

| 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                                       | Abbreviation                         | 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              | 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 | Abbreviation | Course Type | Course Code | Total IKS Hrs for Sem. | Learning Scheme          |    |    | Credits | Assessment Scheme                                   |                             |                       |        |       |       |                  |       |     |     | Total Marks |                        |     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------|-------------|-------------|------------------------|--------------------------|----|----|---------|-----------------------------------------------------|-----------------------------|-----------------------|--------|-------|-------|------------------|-------|-----|-----|-------------|------------------------|-----|
|                                                                                                                                                                                                                                                                           |              |              |             |             |                        | 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 |     |
|                                                                                                                                                                                                                                                                           |              |              |             |             |                        | CL                       | TL | LL |         |                                                     |                             |                       |        |       |       | Practical        |       |     |     |             |                        |     |
|                                                                                                                                                                                                                                                                           |              |              |             |             |                        |                          |    |    |         |                                                     |                             |                       | FA-TH  | SA-TH | Total | FA-PR            | SA-PR | SLA |     |             |                        |     |
|                                                                                                                                                                                                                                                                           |              |              |             |             |                        |                          |    |    |         |                                                     |                             |                       | Max    | Max   | Max   | Min              | Max   | Min | Max |             | Min                    | Max |
| <b>Abbreviations :</b> CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, FA - Formative Assessment,SA -Summative Assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment                                                          |              |              |             |             |                        |                          |    |    |         |                                                     |                             |                       |        |       |       |                  |       |     |     |             |                        |     |
| <b>Legends :</b> @ Internal Assessment, # External Assessment, *# On Line Examination , @\$ Internal Online Examination                                                                                                                                                   |              |              |             |             |                        |                          |    |    |         |                                                     |                             |                       |        |       |       |                  |       |     |     |             |                        |     |
| <b>Note :</b>                                                                                                                                                                                                                                                             |              |              |             |             |                        |                          |    |    |         |                                                     |                             |                       |        |       |       |                  |       |     |     |             |                        |     |
| 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.                                                                                                                                                                                                |              |              |             |             |                        |                          |    |    |         |                                                     |                             |                       |        |       |       |                  |       |     |     |             |                        |     |
| <b>Course Category :</b> 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 & Telecommunication 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

**MANAGEMENT****Course Code : 315301**

| Course Code | Course Title | Abbr | Course Category/s | Learning Scheme          |     |     |        |     | Credits | Paper Duration | Assessment Scheme |      |     |     |             |       |       |       |       |       | Total Marks |
|-------------|--------------|------|-------------------|--------------------------|-----|-----|--------|-----|---------|----------------|-------------------|------|-----|-----|-------------|-------|-------|-------|-------|-------|-------------|
|             |              |      |                   | Actual Contact Hrs./Week | SLH | NLH | Theory |     |         |                | Based on LL & TL  |      |     |     | Based on SL |       |       |       |       |       |             |
|             |              |      |                   |                          |     |     |        |     |         |                |                   |      |     |     |             |       |       |       |       |       |             |
|             |              |      |                   |                          |     |     |        |     |         |                |                   |      |     |     |             |       |       |       |       |       |             |
|             |              |      |                   |                          |     |     | CL     | TL  |         |                | LL                |      |     |     |             | FA-TH | SA-TH | Total | FA-PR | SA-PR |             |
|             |              |      |                   |                          |     |     | Max    | Max | 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.                                                                                        |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| 1     | <p>TLO 1.1 Justify the importance of management thoughts in Indian knowledge system.</p> <p>TLO 1.2 Describe the importance of management in day to day life.</p> <p>TLO 1.3 Explain Henry Fayol's principles of management.</p> <p>TLO 1.4 Describe the role of each level of management in its management hierarchy.</p> <p>TLO 1.5 Practice the self management skills for a given situation</p> <p>TLO 1.6 Apply the required managerial skills for a given situation</p> | <p><b>Unit - I Introduction to Management</b></p> <p>1.1 Evolution of management thoughts from ancient/medieval to modern times in India (IKS)</p> <p>1.2 Management: meaning, importance, characteristics, functions &amp; