14,15
7	Scan tool: On Board Diagnostics (OBD) II Generation Scan Tool, Controller area network enabled, Colour Display, Operating Temperature: 0 to 50ºC, Internal Storage: 4 AAA batteries, External Power: 7 to 18 volts; Generic tool; Accessories: Extender cable, OBD II Cable; Relevant optional accessories.	15
8	Battery – 12V,100Amp or above.	3,4,5,9,11,12
9	Hydrometer bulb type or digital 1.100-1.300 Sp. gravity at 27 degree Celsius.	3,5
10	Battery Charger. 2A-10A, 12V-24V	5
11	Alternator – 12V, 40A	6,7,8,9
12	Direct Current Clamp meter: Current measurement – 400 Amperes DC / AC.	8,11,12
13	Auto electrical Test bench –3 phase, 5 HP	8,9,11,12
14	Hand tools: spanner set: Open ended spanner set, Ring spanner set, Box spanner set; Screw driver set, Pliers: Nose plier, Circlip plier, Grip plier ; Engine Belt Tension Gauge, Allen key set, wire brush: internal and external brushes for battery terminal and battery clamp.	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Electrical Components, Circuit Protection Devices, and Smart Wiring Systems	CO1	8	0	0	0	0
2	II	Automotive Batteries and Charging System	CO2	8	0	0	0	0
3	III	Cranking and Ignition System	CO3	8	0	0	0	0
4	IV	Automotive Transducers and On Board Diagnostics (OBD) -II System	CO4	6	0	0	0	0
Grand Total				**30**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- For laboratory learning, 25 marks. For FA PR ,Formative (Continuous) assessment shall be based on process and product related performance indicators. Course teacher may assign 60%, weightage for process and 40% weightage for product related LL work .

Summative Assessment (Assessment of Learning)

- For SA PR At the end of semester PR examination will be conducted by course teacher and based on PR exam performance marks out of 50 will be allocated.

XI. SUGGESTED COS - POS MATRIX FORM

AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEM **Course Code : 316009**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	-	3	-	-	3			
CO2	3	1	-	3	-	-	3			
CO3	3	1	-	2	-	-	3			
CO4	3	1	-	3	-	-	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	James D. Halderman	Automotive Electricity and Electronics	5th Edition Year: 2016, PEARSON ISBN-13: 978-0-13-576442-8
2	James D. Halderman	Diagnosis and Troubleshooting of Automotive Electrical, Electronic, and Computer Systems	5th Edition, Year: 2009, Pearson College Div., ISBN-13: 978-0135066966
3	Tom Denton	Automobile Electrical and Electronic Systems	5th Edition, Routledge, ISBN-13: 978-0415725774
4	A.K. Babu	Automotive Electrical and Electronics	2nd Edition, Year: 2024, Khanna Publishing House ISBN 13 978-93-82609-69-8
5	Dr. P. Thangavel, Dr. M. Vijay Anand, Mr. M. Makeshkumar	Automotive Electrical & Electronics Concepts	Year: 2025, Notion Press, ISBN-13: 979-8896991731

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=mEJEHxlbn9o	How to Use Wiring Diagrams for Car Electrical Diagnosis and Repair
2	https://www.youtube.com/watch?v=0ihkfUbddsk	Circuit Breakers and Fuses Explanation
3	https://www.youtube.com/watch?v=wWGyUpUsZkU	What is Can bus cable, construction, application Automotive ECU to MCU wiring connection
4	https://www.youtube.com/watch?v=hObLxlXJPPM	Working Principle of Lead Acid Battery
5	https://www.youtube.com/watch?v=nrxmQhbZUTc&t=780s	The Battery Basics: Understanding Lithium-Ion, Lead-Acid Battery

Sr.No	Link / Portal	Description
6	https://www.youtube.com/watch?v=cxkVxi9P0EA	Battery Rating
7	https://www.youtube.com/watch?v=v4JGYu4aaEc	Causes and Types of Battery Failure
8	https://www.youtube.com/watch?v=V7EFAvFPOhw&t=25s	Battery Maintenance
9	https://www.youtube.com/watch?v=Gc1hWC3XQI0	Hydrometer Test of Lead Acid Battery
10	https://www.youtube.com/watch?v=YrNRaPP7EKU	Battery Terminal Test
11	https://www.youtube.com/watch?v=jdSKlg80DjU	Alternator Working Principle
12	https://www.youtube.com/watch?v=EVPoI5wgZ4o	Alternator Testing
13	https://www.youtube.com/watch?v=lNUikOnGlAE	PCM (Computer) Controlled Alternators
14	https://www.youtube.com/watch?v=1bK0De9XOP0	Alternator Testing
15	https://www.youtube.com/watch?v=9UKg71wa0e4	Alternator Belt Tension
16	https://www.youtube.com/watch?v=Lfvig36a3og&t=20s	SHVS mild hybrid + DUALJET
17	https://www.youtube.com/watch?v=arWoIjk6seA&t=17s	How electrical and ignition systems work
18	https://www.youtube.com/watch?v=4dPXUzYiGmQ	Camshaft Position Sensor Explained with Animation
19	https://www.youtube.com/watch?v=CpmOv83HYhQ	Throttle Position Sensor Explained with Animation
20	https://www.youtube.com/watch?v=OhShoU_E-0g&t=394s	OBD2 Explained - A Simple Intro
21	https://www.youtube.com/watch?v=YGG9VLzeMk8&t=11s	How to Use an OBD2 Scan Tool

Note :

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AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEM **Course Code : 316009**

Programme Name/s : **Automobile Engineering.**
Programme Code : **AE**
Semester : **Sixth**
Course Title : **AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEM**
Course Code : **316009**

I. RATIONALE

Modern vehicles are equipped with a variety of electrical, electronic, and computer-controlled systems that play a crucial role in enhancing performance, drivability, and safety. These systems are managed by multiple control units to ensure optimal efficiency and functionality. Diploma holders in automobile engineering are expected to identify electrical, electronic and computer controlled system components and demonstrate diagnosis thereof. This course is designed to provide students with the essential skills needed to maintain and troubleshoot these advanced systems, preparing them for the demands of automobile industry.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Maintain automotive electrical and electronic systems efficiently and safely.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Test components of automotive electrical and electronic circuits.
- CO2 - Test automotive batteries and charging system.
- CO3 - Test cranking system and ignition system.
- CO4 - Troubleshoot automotive transducers and OBD-II systems.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316009	AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEM	AES	AEC	2	-	2	-	4	2	-	-	-	-	-	25	10	50@	20	-	-	75

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 State the function of electrical components in the given circuit. TLO 1.2 Describe the operation of the given circuit protection device. TLO 1.3 Describe the test procedure of the given circuit. TLO 1.4 Describe the impact of integrating a smart wiring harness with Flexible Data-rate Controller Area Network (CAN-FD) on modern vehicles.	**Unit - I Electrical Components, Circuit Protection Devices, and Smart Wiring Systems** 1.1 Purpose and operation of electrical components and circuit protection devices. a)Switches: Single Pole Single Throw (SPST), Single Pole Double Throw (SPDT), Ganged switch. b)Relays, Solenoids, Buzzers, Resistors. c)Fuses, Maxi fuses, Fusible links, Smart fuses and circuit breakers with self-resetting capabilities. 1.2 Testing of circuit defects: Open circuit, short circuit, short to ground, voltage drop. 1.3 Smart Wiring Harness & Flexible Data-rate Controller Area Network (CAN-FD) – Evolution from traditional wiring harness to high-speed communication networks. 1.4 Wiring diagrams: Headlight, turn indicators, Horn, Windshield wiper, Stop light.	Lecture Using Chalk-Board Video Demonstrations Model Demonstration

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Describe working of the given type of battery. TLO 2.2 List the causes of battery failure based on given symptoms. TLO 2.3 Explain working of Computer/ ECM -controlled alternator. TLO 2.4 Explain working of the computer controlled charging system.	**Unit - II Automotive Batteries and Charging System** 2.1 Battery: Types of Battery, Construction and Working of following types: Lead acid battery, Maintenance free battery, Hybrid Battery, Lithium-ion battery, Battery rating and specifications. 2.2 Standard procedure of battery charging. 2.3 Battery failure: Types and causes 2.4 Charging system: Charging system circuit, Alternator – Principle of working, Construction and working, Computer/ Electronic Control Module (ECM) controlled alternator.	Lecture Using Chalk-Board Video Demonstrations Model Demonstration
3	TLO 3.1 Describe working of the given cranking system aggregates. TLO 3.2 State remedial measures for starting system trouble with justification. TLO 3.3 Explain working of the computer-controlled ignition system.	**Unit - III Cranking and Ignition System** 3.1 Cranking system: solenoid-operated starter circuit, components and their functions. 3.2 Types of starter drive: overrunning clutch and Integrated Starter Generator (ISG) system. Stop-Start System: components and working. 3.3 Computer-controlled cranking system. 3.4 Starter motor components, working principle. 3.5 Cranking system: Symptoms and troubleshooting. 3.6 Computer controlled ignition system: operation with block diagram.	Lecture Using Chalk-Board Video Demonstrations Model Demonstration
4	TLO 4.1 Describe working of the given transducer on engine. TLO 4.2 Describe testing procedure of the given transducer. TLO 4.3 Describe diagnosis procedure of the given sensors using scan tool.	**Unit - IV Automotive Transducers and On Board Diagnostics (OBD) -II System** 4.1 Transducers - construction, working: Camshaft position sensor, Coolant temperature sensor, Throttle position sensor, Oxygen sensor, Manifold absolute pressure sensor, Mass air flow sensor, electronic fuel injector, idle air control valve. 4.2 OBD II procedure for body computer and relevant transducers: Function, diagnosis and procedure to erase fault code.	Video Demonstrations Demonstration Site/Industry Visit Flipped Classroom

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Inspect given electrical/ electronic component using multi meter. LLO 1.2 Inspect given circuit protection device.	1	*Electrical components and circuit protection devices.	2	CO1
LLO 2.1 Diagnose given parallel/ series circuit fault using service manual standard procedure. LLO 2.2 Troubleshoot fault in wiring harness.	2	Troubleshooting of the faults in automobile circuit/ wiring harness.	2	CO1

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 3.1 Perform battery specific gravity test. LLO 3.2 Perform battery terminal test.	3	*Battery specific gravity test and battery terminal test.	2	CO2
LLO 4.1 Perform battery load test. LLO 4.2 Perform battery drain test.	4	Battery load test and battery drain test.	2	CO2
LLO 5.1 Inspect the battery visually. LLO 5.2 Test the battery terminals and clamps. LLO 5.3 Test the battery voltage. LLO 5.4 Perform battery charging.	5	*Regular maintenance of battery.	2	CO2
LLO 6.1 Dismantle the given alternator. LLO 6.2 Examine the internal components of alternator. LLO 6.3 Assemble the given alternator. LLO 6.4 Measure alternator drive belt tension.	6	*Dismantle and assemble the alternator.	2	CO2
LLO 7.1 Test the Continuity of the stator windings. LLO 7.2 Test the Continuity of rotor winding. LLO 7.3 Inspect the diode rectifier.	7	Continuity test of alternator stator and rotor windings.	2	CO2
LLO 8.1 Perform the Current Output Test. LLO 8.2 Perform the Field Current Draw Test.	8	Current Output Test and Field Current Draw Test on alternator.	2	CO2
LLO 9.1 Perform the Regulator Output Test. LLO 9.2 Perform the Charging Circuit Resistance Test.	9	*Regulator Output Test and Charging Circuit Resistance Test on alternator.	2	CO2
LLO 10.1 Dismantle the given starter motor. LLO 10.2 Identify the components of starter motor. LLO 10.3 Assemble the starter motor.	10	*Dismantle and assemble the starter motor.	2	CO3
LLO 11.1 Perform the Current Draw Test. LLO 11.2 Perform the Insulated Circuit Resistance Test.	11	Current Draw Test, Insulated Circuit Resistance Test on starter motor.	2	CO3
LLO 12.1 Perform the Ground Circuit Test. LLO 12.2 Perform the No-Crank Test. LLO 12.3 Perform the Free Speed Test.	12	*Ground Circuit Test, No Crank Test and Free Speed Test on starter motor.	2	CO3
LLO 13.1 Interpret timing marks on the crankshaft pulley or flywheel. LLO 13.2 Make use of a stroboscope for measuring ignition timing. LLO 13.3 Modify ignition timing or Electronic Control Unit (ECU) settings.	13	Ignition timing inspection of a multi-cylinder engine with Stroboscope.	2	CO3
LLO 14.1 Test the given transducer.	14	Test the sensor and fuel injector.	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 15.1 Make use of a diagnostic scan tool. LLO 15.2 Diagnose faults in body control functions. LLO 15.3 Interpret Diagnostic Trouble Codes (DTCs) related to the Body Control Unit (BCU).	15	*Fault diagnosis of the body control unit using a scan tool.	2	CO4

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Not Applicable

Assignment

- Not Applicable

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Wiring harness of two and four wheeled vehicle.	1,2
2	Digital Multimeter: LCD Display, 0 to 50ºC Operating Temperature, DCvoltage-200mV to 1000 V DC, 2 to 1000 V Alternating Current, Current:2mA to 20 A DC, Diode Test, Continuity Test- Audible buzzer, Resistance: 200 ohm to 200 mega ohm; Accessories: Test leads, Current Clamp 300 A, Current Clamp Adapter.	1,2,3,4,5,6,7,8,9,11,12,14
3	Trainer electrical circuits of two and four wheeled vehicle.	1,2,3,9,11,12
4	Starter Motor – 12V, 0.7KW. Over running clutch type.	10,11,12

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
5	Stroboscope/ Timing gun: Ignition Advance: 0 to 45º, 12V DC system, Reverse polarity protection, Bright flash for daylight use.	13
6	Multiport Fuel Injection engine with sensors, actuators and Electronic Control Module, Exhaust Gas Regulation valve and Positive Crankcase Ventilation valve; Power: 25 KW @ 5000 rpm to 55KW@ 5000 rpm, Cubic Capacity: 800 CC to 2000 CC.	13,14,15
7	Scan tool: On Board Diagnostics (OBD) II Generation Scan Tool, Controller area network enabled, Colour Display, Operating Temperature: 0 to 50ºC, Internal Storage: 4 AAA batteries, External Power: 7 to 18 volts; Generic tool; Accessories: Extender cable, OBD II Cable; Relevant optional accessories.	15
8	Battery – 12V,100Amp or above.	3,4,5,9,11,12
9	Hydrometer bulb type or digital 1.100-1.300 Sp. gravity at 27 degree Celsius.	3,5
10	Battery Charger. 2A-10A, 12V-24V	5
11	Alternator – 12V, 40A	6,7,8,9
12	Direct Current Clamp meter: Current measurement – 400 Amperes DC / AC.	8,11,12
13	Auto electrical Test bench –3 phase, 5 HP	8,9,11,12
14	Hand tools: spanner set: Open ended spanner set, Ring spanner set, Box spanner set; Screw driver set, Pliers: Nose plier, Circlip plier, Grip plier ; Engine Belt Tension Gauge, Allen key set, wire brush: internal and external brushes for battery terminal and battery clamp.	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Electrical Components, Circuit Protection Devices, and Smart Wiring Systems	CO1	8	0	0	0	0
2	II	Automotive Batteries and Charging System	CO2	8	0	0	0	0
3	III	Cranking and Ignition System	CO3	8	0	0	0	0
4	IV	Automotive Transducers and On Board Diagnostics (OBD) -II System	CO4	6	0	0	0	0
Grand Total				**30**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- For laboratory learning, 25 marks. For FA PR ,Formative (Continuous) assessment shall be based on process and product related performance indicators. Course teacher may assign 60%, weightage for process and 40% weightage for product related LL work .

Summative Assessment (Assessment of Learning)

- For SA PR At the end of semester PR examination will be conducted by course teacher and based on PR exam performance marks out of 50 will be allocated.

XI. SUGGESTED COS - POS MATRIX FORM

AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEM **Course Code : 316009**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	-	3	-	-	3			
CO2	3	1	-	3	-	-	3			
CO3	3	1	-	2	-	-	3			
CO4	3	1	-	3	-	-	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	James D. Halderman	Automotive Electricity and Electronics	5th Edition Year: 2016, PEARSON ISBN-13: 978-0-13-576442-8
2	James D. Halderman	Diagnosis and Troubleshooting of Automotive Electrical, Electronic, and Computer Systems	5th Edition, Year: 2009, Pearson College Div., ISBN-13: 978-0135066966
3	Tom Denton	Automobile Electrical and Electronic Systems	5th Edition, Routledge, ISBN-13: 978-0415725774
4	A.K. Babu	Automotive Electrical and Electronics	2nd Edition, Year: 2024, Khanna Publishing House ISBN 13 978-93-82609-69-8
5	Dr. P. Thangavel, Dr. M. Vijay Anand, Mr. M. Makeshkumar	Automotive Electrical & Electronics Concepts	Year: 2025, Notion Press, ISBN-13: 979-8896991731

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=mEJEHxlbn9o	How to Use Wiring Diagrams for Car Electrical Diagnosis and Repair
2	https://www.youtube.com/watch?v=0ihkfUbddsk	Circuit Breakers and Fuses Explanation
3	https://www.youtube.com/watch?v=wWGyUpUsZkU	What is Can bus cable, construction, application Automotive ECU to MCU wiring connection
4	https://www.youtube.com/watch?v=hObLxlXJPPM	Working Principle of Lead Acid Battery
5	https://www.youtube.com/watch?v=nrxmQhbZUTc&t=780s	The Battery Basics: Understanding Lithium-Ion, Lead-Acid Battery

Sr.No	Link / Portal	Description
6	https://www.youtube.com/watch?v=cxkVxi9P0EA	Battery Rating
7	https://www.youtube.com/watch?v=v4JGYu4aaEc	Causes and Types of Battery Failure
8	https://www.youtube.com/watch?v=V7EFAvFPOhw&t=25s	Battery Maintenance
9	https://www.youtube.com/watch?v=Gc1hWC3XQI0	Hydrometer Test of Lead Acid Battery
10	https://www.youtube.com/watch?v=YrNRaPP7EKU	Battery Terminal Test
11	https://www.youtube.com/watch?v=jdSKlg80DjU	Alternator Working Principle
12	https://www.youtube.com/watch?v=EVPoI5wgZ4o	Alternator Testing
13	https://www.youtube.com/watch?v=lNUikOnGlAE	PCM (Computer) Controlled Alternators
14	https://www.youtube.com/watch?v=1bK0De9XOP0	Alternator Testing
15	https://www.youtube.com/watch?v=9UKg71wa0e4	Alternator Belt Tension
16	https://www.youtube.com/watch?v=Lfvig36a3og&t=20s	SHVS mild hybrid + DUALJET
17	https://www.youtube.com/watch?v=arWoIjk6seA&t=17s	How electrical and ignition systems work
18	https://www.youtube.com/watch?v=4dPXUzYiGmQ	Camshaft Position Sensor Explained with Animation
19	https://www.youtube.com/watch?v=CpmOv83HYhQ	Throttle Position Sensor Explained with Animation
20	https://www.youtube.com/watch?v=OhShoU_E-0g&t=394s	OBD2 Explained - A Simple Intro
21	https://www.youtube.com/watch?v=YGG9VLzeMk8&t=11s	How to Use an OBD2 Scan Tool

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

SOLID MODELLING AND ADDITIVE MANUFACTURING **Course Code : 316010**

Programme Name/s : **Automobile Engineering.**

Programme Code : **AE**

Semester : **Sixth**

Course Title : **SOLID MODELLING AND ADDITIVE MANUFACTURING**

Course Code : **316010**

I. RATIONALE

The Solid Modeling and Additive Manufacturing course is designed to equip students of diploma in the automobile and allied Industries with essential skills in solid modeling techniques and additive manufacturing technologies. This course will empower students to apply solid modeling and additive manufacturing concepts and methodologies in the design, development, and production of mechanical parts.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Apply skills to create, prototype, and manufacture automobile components using solid modeling and additive manufacturing techniques.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Prepare 2D Drawing using sketch toolbar of given 3D modeling software.
- CO2 - Prepare 3D Solid models from 2D sketch using given 3D modeling software.
- CO3 - Prepare assembly of part models using given 3D modeling software.
- CO4 - Plot a drawing for given part model/assembly.
- CO5 - Print components of assembly using 3D Printer/Rapid prototyping machine.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316010	SOLID MODELLING AND ADDITIVE MANUFACTURING	SAM	SEC	-	-	4	2	6	3	-	-	-	-	-	25	10	25#	10	25	10	75

SOLID MODELLING AND ADDITIVE MANUFACTURING **Course Code : 316010**

Total IKS Hrs for Sem. : Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Drawing 2D sketch using sketch tool. TLO 1.2 Draw template for 2D sketch.	**Unit - I Working in 2D environment** 1.1 Drawing tool: Line, Construction line, Rectangle, Polygon, Circle, Arc, Ellipse, Spline, etc. 1.2 Editing tool: Trim, Delete, Extend, Erase, Mirror, etc. 1.3 Modify tool: Chamfer, Fillet, Copy, Move, pattern etc. 1.4 Linear, angular dimensions. Dimensioning constraint and Geometrical constraint. 1.5 Drawing template: prepare drawing template consisting of Name plate boundary lines and projection symbol.	Presentations Video Demonstrations Hands-on
2	TLO 2.1 Draw 3D models of given components. TLO 2.2 Modify 3D models of given components TLO 2.3 Draw Auxiliary planes	**Unit - II Development of solid models** 2.1 Working in 3D environment: planes, Creating 3D Solid Models of simple machine parts. 2.2 Part tool: Extrude, Hole, Revolve, Rib, Sweep, swept blend, Pattern, etc. 2.3 Part Modify tool: Chamfer, Round, Copy, Move, Draft, etc. 2.4 Creating parts using auxiliary plane.	Presentations Video Demonstrations Hands-on
3	TLO 3.1 Assemble given 3D components. TLO 3.2 Produce exploded view of given assembly drawing.	**Unit - III Computer Aided Assembly** 3.1 Assembly drawing: preparation of assembly drawing by using assembly tool. 3.2 Relative degrees of freedom and constraints of assembly. 3.3 Rotational and translational motions of assembly. Constraining motions. 3.4 Exploded view: Explode the assembly.	Presentations Video Demonstrations Hands-on Site/Industry Visit

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Generate production drawing from given assembly. TLO 4.2 Prepare part list. TLO 4.3 Setup printing parameters. TLO 4.4 Plot Production Drawing.	**Unit - IV Ploting and Drafting 3D Assembly** 4.1 Generate orthographic projection of assembly Projections – Generate various views- Sectional, Auxiliary and Isometric Views. 4.2 Bill of Materials – Prepare part lists, Name plate on sheet. 4.3 Printer selection, paper size, orientation. 4.4 Page set up and plotting drawing.	Presentations Video Demonstrations Hands-on
5	TLO 5.1 Select suitable material for printing part using 3D printer. TLO 5.2 Create slices in Slicer software. TLO 5.3 Print given component using 3D printer.	**Unit - V Additive Manufacturing** 5.1 3D printing file formats 5.2 Selection of material 5.3 Printing parameter setting: temperature, wall thickness, infill percentage. Orientation etc 5.4 Need of Supports, types of support 5.5 Slicing layers using software 5.6 Exporting and printing	Presentations Video Demonstrations Hands-on Site/Industry Visit

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Use of sketch toolbar for drawing 2D entities.	1	*Setting drawing template consisting of Name plate boundary lines and projection symbol.	4	CO1
LLO 2.1 Draw given simple 2D components. LLO 2.2 Plot given components.	2	*Drawing and plotting two given simple 2D geometries using sketcher commands.	4	CO1 CO4
LLO 3.1 Draw given simple 3D components. LLO 3.2 Plot given components.	3	Drawing and plotting the given two simple 3-D drawings using 3D modeling commands.	4	CO1 CO2 CO4
LLO 4.1 Draw given complex 3D components. LLO 4.2 Plot given components.	4	Drawing and plotting the given two Complex 3-D drawings using 3D modeling commands.	4	CO1 CO2 CO4
LLO 5.1 Develop 3D model of given components. LLO 5.2 Plot given components	5	*Drawing and plotting of the 05 identified individual components of assembly drawing of the 3D part models. (e.g. Bench vice/ Drill Jig/ Screw Jack /Tool Post / Piston-cylinder-connecting rod / Cam-shaft / hydraulic brake / or any assembly consisting of at least five parts.) (Problem-I)	4	CO1 CO2 CO4

SOLID MODELLING AND ADDITIVE MANUFACTURING **Course Code : 316010**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 6.1 Develop 3D model of given components. LLO 6.2 Plot given components.	6	*Drawing and plotting of the 05 identified individual components of assembly drawing of the 3D part models. (e.g. Bench vice/ Drill Jig/ Screw Jack /Tool Post / Piston-cylinder-connecting rod / Cam-shaft / hydraulic brake / or any assembly consisting of at least five parts.) (Problem-I continued for identified part)	4	CO1 CO2 CO4
LLO 7.1 Develop 3D model of given components. LLO 7.2 Plot given components	7	*Drawing and plotting of the 05 identified individual components of assembly drawing of the 3D part models. (e.g. Bench vice/ Drill Jig/ Screw Jack /Tool Post / Piston-cylinder-connecting rod / Cam-shaft / hydraulic brake / or any assembly consisting of at least five parts.) (Problem-I continued for identified part)	4	CO1 CO2 CO4
LLO 8.1 Develop 3D model of given components. LLO 8.2 Plot given components.	8	*Drawing and plotting of the 05 identified individual components of assembly drawing of the 3D part models. (e.g. Bench vice/ Drill Jig/ Screw Jack /Tool Post / Piston-cylinder-connecting rod / Cam-shaft / hydraulic brake / or any assembly consisting of at least five parts.) (Problem-I continued for identified part)	4	CO1 CO2 CO4
LLO 9.1 Assemble given 3D components. LLO 9.2 Plot given components.	9	*Assembly of the parts of identified assembly. Creating the orthographic views and bill of materials for the given assembly. (e.g. Bench vice/ Drill Jig/ Screw Jack /Tool Post / Piston-cylinder-connecting rod / Cam-shaft / hydraulic brake / or any assembly consisting of at least five parts.) (Problem-I continued for identified assembly)	4	CO1 CO2 CO3 CO4
LLO 10.1 Develop 3D model of given components. LLO 10.2 Plot given components.	10	Drawing and plotting of the 05 identified individual components of assembly drawing of the 3D part models. (e.g. Bench vice/ Drill Jig/ Screw Jack /Tool Post / Piston-cylinder-connecting rod / Cam-shaft / hydraulic brake / or any assembly consisting of at least five parts.) (Problem-II)	4	CO1 CO2 CO4
LLO 11.1 Develop 3D model of given components. LLO 11.2 Plot given components.	11	Drawing and plotting of the 05 identified individual components of assembly drawing of the 3D part models. (e.g. Bench vice/ Drill Jig/ Screw Jack /Tool Post / Piston-cylinder-connecting rod / Cam-shaft / hydraulic brake / or any assembly consisting of at least five parts.) (Problem-II continued for identified part)	4	CO1 CO2 CO4
LLO 12.1 Develop 3D model of given components. LLO 12.2 Plot given components.	12	Drawing and plotting of the 05 identified individual components of assembly drawing of the 3D part models. (e.g. Bench vice/ Drill Jig/ Screw Jack /Tool Post / Piston-cylinder-connecting rod / Cam-shaft / hydraulic brake / or any assembly consisting of at least five parts.) (Problem-II continued for identified part)	4	CO1 CO2 CO4
LLO 13.1 Develop 3D model of given components. LLO 13.2 Plot given components.	13	Drawing and plotting of the 05 identified individual components of assembly drawing of the 3D part models. (e.g. Bench vice/ Drill Jig/ Screw Jack /Tool Post / Piston-cylinder-connecting rod / Cam-shaft / hydraulic brake / or any assembly consisting of at least five parts.) (Problem-II continued for identified part)	4	CO1 CO2 CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 14.1 Assemble given 3D components. LLO 14.2 Plot given components.	14	Assembly of the of the parts of identified assembly. Creating the orthographic views and bill of materials for the given assembly. (e.g. Bench vice/ Drill Jig/ Screw Jack /Tool Post / Piston-cylinder-connecting rod / Cam-shaft / hydraulic brake / or any assembly consisting of at least five parts.) (Problem-II continued for identified assembly)	4	CO1 CO2 CO3 CO4
LLO 15.1 Print the given component using 3D printer.	15	*Printing of any one component from above assembly using 3D printer/ Rapid prototyping machine.	4	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:
- 3D model: Each student will identify a small assembly from the institute workshop/laboratory. Measure the dimensions of each part and prepare sketches. Using sketches prepared 3D model of parts and assembly. Plot the assembly and detail drawings. (e.g. Piston-cylinder-connecting rod assembly, Cam-shaft assembly, Gear-train, Brake assembly, Bench vice, Machine vice, Tool post, Couplings, Joints, Bearings etc.)
- 3D printing/RPT: Each student will visits a nearby institute/industry. Collect information regarding troubleshooting of 3D printer/Rapid prototyping machine and prepare a report

Assignment

- Write a Brief Introduction to 3D Modelling with key features, advantages, and typical applications.
- Draw and plot simple 2D geometries using sketcher commands.
- Draw and plot the simple 3-D drawings using 3D modeling commands.
- Write a Brief Introduction to additives manufacturing with main characteristics, advantages over conventional methods, and specific applications.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	3 D printer (FDM)- size- 200x200x250 mm, layer resolution 0.08 mm to 0.4 mm, print speed 40-120 mm/sec, Nozzle size 0.4mm,Filament-ABS/PLA/Composite	15
2	Software: 3D printing software (slicing software).	15
3	Filament PLA, PETG, Nylon, ABS	15
4	Plotter: Multifunction Wide format plotter size A0-A4, resolution 1200X1200 / Printer with latest versions (A3/A4 size) Laserjet	2,1,3,4,5,6,7,8,9,10,11,12,13,14
5	Workstation with latest configurations for each student. Microsoft Windows 10 or above, with minimum i5 Processor (2.5 GHz), 8 GB RAM, 512 SDD	All
6	Any free version of 3D modeling software / Academic version of 3-D modelling commercial software. (CATIA, Solid Works, Creo, NX4, Solid Edge, Delcam, Autocad etc.)	All
7	LCD projector with at least 4500 lumens and aspect ratio 16:10. OR Screen/ Interactive board.	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table) : NOT APPLICABLE

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Continuous assessment based on process and product related performance indicators. Each practical will be assessed considering 1) 60% weightage is to process 2) 40% weightage to product

Summative Assessment (Assessment of Learning)

- Practical Exam of 25 Marks

XI. SUGGESTED COS - POS MATRIX FORM

SOLID MODELLING AND ADDITIVE MANUFACTURING **Course Code : 316010**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	2	3	1	2	1			
CO2	3	1	2	3	1	2	1			
CO3	3	1	2	3	1	2	1			
CO4	3	1	2	3	1	2	1			
CO5	3	1	2	3	2	2	1			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Sham Tickoo	CATIA V5R17 for Designers	Softcover, Cadcim Technologies
2	Sham Tickoo	Pro/ENGINEER Wildfire for Designers	Softcover, Cadcim Technologies
3	Sham Tickoo	Solid Works For Designers Release 2006	Softcover, Cadcim Technologies
4	Sham Tickoo	Autodesk Inventor for Designers: Release 10	Softcover, Cadcim Technologies
5	Sham Tickoo, Deepak Maini	NX 4 for Designers	Softcover, Cadcim Technologies
6	Sham Tickoo, Deepak Maini	Solid Edge V19 for Designers	Softcover, Cadcim Technologies
7	R.B. Patil, G. J. PAGAR, SATISH MANIAR	Solid Modeling and Drafting	TechKnowledge Publications, Pune

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://archive.nptel.ac.in/courses/112/102/112102304/	NPTEL: Engineering graphics and design
2	https://www.3ds.com/store/cad/solid-modeling	Dassault systems: What is solid modeling and why is it so essential to design?
3	https://youtu.be/5DxUK-n16sg?si=BU9HGgRC3jcfaChY	Screw Jack Assembly Design
4	https://www.youtube.com/watch?v=vjX4PDJcFOI	Solid modeling
5	https://www.youtube.com/watch?v=JjKs-lePlPY	How to Read & Create 3d Models from 2d Drawings
6	https://archive.nptel.ac.in/courses/112/103/112103306/	NPTEL: Fundamentals of additive manufacturing Technologies
7	https://youtu.be/iM2qhc-cmV4?si=57xSDJX_yfROg4rb	Assembly Introduction Types Catia V5.

SOLID MODELLING AND ADDITIVE MANUFACTURING **Course Code : 316010**

Sr.No	Link / Portal	Description
8	https://youtu.be/f94CnlQ0eq4?si=EuDF4ehMaphCH88M	How does a 3D Printer work?

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

Programme Name/s	: Automobile Engineering./ Artificial Intelligence/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Computer Hardware & Maintenance/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Production Engineering/ Computer Science/ Electronics & Computer Engg.
Programme Code	: AE/ AI/ AN/ AO/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ HA/ IE/ IF/ IH/ LE/ ME/ MK/ PG/ SE/ TE
Semester	: Sixth
Course Title	: CAPSTONE PROJECT
Course Code	: 316004

I. RATIONALE

Capstone projects in engineering study are considered important as it allow students to integrate and apply the knowledge and skills acquired throughout their academic program and effectively demonstrating their learning of programme by tackling a real-world problem, ultimately keeping them well prepared for the job market. The capstone project is usually the final assignment and plays a vital role in preparing students for the world of work to its practical applications and ability to help hone students' professional knowledge and skills. Normally, capstone projects are developed in collaboration with industries or businesses, providing students with valuable insights. Capstone projects has been considered as an integral part of diploma curriculum. It helps learners to perform and demonstrate skills gained due to early courses of Diploma study independent. Therefore, this is considered as a course of final year/semester study.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Apply professional skills for solving , executing and demonstrating solutions to real-world problems

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Elaborate the identified field problem from the perspective of project work at institute.
- CO2 - Conduct feasibility & viability analysis (using data collection, experiments, Simulation , Coding) to validate required resources, cost, support of the project work.
- CO3 - Apply the acquired knowledge and skills in providing solutions to the real field/industrial problems.
- CO4 - Present Project and its output/ findings / achievements alongwith its exhibits.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316004	CAPSTONE PROJECT	CPE	INP	-	-	2	2	4	2	-	-	-	-	-	50	20	50#	20	50	20	150

V. General guidelines for PROJECT WORK

- The Project- problems must be related to the programme or may be interdisciplinary, based on the industry expected outcomes.
- The individual students have different aptitudes and strengths. Project work, therefore, should match the strengths of students. For this purpose, students should be asked to identify the type of project work they would like to execute.
- Project titles are to be finalized in co-ordination/consultation with the Faculty mentor. However, faculty may form a team of students as per specific roles- Literature survey/data collection, data Analysts, model/prototype developers, testers, Project managers using IoTs ITES and software /application development. Study type project is NOT advisable.
- Project must be assigned to a group of 3-4 students under the guidance of identified faculty mentor.
- Students are required to prepare a prototype/working model/software of the Project and simultaneously prepare a report.
- Students shall Submit One Hard copy and one Soft copy each of Project Report and soft-copy of the project code or the working model.
- Students must maintain a project execution diary having the progress steps and details. The concerned faculty should check the diary on a weekly basis and accordingly interact with students based on the progress shown and keep proper record with feedback if any.
- Project shall address National Thrust area such as Environment, Digitization, Automation, sustainability and similar domains.
- Student shall try to use the national and international standards wherever possible (processes / materials / equipments etc ..)

VI. Project facilitation guidelines:

Once the Project statement has been finalized and allotted to the students, the Faculty Mentor role is very important as guide, motivator, catalyser to promote learning and sustain the interest of the students. At the same time the Faculty Mentor is not expected to guide the students on each step, otherwise it will curb the creativity of the students-group. The Faculty Mentor has to work as a mentor. Following should be kept in mind while facilitating the project at the institute:

1.Project orientation cum -briefing: the project should be relevant to the curriculum of the programme. The project shall be cost effective taking safety aspects, ethical issues, environmental issues and confidentiality as per expectation of industry(if any) into consideration, The work may be industry Sponsored.

2.Information search and data collection: the information and data should be realistic and relevant to the problem /project. Hypothetical data is not to be taken into consideration.

3.Implementation and Monitoring: The project must have important steps /milestones to achieve as per the time frame/action plan prepared by students and faculty. The monitoring mechanism such as daily/weekly dairy **(Format given below)** must be clearly explained and delineated for the students.

VII.Criteria of Assessment /Evaluation of Project work

A. Formative Assessment (FA) criteria

The **Formative Assessment** (FA) of the students for 50 marks is to be done based on following criteria.

Appropriate RUBRICS may be used for assessment

Rubrics for Assessment of the team

Sr.No.	Criteria	Marks
1	Project Selection & Problem definition	05
2	Literature survey and data collection/ Gathering	05
3	Design / concept of project/ Working - Execution of Project	10
4	Stage wise progress as per Action plan/milestone	05
5	Quality Report Writing	05

Rubrics for Individual Assessment

Sr.No.	Criteria	Marks
1	Contribution as a team member	05
2	Depth of Knowledge	10
3	Presentation	05

B. Summative Assessment Criteria

- The summative assessment for 50 marks is to be done and based on following criteria. This assessment shall be done by the faculty mentor and External examiner.

Sr.No.	Criteria	Marks
1	Capstone Project Completion as per plan	10
2	Project related Requirement Analysis & Designing	10
3	Developing a Solution with proper justifications, Teamwork	10
4	Project Report Writing	10
5	Project Presentation	10

(**NOTE :** Team based and Individual performance based summative assessment may include Innovativeness , Technology used , user friendliness , cost effectiveness , society benefits etc..)

SUGGESTED RUBRIC FOR SUMMATIVE ASSESSMENT OF CAPSTONE PROJECT

PROJECT ASSESSMENT

Project Title:				
Project Assessment Rubric				
Performance	**Excellent**	**Good**	**Fair**	**Poor**
Criteria	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
Capstone Project Completion	Excellent	Good	Fair	Poor
	The project is completed as per tasks described in synopsis.	**The project is completed but require minor modifications.**	**The project is completed but require several modifications.**	**The project is not completed as per tasks described in synopsis.**
Project related Requirement Analysis & Designing	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
	Effectively contributed in requirement analysis and designing.	**Partially Contributed in requirement analysis and designing.**	**Attempted to contribute in requirement analysis and designing**	**No contribution in requirement analysis and designing.**
Developing a Solution with proper justifications , Teamwork	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
	Developed the critical solution modules with Innovation, optimized design and worked very well with the team.	**Developed some solutions with higher complexity and worked well with the team.**	**Attempted to develop few solutions and worked with the team.**	**No contribution in developing a solution and in the team.**
Project Report Writing	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
	Worked very well to submit an excellent project report .	**Worked well to submit the project report with covering all the aspects of a standard report.**	**Tried to submit the project report but standard of report was not satisfactory.**	**No contribution in project report writing.**
Project Presentation	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
	Presented the project work flawlessly.	**Presented the project work very nice.**	**Presented the project work not so well.**	**Presentation skill is not up to the mark.**
Project Group Members				
ROLL NUMBER/Enrollment Number				
NAME				

Comments (if any)

NOTE : " These are suggestive rubrics Faculty mentor and external examiner may frame different rubrics as per Programme need and assigned Project work "

C. Self Learning Assessment

Self Learning Assessment **Max Marks -50**

Sr.No.	Criteria	Max Marks	Marks Obtained
1	Project Selection & Problem definition	10	
2	Literature survey and data collection/ Gathering	05	
3	Design / concept of project/ Working - Execution of Project	15	
4	Stage wise progress as per Action plan/milestone/ psychomotor motor skills acquired	10	
5	Quality Report Writing	10	

VIII. CO-PO Mapping

CO-PO mapping will vary project wise and shall be prepared by concerned faculty for the given project

IX. Typographical instructions/guidelines for Project report writing

Following is the suggestive format for preparing the Project report. Actual report may differ slightly depending upon the nature of industry. The training report may contain the following.

a. The PROJECT report shall be computer typed (English- British) and printed on A4 size paper.
b. Text Font -Times New Roman (TNR), Size-12 point
c. Subsection heading TNR- 12 point bold normal
d. Section heading TNR- 12 capital bold
e. Chapter Name/ Topic Name – TNR- 14 Capital
f. All text should be justified. (Settings in the Paragraph)
g. The report must be typed on one side only with double space with a margin 3.5 cm on the left, 2.5 cm on the top, and 1.25 cm on the right and at bottom.
h. The training report must be hardbound/ Spiralbound with cover page in black colour. The name of the candidate, diploma (department), year of submission, name of the institute shall be printed on the cover [Refer sample sheet (outer cover)]
i. The training report, the title page [Refer sample sheet (inner cover)] should be given first then the Certificate followed by the acknowledgment and then contents with page numbers.

X. Project Report

On completion of the project work, every student will submit a project report which should contain the following:
1. Cover Page (as per annexure 1)
2. Title page (as per annexure 2)
3. Certificate by the Guide (as per annexure 3)
4. Acknowledgment (The candidate may thank all those who helped in the execution of the project.)
5. Abstract (It should be in one page and include the purpose of the study; the methodology used.)

6. Table of Contents (as per general guidelines): Detailed description of the project (This should be split in various chapters/sections with each chapter/section describing a project activity in totality).

Chapter–1 Introduction (background of the Industry or User based Problem/Task)
Chapter–2 Literature Survey (to finalize and define the Problem Statement)
Chapter–3 Scope of the project
Chapter–4 Methodology/Approach, if any
Chapter-5 Details of designs, working and processes
Chapter-6 Results and Applications

7. Conclusion
8. References (The listing of references should be typed 2 spaces below the heading "REFERENCES" in alphabetical order in single spacing left – justified. It should be numbered consecutively (in square [ ] brackets, throughout the text and should be collected together in the reference list at the end of the report. The references should be numbered in the order they are used in the text. The name of the author/authors should be immediately followed by the year and other details). Typical examples of the references are given below:

NOTE:

1.Project report must contain only a relevant and short mention – technology or platform or tools used. It must be more focussed on project work and its implementation
2.Students can add/remove/edit chapter names as per the discussion with their guide

Formats

Project Report

"Project Title----------"

as a partial fulfilment of requirement of the

THIRD YEAR DIPLOMA IN

Submitted by

1)Name Of Student **Enrollment Number**

2)Name Of Student **Enrollment Number**

3)Name Of Student **Enrollment Number**

4)Name Of Student **Enrollment Number**

Are the bonafide on

FOR THE ACADEMIC YEAR

20-----20---

(H.O.D)

(Principal)

(Internal Guide) **(External Examiner)**

Department Name

(If NBA Accredited mention that)
Institute Name

(An Affiliated Institute of Maharashtra State Board of Technical Education)

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Note:

***Students can add/remove/edit chapter names as per the discussion with their guide**

Annexure

PROJECT DIARY (Weekly/Daily)

Name of the Student : _____

Name of Guide (Faculty) : _____

Enrollment Number : _____ Semester: _____Project batch Number : _____

WEEK : _____

Date	Activity carried out (Details)	Achievement of mile stone/step as per plan	Remark of Faculty

Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			

Dated Signature of Faculty **Dated Signature of HOD**

MSBTE LOGO INST LOGO

Certificate

This is to certify that

Mr./Ms. *bearing examination seat No.* *has*

Satisfactorily completed his/her ***PROJECT*** *entitled*

Along with his/her batchmates in partial fulfillm ent for the

Diploma Course in

< PROGRAMME NAME>

Of the ***Maharashtra State Board of Technical Education*** *at our Polytechnic during the Academic Year20 -20 .*

The Project is completed by a group consisting of Persons under the guidance of the Faculty Guide

Faculty Name and Signature (Internal)	**Faculty Name and Signature (External if applicable)**	**HOD Name and Signature with Department Stamp**
Date and Time		

ALTERNATIVE FUELS FOR AUTOMOBILES **Course Code : 316348**

Programme Name/s : **Automobile Engineering.**
Programme Code : **AE**
Semester : **Sixth**
Course Title : **ALTERNATIVE FUELS FOR AUTOMOBILES**
Course Code : **316348**

I. RATIONALE

The limited supply of fossil fuels, environmental pollution, and fluctuating crude oil prices have increased interest in alternative fuels. In the long run, the use of alternative energy sources and their impact on different markets, especially transportation, need more attention. Renewable alternative fuels, like biofuels, produce fewer greenhouse gases. Many countries, including India, are promoting them to reduce emissions and improve energy security. Therefore, it is important to educate diploma students about different alternative fuels, their key properties, production methods, and applications in the transportation industry.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attend the following industry identified outcome through various teaching learning experiences: Evaluate the use of alternative fuels in automobiles based on cost, performance and environmental aspects.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Choose relevant alternative fuel based on engine type and its performance characteristics.
- CO2 - Analyze the impact of ethanol-gasoline blends on the performance and emission characteristics of spark ignition engines.
- CO3 - Evaluate the properties and performance of diesel and biodiesel blends through testing.
- CO4 - Analyze the performance of fuels LPG, CNG and Biogas based on environmental parameters.
- CO5 - Assess the feasibility of hydrogen as a fuel for IC engines based on safety aspects

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316348	ALTERNATIVE FUELS FOR AUTOMOBILES	AFL	DSE	4	-	2	-	6	3	3	30	70	100	40	25	10	25#	10	-	-	150

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the current energy scenario in the India and world. TLO 1.2 Explain the necessity of alternative fuels for automobiles. TLO 1.3 Classify different types of alternative fuels based on their sources and properties. TLO 1.4 Identify the essential properties of alternative fuels for automotive applications. TLO 1.5 Compare alternative fuels with conventional fuels. TLO 1.6 Suggest a suitable alternative fuel for the given engine.	**Unit - I Introduction to Alternative Fuels** 1.1 Current energy scenario in world and India. 1.2 Necessity of the alternative fuels for an automobile. 1.3 Types of alternative fuels. 1.4 Essential properties of alternative fuels. 1.5 Comparison with conventional fuels 1.6 Alternative fuels for SI engines 1.7 Alternative fuels for CI engines. 1.8 Government policies and regulations.	Case Study Presentations Chalk-Board Cooperative Learning Collaborative learning

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Define various properties of the alcohol. TLO 2.2 Describe emulsification process of alcohol and diesel. TLO 2.3 Describe effect of alcohol blending with gasoline on engine performance and emission characteristics. TLO 2.4 Describe fuel supply system modifications required to use a ethanol as an alternative fuel.	**Unit - II Alcohols** 2.1 Sources of methanol and ethanol, methods of its production. 2.2 Properties of methanol and ethanol as engine fuels. 2.3 Use of alcohols in SI and CI engines. 2.4 Engine performance by using blends of ethanol/methanol with gasoline. 2.5 Emulsification of alcohol and diesel. 2.6 Improvement/Change in emission characteristics with respect to percentage blending of alcohol with gasoline. 2.7 Recent advances in vehicles running on alcohols related to materials, fuel supply systems, and emission reduction system.	Case Study Collaborative learning Cooperative Learning Chalk-Board Lecture Using Chalk-Board
3	TLO 3.1 Define various properties of the biodiesel. TLO 3.2 List different sources of biodiesels. TLO 3.3 Compare various types of biodiesels on the basis of their chemical compositions. TLO 3.4 Describe effects of biodiesel as an alternative fuel on the engine performance. TLO 3.5 Describe various biodiesel production methods.	**Unit - III Biodiesels** 3.1 Sources of vegetable oils for engine applications. 3.2 Materials required for Biodiesel Production. 3.3 Methods of Biodiesel Production. 3.4 Properties of Diesel - biodiesel blends. 3.5 Effect of biodiesel and diesel - biodiesel blends on overall performance of an engine. 3.6 Recent advances in vehicles running on biodiesel related to material, fuel supply and emission reduction system. 3.7 Economics of Biodiesel Production.	Case Study Cooperative Learning Collaborative learning Lecture Using Chalk-Board Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 List the properties of LPG/CNG/Biogas as a fuel for an automobile. TLO 4.2 Distinguish LPG and CNG on the basis of their chemical composition, fuel consumption, cost, emission etc. TLO 4.3 Describe effect of various properties of the CNG on engine performance. TLO 4.4 Draw engine performance curves for CNG operated vehicles. TLO 4.5 Compare the properties of LPG, CNG and Biogas. TLO 4.6 Prepare the list of modifications required in engine systems to use LPG/CNG/Biogas as an alternative fuel. TLO 4.7 Compare the engine performance using LPG, CNG and Biogas as a fuel.	**Unit - IV LPG, CNG and Biogas** 4.1 Properties of CNG as engine fuels. 4.2 Combustion and emission characteristics of the CNG. 4.3 Effect of CNG on the engine performance. 4.4 Storage, cost and safety of CNG. 4.5 Bio CNG - production, properties and its vehicular applications. 4.6 Properties of LPG as an engine fuel. 4.7 Combustion and emission characteristics of the LPG. 4.8 Effect of LPG on engine performance. 4.9 Storage, cost and safety of LPG. 4.10 Recent advances in vehicles running on LPG for enhancing performance, efficiency and environmental sustainability. 4.11 Comparison of LPG, CNG and biogas on the basis of various parameters and properties. 4.12 Introduction to Biogas plant. 4.13 Processes during biogas generation. 4.14 Factors affecting biogas formation. 4.15 Effect of Biogas on vehicle performance. 4.16 Modifications required in existing engine systems to use the biogas as a fuel.	Case Study Lecture Using Chalk-Board Collaborative learning Presentations Cooperative Learning Flipped Classroom
5	TLO 5.1 Enlist the properties of the hydrogen as a fuel for automobile. TLO 5.2 Describe various challenges associated with the hydrogen storage and transportation. TLO 5.3 Describe various safety precautions of the hydrogen storage.	**Unit - V Hydrogen** 5.1 Properties of hydrogen as an alternative fuel. 5.2 Production methods of hydrogen. 5.3 Challenges associated with hydrogen as a fuel for IC engine and its solutions. 5.4 Different methods of using hydrogen in SI and CI engines. 5.5 Performance, emission and combustion characteristics of hydrogen as a fuel. 5.6 Safety aspects of hydrogen storage.	Case Study Cooperative Learning Lecture Using Chalk-Board Presentations Collaborative learning Flipped Classroom

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Select most suitable alternative fuels for the given applications. LLO 1.2 Compare properties of given alternative fuels like colour, calorific values, specific gravity, density, volatility, fire point, flash point etc.	1	*Alternative fuels for SI and CI engines.	2	CO1

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 2.1 Prepare the ethanol gasoline blend on the basis of volume. LLO 2.2 Measure key fuel properties of the ethanol-gasoline blend and compare them with pure gasoline.	2	Preparation of the ethanol gasoline blends.	2	CO1
LLO 3.1 Conduct a performance test on a two or four wheeler engine using pure gasoline. LLO 3.2 Conduct a performance test on a two or four wheeler engine using ethanol-gasoline blends. LLO 3.3 Compare the performance, emissions, and efficiency results of pure gasoline and ethanol-gasoline blends.	3	*Performance and emission characteristics of two/four wheeler engine fuelled with ethanol gasoline blends.	2	CO2
LLO 4.1 Conduct a performance test on an engine using pure diesel LLO 4.2 Conduct a performance test on an engine using an alcohol-diesel emulsion. LLO 4.3 Compare the performance, emissions, and combustion characteristics of pure diesel and alcohol-diesel emulsion.	4	*Emulsification of alcohol and diesel.	2	CO3
LLO 5.1 Conduct a performance test on an engine using pure diesel. LLO 5.2 Conduct a performance test on an engine using diesel - biodiesel blends. LLO 5.3 Compare the performance, emission and combustion characteristics of pure diesel and diesel - biodiesel blends.	5	Performance and emission characteristics of four wheeler engine fuelled with diesel - biodiesel blends.	2	CO3
LLO 6.1 Measure properties of the biodiesel like density, viscosity, specific gravity, calorific value etc. LLO 6.2 Compare properties of biodiesel with conventional diesel fuel.	6	*Measurement of various properties of biodiesel.	2	CO3
LLO 7.1 Measure the vehicle performance with pure gasoline. LLO 7.2 Measure the vehicle performance with CNG. LLO 7.3 Compare the results of gasoline and CNG.	7	*Comparative performance analysis of CNG and Gasoline.	2	CO4
LLO 8.1 Measure the engine performance with LPG. LLO 8.2 Measure the engine performance with CNG. LLO 8.3 Compare the performance and emission characteristics of LPG and CNG.	8	Comparative performance analysis of LPG and CNG.	2	CO4
LLO 9.1 Identify the various components of the LPG kit. LLO 9.2 Draw a layout of LPG fuel supply system.	9	Demonstration of LPG Kit.	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 10.1 Identify the various components of the CNG kit. LLO 10.2 Draw a layout of CNG fuel supply system.	10	* Demonstration of CNG Kit.	2	CO4
LLO 11.1 Justify the necessity of the hydrotesting of the CNG tank. LLO 11.2 Identify the key equipment, tools, and safety precautions required for conducting hydrostatic testing.	11	*Hydrotesting of the CNG Storage Tank.	2	CO4
LLO 12.1 Identify the various components of the Biogas plants. LLO 12.2 Draw a layout of biogas plant.	12	Demonstration of biogas plant.	2	CO4
LLO 13.1 Conduct a performance test on an engine using pure diesel. LLO 13.2 Conduct a performance test on an engine using diesel blends. LLO 13.3 Compare the performance, emissions, and efficiency of pure diesel and blended fuels.	13	Performance and emission characteristics of small stationary dual fuel diesel engine.	4	CO4
LLO 14.1 Identify the various components of the hydrogen fueled vehicle. LLO 14.2 Draw a layout of hydrogen fuel supply system.	14	*Demonstration of hydrogen operated vehicle.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Collect components of LPG kit and prepare a board model with its details.
- Prepare a report on safety practices and routine maintenance of the CNG/LPG operated vehicles.
- Prepare on a report on challenges related to utilization of the alternative fuels and suggest possible solutions
- Extract biodiesel from various sources and compare their properties.
- Collect components of CNG kit and prepare a board model with its details.

Assignment

- Prepare report on economic evaluation of biodiesel production.
- Prepare a report on policy for the production and utilization of the biofuels in India.
- Collect the details of biodiesels available in market and prepare a report.
- Prepare a report on modifications in SI and CI engine to utilize the alternative fuels.
- Prepare a report on processes used for biodiesel preparation.
- Prepare a report on engine material compatibility to use the alternative fuels.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Test rig of multicylinder SI/CI engine available in laboratory.	2,3,4
2	Test rig of single cylinder SI/CI engine available in laboratory.	2,3,4
3	CNG and LPG kits.	4

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Alternative Fuels	CO1	8	4	4	0	8
2	II	Alcohols	CO2	10	2	4	8	14
3	III	Biodiesels	CO3	14	2	4	8	14
4	IV	LPG, CNG and Biogas	CO4	18	4	8	8	20
5	V	Hydrogen	CO5	10	2	12	0	14
Grand Total				**60**	**14**	**32**	**24**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Laboratory learning of 25 marks
- Two-unit tests of 30 marks and average of two-unit tests.

Summative Assessment (Assessment of Learning)

- End semester assessment of 25 marks for laboratory learning.
- End semester assessment of 70 marks.

XI. SUGGESTED COS - POS MATRIX FORM

ALTERNATIVE FUELS FOR AUTOMOBILES **Course Code : 316348**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	3	3	-	3	2	2			
CO2	3	3	3	3	3	2	-			
CO3	3	3	3	3	3	2	3			
CO4	3	3	3	3	3	2	3			
CO5	3	3	3	-	3	2	-			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Arumugam S. Ramadhas	Alternative Fuels for Transportation.	CRC Press Taylor & Francis Group 2016, ISBN: 978-1-4398-1958-6
2	M. K. Gajendra Babu K. A. Subramanian	Alternative Transportation Fuels Utilisation in Combustion Engines.	CRC Press Taylor & Francis Group, 2013, ISBN-13: 978-1-4398-7282-6
3	Zainal Ambri Abdul Karim Shaharin Anwar Bin Sulaiman	Alternative Fuels for Compression Ignition Engines	Springer Briefs in Energy, 2016, ISBN: 978-981-10-7754-8
4	S.S. Thipse	Alternative Fuels	Jaico Publishing House, 2010, ISBN-13: 978-8184950786
5	Venkateswarlu. K., Murthy, B.S.R. ·	Alternative Fuels And Advanced Vehicle Technologies	PHI Learning Pvt. Ltd., 2021, ISBN:9788194685173, 8194685176
6	Richard L. Bechtold, RE.	Alternative Fuels Guidebook Properties, Storage, Dispensing, and Vehicle Facility Modifications.	SAE International, 1st Edition, ISBN 0-7680-0052-1

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=VnGH2EScMDE	IC engine fuels - types, requirement and characteristics, Alternative Fuels
2	https://www.youtube.com/watch?v=iSfI_OtSKxs	Alternate Fuels and Sustainable Transportation
3	https://www.youtube.com/watch?v=k6JH0Jl7rx8	Bio-based Fuels
4	https://www.youtube.com/watch?v=5pL_3hKAr2U	Effects of ethanol/gasoline fuel blends on nitrogen oxides emissions in spark-ignition engines
5	https://www.youtube.com/watch?v=rrldwVGmmy4	Transesterification of Vegetable Oil and Alcohol to Produce Ethyl Esters (Biodiesel)

ALTERNATIVE FUELS FOR AUTOMOBILES **Course Code : 316348**

Sr.No	Link / Portal	Description
6	https://www.youtube.com/watch?v=8gpF8s915Gc	How CNG Fuel System Works?
7	https://www.youtube.com/watch?v=GdW2DtMQgJA	How does a Diesel LPG engine work?
8	https://www.youtube.com/watch?v=3bhMTDSPP7E	Upgrading Biogas for its application as a fuel for I C engine
9	https://www.youtube.com/watch?v=SRt1KOP9a2g	How Does A Hydrogen Car Work | Future Technology
10	https://www.youtube.com/watch?v=shhrBXwEmTw	How Does A Hydrogen Car Work | Future Technology Part 1
11	https://www.youtube.com/watch?v=nPsbolmB6Qo	https://www.youtube.com/watch?v=shhrBXwEmTw

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

AUTOMOBILE AIR CONDITIONING **Course Code : 316349**

Programme Name/s : **Automobile Engineering.**
Programme Code : **AE**
Semester : **Sixth**
Course Title : **AUTOMOBILE AIR CONDITIONING**
Course Code : **316349**

I. RATIONALE

Automobile air conditioning is essential for modern vehicles, enhancing comfort and safety. This course offers a thorough understanding of air conditioning systems, covering principles, components, and operation. Students will gain diagnostic and problem-solving skills to ensure efficient cooling and passenger comfort. Mastering these aspects prepares students to contribute to the development of more efficient and eco-friendly vehicles.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Maintain air conditioning system for automotive applications using relevant knowledge & skills related to HVAC system.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Interpret the Heating, Ventilation and Air-conditioning system in various environmental conditions.
- CO2 - Illustrate various components of automobile air conditioning system.
- CO3 - Select relevant duct system for vehicles.
- CO4 - Troubleshoot air conditioning control systems
- CO5 - Maintain air-conditioning system.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316349	AUTOMOBILE AIR CONDITIONING	AAC	DSE	4	-	2	-	6	3	3	30	70	100	40	25	10	25#	10	-	-	150

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain the vapour compression refrigeration cycle and its key components TLO 1.2 Distinguish between controlled and uncontrolled ventilation systems on the basis of given parameters TLO 1.3 Explain the effects of air movement, wind chill factor, odor problems, and humidity on human comfort. TLO 1.4 Compare the requirements of heating ventilation and air conditioning (HVAC) systems in light motor vehicles, heavy goods vehicles, and heavy passenger vehicles. TLO 1.5 Describe handling and disposal of refrigerant in automobile safely	**Unit - I Overview of HVAC System** 1.1 Vapour compression refrigeration cycle and Basic components 1.2 Uncontrolled and controlled ventilation 1.3 Human comfort factors: comfort zone, air movement, wind chill factor, odor problems and effects of humidity. 1.4 Requirements of heating, ventilation and air conditioning system in- light Motor Vehicle, driver cabin of heavy goods vehicle,goods compartment of heavy goods vehicle and heavy passenger motor vehicle 1.5 Environmental and safety aspects in heating, ventilation and air conditioning systems.	Lecture Using Chalk-Board Presentations Demonstration Video Demonstrations

AUTOMOBILE AIR CONDITIONING **Course Code : 316349**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Explain the operational flow of air and refrigerant within the system. TLO 2.2 Explain the function and operation of the given component of air conditioning system TLO 2.3 Differentiate between reciprocating, scroll, and rotary vane compressors in terms of design, application, and performance. TLO 2.4 Explain the properties of refrigerants used in automotive AC systems TLO 2.5 List different refrigerants used in AC system TLO 2.6 Explain the operation of the electromagnetic clutch in controlling compressor engagement. TLO 2.7 Explain with sketch the construction and working of the given type of metering device of vehicle air conditioning system. TLO 2.8 Explain the throttling action, modulating action, and controlling action in an automotive air conditioning system. TLO 2.9 Explain the working of automotive heating systems in given situation	**Unit - II AC System Components** 2.1 General layout of automotive air conditioning system , constructional details. 2.2 Types of AC Systems: AC system with thermostatic expansion valve with components evaporator, compressor, condenser, receiver drier, thermostatic expansion valve & its type (internally equalized, externally equalized). 2.3 Throttling action, modulating action and controlling action, remote bulb. 2.4 AC system with orifice tube with components evaporator, accumulator, compressor, condenser, fixed orifice Tube. 2.5 Types of compressor - Scroll compressor, rotary vane compressors. 2.6 Construction and working of electromagnetic clutch. 2.7 Drive systems for compressor for IC engine & electric vehicle. 2.8 Types of automobile refrigerants, properties.	Lecture Using Chalk-Board Model Demonstration Presentations Video Demonstrations Demonstration
3	TLO 3.1 Explain the functions of the air intake section, core section, and distribution section in an automotive air conditioning system. TLO 3.2 Explain the purpose and operation of air filters and air blowers in AC systems. TLO 3.3 Select case and duct system for the given seating capacity of vehicle with justification. TLO 3.4 Explain with sketch the construction and working of the given type of duct. TLO 3.5 Explain the components and operation of a rear cooling system for given Vehicle.	**Unit - III Case and Duct System** 3.1 Air intake section, core section, and distribution section 3.2 Air filter and air blower in A.C. system 3.3 Downstream, upstream, split and hybrid case & duct systems, case & duct System in electric vehicle. 3.4 Construction and working of rear cooling system 3.5 Air Conditioning system in electric vehicle & hybrid Vehicles 3.6 Heating system: Construction working and functions of I.C, engine vehicle and electric vehicle	Lecture Using Chalk-Board Video Demonstrations Presentations Demonstration

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Explain the components and operation of vacuum control systems and electronic temperature control systems. TLO 4.2 Explain the function and operation of given vacuum operated device. TLO 4.3 Explain the function and operation of given switch used in automotive air conditioning systems. TLO 4.4 State the purpose and location of given sensor used in automotive air conditioning systems. TLO 4.5 Explain the function and operation of given AC control devices used in automotive air conditioning systems. TLO 4.6 Compare manual climate control systems and electronic climate control systems.	**Unit - IV Vehicle Climate Control Systems** 4.1 System controls – Vacuum control system and electronic temperature control system. 4.2 Vacuum operated devices i.e. vacuum reserve tank, vacuum restrictor, vacuum motor, check valve and check relays. 4.3 Switches - High-Side temperature switch, low-side temperature switch, high-pressure switch, low- pressure switch, pressure regulator and superheat switch. 4.4 Sensors- Sunload sensor, outside temperature sensor and in-car temperature sensor. 4.5 A.C. Control devices: aspirator, blower motor speed control, heater control, and time delay relay for heater control. 4.6 Manual climate control system and automatic climate control system.	Lecture Using Chalk-Board Model Demonstration Presentations Video Demonstrations
5	TLO 5.1 List potential faults of AC systems using visual and acoustic methods. TLO 5.2 Write the operating procedure of manifold gauge to measure low-side and high-side pressures in an air conditioning system. TLO 5.3 Describe the procedure to perform a temperature test. TLO 5.4 Explain different leak detection tests and their applications. TLO 5.5 Describe the prcedure to check hoses and connectors of an air conditioning system. TLO 5.6 Write the procedure of evacuation and charging procedures for refrigerant charging. TLO 5.7 List common symptoms and faults in an air conditioning system, compressor, electromagnetic clutch and heating system.	**Unit - V HVAC System Diagnostic and Repair Procedures** 5.1 Inspection of A.C. System: Visual and acoustic, sight glass. 5.2 Service equipment and tools: Vacuum pump, Manifold and gauge i.e. low side and high side, gauge calibration recovery unit and recycling unit, Halide (Freon) and Fluorescent leak detector, Ntrogen leak tester. 5.3 Leak test and Temperature test, Evacuation, Charging of refrigerant and Moisture removal. 5.4 Proper use and safety precautions when working with hoses and connectors. 5.5 Symptoms, Faults, Causes and Remedies in compressor and electromagnetic clutch. 5.6 Maintenance of the heating system in IC engine vehicle and electric vehicle: Fault diagnosis, remedial action.	Lecture Using Chalk-Board Site/Industry Visit Video Demonstrations Presentations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs

AUTOMOBILE AIR CONDITIONING **Course Code : 316349**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify different processes used in vapour compression cycle Draw the vapour compression cycle P-V and H-S diagramessor, condenser, expansion valve, and evaporator.	1	*Basics of vapour compression cycle	2	CO1
LLO 2.1 Identify the different types of environmental effect of automobile heating ventilation and air conditioning (HVAC) system LLO 2.2 Calculate heat transfer by automotive HVAC system	2	Assessment of Environmental Effect of automotive heating ventilation and air conditioning (HVAC) Systems	2	CO1
LLO 3.1 Identify the major components of (HVAC) system used in given type of vehicle LLO 3.2 Draw the layout and arrangement of the HVAC system components in given type of vehicle.	3	* Layout of automobile air conditioning system and sub systems.	2	CO2
LLO 4.1 Identify parts of given at expansion device in an automotive AC system. LLO 4.2 Check the functionality of given expansion valve	4	*Types of expansion devices used in automotive AC system	2	CO2
LLO 5.1 Dismantle a scroll/rotary vane type compressor and identify its components. LLO 5.2 Clean and inspect the compressor components for wear and damage LLO 5.3 Assemble the compressor	5	*Dismantle and assemble Scroll/Rotary vane type Compressor	2	CO2
LLO 6.1 Check case & duct system of IC vehicle /electric vehicle LLO 6.2 Draw various components of the case & duct system in ic vehicle/electric vehicle	6	Types of Case Duct system	2	CO3
LLO 7.1 Identify the different types of air blowers and air filters used in HVAC systems. LLO 7.2 Write procedure of regular maintenance of the air blower and air filter in an HVAC system.	7	*Servicing of air filters and air blowers	2	CO3
LLO 8.1 Check the components and operation of manual and automatic climate control systems LLO 8.2 Differentiate the principles of temperature control and humidity control in manual and automatic climate control systems	8	Comparative Study of Manual & Automatic Climate Control System	2	CO4
LLO 9.1 Identify different types of sensors and switches utilized in AC systems, including their specific functions and applications LLO 9.2 Compare the operational principles and performance characteristics of sensors & switches	9	*Various types of Sensors & Switches used in AC System.	2	CO4
LLO 10.1 Diagnose faults in climate control systems using appropriate diagnostic tools and methodologies. LLO 10.2 Perform corrective action based on service, information and technical resources of given system	10	*Troubleshoot the climate control system of Vehicle	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 11.1 Prepare the vehicle's AC system for temperature testing by ensuring it is properly charged with the appropriate refrigerant LLO 11.2 Interpret temperature readings to assess the performance and efficiency of the AC system	11	Perform AC System Temperature test of Given Vehicle	2	CO5
LLO 12.1 Identify various leak detection methods, including soap trace solutions, electronic leak detectors, halogen leak detectors, and dye solutions LLO 12.2 Perform leak tests on A.C. systems using different detection methods, accurately locating and diagnosing leaks. .	12	Leak detection test of automotive A.C. System.	2	CO5
LLO 13.1 Identify faults within an Air Conditioning control. LLO 13.2 Diagnose faults within an Air Conditioning control	13	* Evacuation & charging of refrigerant in automotive A.C. system	4	CO5
LLO 14.1 Identify components of automotive heating systems, including their functions and interrelationships. LLO 14.2 Carry out repairing of faulty heating system components, ensuring compliance with manufacturer specifications.	14	Troubleshoot of heating system	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Not applicable

- Not applicable

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Evaporator of Commonly used car A.C. System (any car AC system of 1 Ton Capacity)	1,3
2	Condenser of commonly used car A.C System (any car AC system of 1 Ton Capacity)	1,3
3	Accumulator of commonly used car A C System(any car AC system of 1 Ton Capacity)	1,3
4	Working model of Automobile HVAC system of any Car model Make: car manufacturer in India Power supply: 220 V AC 50 Hz 110 V AC 60 Hz Compressor Scroll / Rotary Vane type Condenser parallel flow type suitable for car Evaporator serpentine type with a thermostatic expansion valve, blower motor, and grill. Receiver with sight glass and other accessories. All ideal controls and safety controls for car ac. Single phase electric motor 2 HP Suitable 12volt battery to run condenser fan, evaporator fan and to operate magnetic clutch of the compressor. Battery Charger to recharge Battery.	1,3,4
5	Scroll Type, Rotary Vane Type AC Compressor (For Dismantling & Assembly)(any car AC system of 1 Ton Capacity)	1,3,6
6	Digital Temperature Guage (Temp Range -200C to 700C)	12
7	Halide & Fluorescent Refrigerant Leak Detector (HFC Halogen Gas Refrigerant Leak Detector in Automobile Air Conditioning	13
8	Refrigerant tank for R-134a(Capacity 13.6)	13,14
9	Refrigerant Recovery, Recycling, and recharging Machine Power supply: 220 V AC 50 Hz 110 V AC 60 Hz Evacuating air speed of vacuum pump: 4.5 CFM Compressor power: 3/8 HP Accuracy of electronic scale: 5 g Maximum weight of the electronic scale: 50 Kg Drying filter: 500 cc, 3/8 connecting port Capacity of refrigerant tank: 23.5 L 13.6 L Maximum working pressure: 17.5 bar Maximum recovery speed: 0.5 Kg/Min Maximum recharging speed: 2 Kg/Min	14
10	Thermostatic Expansion valve commonly used car A.C System and orifice tube	4,5
11	Electromagnetic Clutch of commonly used car A C System (any car AC system of 1 Ton Capacity)	6
12	Manifold gauge Set, Compressor & Vacuum pump (Single Stage Rotary Vane R134A, 1/3HP Deep Vacuum Pump of Car AC)	6,14
13	Car Heater Blower Assembly	7,8
14	General Purpose Tools (Spanner, Ring Spanner & Socket)(6mm to 32mm)	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Overview of HVAC System	CO1	10	2	6	4	12
2	II	AC System Components	CO2	16	4	6	8	18
3	III	Case and Duct System	CO3	10	2	6	4	12
4	IV	Vehicle Climate Control Systems	CO4	12	4	4	6	14
5	V	HVAC System Diagnostic and Repair Procedures	CO5	12	2	4	8	14
Grand Total				**60**	**14**	**26**	**30**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- • Two-unit tests of 30 marks and average of two-unit tests.
- For laboratory learning 25 Marks

Summative Assessment (Assessment of Learning)

- End semester assessment of 25 marks for laboratory learning.
- End semester assessment of 70 marks.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	--	--	--	3	--	2			
CO2	3	--	--	2	2	2	2			
CO3	3	--	--	--	2	2	2			
CO4	2	2	--	2	2	2	2			
CO5	2	3	--	3	2	2	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Dwiggins, Boyce H.	Automobile Air Conditioning	Delmar Cengage Learning; 8th Revised edition edition, ISBN: 978-0827358188
2	Haynes, John H. ; Stubblefield, Mike	Automotive Heating & Air Conditioning Manual	Haynes Manuals N. America, Incorporated, 2011 ISBN 1563929139
3	Ananthanarayanan, P. N.	Basic Refrigeration and Air Conditioning	McGraw Hill Education; Fourth edition (2013) ISBN-10: 9781259062704
4	Halderman , J. D.	Automotive Heating and Air Conditioning	Pearson Prentice Hall; 7 edition (2014) ISBN: 978-0133514995
5	Khurmi, R. S. ; Gupta , J. K.	Textbook of Refrigeration & Air conditioning	S. Chand Limited, New Delhi (2008) ISBN: 8121927811, 9788121927819
6	Arora; Domkundwar	Refrigeration and Air-Conditioning	Dhanpatrai & Son’s, New Delhi ISBN: 9780000229663

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description

AUTOMOBILE AIR CONDITIONING **Course Code : 316349**

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=nHZEAe08sE8	Understanding working of HVAC system.
2	https://www.youtube.com/watch?v=I5rrZSu4PxQ	Understanding the working of Car AC
3	https://www.youtube.com/watch?v=Pdq8JAlct6s	Procedure to Recharge refrigerant in AC System
4	https://www.youtube.com/watch?v=F5w3lR88fqQ	Procedure to evacuate refrigerant from AC System
5	https://www.2carpros.com/articles/re-charge-an-air-conditioner-system	Evacuation and charging of A.C. System
6	https://www.youtube.com/watch?v=Yyf30wStUE4	Leak Detection in A.C. System
7	https://www.youtube.com/watch?v=WncHNLdU4EA	Trouble diagnosis of A.C. System
8	https://www.youtube.com/watch?v=FzbM0YoUZgo	Cleaning air conditioner evaporator
9	https://www.youtube.com/watch?v=rulXlnG2Unk for Servicing of Compressor in car	Servicing of Compressor in car
10	https://www.youtube.com/watch?v=UW1GDiOa0kE	How To Diagnose Car Air Conditioning Problems

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

AUTOTRONICS **Course Code : 316350**

Programme Name/s : **Automobile Engineering.**
Programme Code : **AE**
Semester : **Sixth**
Course Title : **AUTOTRONICS**
Course Code : **316350**

I. RATIONALE

As the automotive industry continues to embrace automation, electrification, and smart technologies, there is an increasing demand for skilled professionals capable of bridging traditional automotive engineering with modern electronics. These professionals must be equipped with the skills necessary to adapt to the rapidly evolving automotive landscape, where technology, electronics, and mechanics are becoming more integrated. This includes expertise in areas such as automotive sensors, actuators, control systems, and advanced vehicle diagnostics, all of which are crucial in shaping the future of the automotive industry.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Perform remedial actions using advanced diagnostic tools of an automobile systems.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Apply the fundamentals of automotive digital electronics and Instrumentation.
- CO2 - Interpret the Computer Electronic Control Module (ECM), different memories and vehicle network systems.
- CO3 - Test the operation of automotive sensors and actuators.
- CO4 - Evaluate the performance of vehicle control systems.
- CO5 - Interpret diagnostic trouble codes in automotive systems.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316350	AUTOTRONICS	ATN	DSE	4	-	2	-	6	3	3	30	70	100	40	25	10	25#	10	-	-	150

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 State the importance of digital electronics in automotive applications. TLO 1.2 Explain the relationship between Voltage, current, resistance and power using Ohm's Law. TLO 1.3 Solve simple circuit problems involving series and parallel configurations. TLO 1.4 List the types of diodes used in automotive applications. TLO 1.5 Describe the purpose of given instrumentation system in Automotive application.	**Unit - I Automotive Digital Electronics & Instrumentations** 1.1 Introduction to Automotive Electronics. 1.2 Overview of Electrical Principles: Voltage, current, resistance, and power. Ohm's Law and basic circuit analysis (Series and Parallel Circuits.) 1.3 Application of Zener Diode, Photo diode and LED in Automobiles. 1.4 Binary number system. 1.5 Instrumentation - Digital Cockpit, Heads Up Display.	Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Explain the function of computer Electronic Control Module (ECM) using block diagram. TLO 2.2 Select the relevant type of computer memory (s) used in automobiles with justification. TLO 2.3 Compare open loop and closed loop control system in automotive application on basis of given parameters. TLO 2.4 Explain multiplexing improves communication in modern vehicle systems. TLO 2.5 Describe the working of a given network system used in vehicle communication. TLO 2.6 Explain Controller Area Network (CAN) Bus is preferred over Local Interconnect Network (LIN) Bus in critical automotive applications.	**Unit - II Automotive Computer Networks** 2.1 Computer Electronic Control Module (ECM): Processor, Control unit, Clock, Input/Output devices 2.2 Computer Memory: - Types:- RAM,ROM,PROM,EPROM,EEPROM,KAM 2.3 Control Theory: Open Loop and Closed loop system in automotive application. 2.4 Multiplexing: - Principle of multiplexing. 2.5 Vehicle Network System: - The principle of Controller Area Network (CAN) Bus, Local Interconnect Network (LIN) Bus.	Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit
3	TLO 3.1 Describe with sketch the construction of the given automotive sensors. TLO 3.2 Analyze the output signals of given automotive sensors. TLO 3.3 Describe with sketch the construction of the given automotive actuators. TLO 3.4 Examine the input signals of given automotive actuators.	**Unit - III Automotive Sensors and Actuators** 3.1 Automotive Sensors: -Construction and working of Accelerator pedal position sensor, Speed sensor – Cam shaft, Crank shaft, wheel speed. Knock sensor, Lambda sensor. 3.2 Automotive Engine Control Actuators: - Construction and Working of Electronic Throttle Control, Idle speed controller, Electronic Unit injector, Exhaust Gas Recirculation (EGR) Valve, Purge control Valve, Exhaust Throttle Valve.	Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Describe working of given power train control systems with block diagram. TLO 4.2 Illustrate the given motion control system functions with the help of a block diagram. TLO 4.3 Inspect the components of safety control systems. TLO 4.4 Explain necessity of given safety/motion control system with justification.	**Unit - IV Automotive Control Systems** 4.1 Power train control system: Electronic control system used in Fuel Stratified Injection (FSI)/Turbo Stratified Injection (TSI) and Common Rail Direct Injection (CRDI) system. 4.2 Motion Control System: Anti-Lock Braking System (ABS) - Electronic Stability Program, Electronic Brakeforce Distribution, Traction control system, Electronic Differential Lock, Adaptive cruise control System, Electronic Suspension Control System, 4.3 Safety systems: Automatic emergency braking. Lane departure warning, Blind spot monitoring	Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit
5	TLO 5.1 Describe with flow chart the six-step approach in testing given component. TLO 5.2 Illustrate the diagnostic procedure of given electronic control systems. TLO 5.3 Recommend procedure of stand-alone diagnosis of the given electronic components. TLO 5.4 Measure signals of given sensors and actuators using suitable measuring instrument.	**Unit - V Diagnostic Techniques in Automotive Systems** 5.1 The “Six step” approach of component testing. 5.2 On board diagnostic (OBD-II) procedure of Turbo Stratified Injection (TSI) system. 5.3 Emission Related Diagnosis: - Oxygen Sensor, Air mass flow sensor, Throttle position sensor, MAP Sensor, Coolant Temperature Sensor. 5.4 Measuring Instruments:- Digital multi-meters, Scan tool.	Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Measure the required parameters of diodes (Zener, LED, Power, P-N diode)	1	*Test condition of given diodes using multimeter.	2	CO1
LLO 2.1 Identify key components of the Heads-up Display system. LLO 2.2 Use the Features of Heads-up Display system in given situations (speed, navigation, alerts, etc.).	2	Heads-up Display system.	2	CO1
LLO 3.1 Demonstrate functioning of various sensors using real-time data of different vehicle control units LLO 3.2 Demonstrate interconnectivity of various ECMs using real-time data of different vehicle control units.	3	Case study on "Real-Time Sensor Data Processing for Vehicle Control.	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 4.1 Measure the oxygen sensor feedback and other relevant engine parameters to evaluate the system's performance. LLO 4.2 Interpret the oxygen sensor feedback to evaluate the system's performance.	4	Engine Performance Optimization Using Closed-Loop Lambda Control.	2	CO2
LLO 5.1 Capture the waveform output from the Accelerator pedal position sensor using an oscilloscope. LLO 5.2 Interpret the waveform to identify any irregularities, such as noise, flatlines, or unexpected voltage levels. LLO 5.3 Analyze the waveform for expected voltage fluctuations corresponding to pedal position changes.	5	*Diagnosis of Accelerator pedal position sensor.	2	CO3
LLO 6.1 Measure the resistance of the Crank Shaft Position sensor using a multimeter. LLO 6.2 Verify the measured resistance values of CKP with the manufacturer’s specifications to detect possible sensor failure. LLO 6.3 Analyze the waveform of CKP signal patterns for proper functioning.	6	*Diagnosis of Crank shaft position sensor.	2	CO3
LLO 7.1 Check the voltage output of the wheel speed sensor while the vehicle is stationary and during wheel rotation using a multimeter or oscilloscope. LLO 7.2 Verify the voltage signal changes in direct proportion to the wheel's rotation speed.	7	*Diagnosis of Wheel Speed Sensor.	2	CO3
LLO 8.1 Test the Response of the Idle Speed Actuator. LLO 8.2 Measure the Voltage or Resistance of the Idle Speed Actuator. LLO 8.3 Test the Voltage and Pulse Duration of the Solenoid-Operated Fuel Injector.	8	*Test Idle speed actuators and Solenoid operated Fuel Injector.	2	CO3
LLO 9.1 Test the Response of the EGR Actuator. LLO 9.2 Measure the Voltage or Resistance of the EGR Actuator. LLO 9.3 Measure the Voltage or Resistance of the Purge Control Actuator.	9	Test EGR actuator and Purge control actuator.	2	CO3
LLO 10.1 Retrieve Diagnostic Trouble Codes for EBD System using scan tool. LLO 10.2 Identify the EBD-Related DTCs and Their Meanings.	10	Diagnostic trouble codes for Electronic Brakeforce Distribution.	2	CO4
LLO 11.1 Connect the diagnostic tool and retrieve the relevant DTCs for the traction control system LLO 11.2 Identify and explain the meaning of the DTCs, determining the cause of the problem in the traction control system.	11	*Diagnostic trouble codes for Traction control system.	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 12.1 Interpret the DTCs to identify faults related to Lane Departure Warning. LLO 12.2 Examine the DTCs to understand any malfunctions or faults in the BSM system.	12	Diagnostic procedure of Lane departure warning (LDW), Blind spot monitoring (BSM).	2	CO4
LLO 13.1 Connect the OBD-II scan tool to the TSI engine and ensure communication with the ECU. LLO 13.2 Retrieve and interpret DTCs using the scan tool to identify system faults in the TSI engine.	13	*On-Board Diagnosis (OBD-II) of the given TSI engine.	2	CO5
LLO 14.1 Connect the OBD-II scan tool to the CRDI engine and ensure communication with the ECU LLO 14.2 Interpret DTCs using the scan tool to identify system faults in the CRDI engine.	14	*On Board Diagnosis (OBD-II) of the given CRDI engine.	2	CO5
LLO 15.1 Identify symptoms that suggest a malfunction affecting engine performance during starting and idling.	15	Diagnosis of engine conditions at Starting, idling and Acceleration.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

NOT APPLICABLE

- NOT APPLICABLE

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Digital multi-meters; Make: Reputed manufacturers Measure Voltage and Current AC and DC, Resistance, Capacitance, diodes, continuity, frequency, min-max functions; LCD Display, 0 to 50ºC Operating Temperature, DC voltage- 200mV to 1000 V DC, 2 to 1000 V Alternating Current, Current: 2mA to 20 A DC, Diode Test, Continuity Test- Audible buzzer, Resistance: 200 ? to 200 M?; Accessories: Test leads, Current Clamp 300 A, Current Clamp Adapter.	1,5,6,7,8,9
2	Automotive Diagnostic Oscilloscope; Type- PC based or hand held Analog Channel: 8; Bandwidth: 100kHz; Input Impedance: Resistance: 1M?, Input Sensitivity: 10mV/div to 5V/div	10,11,12,13,14
3	Scan tool: Make: Reputed manufacturers On Board Diagnostics (OBD-II) Generation Scan Tool, Controller area network enabled, Color Display, Operating Temperature: 0 to 50ºC, Internal Storage: 4 AAA batteries, External Power: 7 to 18 volts; Generic tool; Accessories: Extender cable, OBD II Cable; Relevant optional accessories	13,14
4	A car equipped with modern automotive power train control, motion control and safety control system; Make: Reputed manufacturers Cubic Capacity: 1000 cc to 2200 cc; Power: 55 KW to 100 KW @ 4000 rpm.	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Automotive Digital Electronics & Instrumentations	CO1	10	2	4	6	12
2	II	Automotive Computer Networks	CO2	12	4	4	6	14
3	III	Automotive Sensors and Actuators	CO3	16	4	6	8	18
4	IV	Automotive Control Systems	CO4	12	2	4	8	14
5	V	Diagnostic Techniques in Automotive Systems	CO5	10	2	4	6	12
Grand Total				**60**	**14**	**22**	**34**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- For laboratory learning 25 Marks
- Two-unit tests of 30 marks and average of two-unit tests.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks.
- End semester assessment of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	2	-	2	-	-	2			
CO2	3	2	-	2	-	-	2			
CO3	3	2	2	2	2	-	2			
CO4	3	2	2	2	-	-	2			
CO5	3	2	2	2	2	-	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Bonnick, Allan W.M.	Automotive Computer Controlled System	Butterworth-Heinemann, UK, 24 April 2001 ISBN 13:978-0750650892
2	Ribbens, William B.	Understanding Automotive Electronics	Butterworth-Heinemann, UK, 18th June 2017 ISBN 13:978-0128104347
3	Bosch, Robert	Automotive Handbook	Bentley Publishers, UK, 9th Edition, 21st Nov 2014 ISBN 13:978-1119975564
4	Mosher, Lynn	Auto mechanic’s Guide to Electronic Instrumentation and Microprocessor.	Prentice – Hall, Inc. USA, 1987 ISBN 13: 978-0130546869
5	Denton, Tom	Advanced Automotive Fault Diagnosis	Routledge, New York, 2012 ISBN 13: 978-0415725767
6	Hollembeak, Barry	Today's Technician Automotive Electricity and Electronics-classroom and shop manual	Cengage Learning, New York, 2011 ISBN 13: 978-1305178403
7	Santini, Al	Automotive Electricity and Electronics	Cengage Learning, New York, 2013 ISBN 13: 978-1133713432

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=Fljk_j6VUHE	Introduction to the course; Current and Voltage; Kirchhoff\'s Current and Voltage laws
2	https://www.youtube.com/watch?v=RogF0ohkMJ4&list=PLdD-IdNhF9PE7kpHawAmk1Z8p9XLBbEU-	Vehicle Network System
3	https://www.youtube.com/watch?v=ceIykzivaw4	Automotive Sensors & Actuators.
4	https://www.youtube.com/watch?v=R5YfLySWQAc	Automotive Sensors & Actuators.
5	https://www.youtube.com/watch?v=RR8LsMBwL2I	OBD-II
6	https://www.youtube.com/watch?v=KzF8ieiJ9UY	Power train control system

AUTOTRONICS **Course Code : 316350**

Sr.No	Link / Portal	Description
7	https://www.youtube.com/watch?v=DaLmofF5iWU	malfunction affecting engine performance during starting and idling.
8	https://www.youtube.com/watch?v=PEBeRtuA6CE	Heads-up Display

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students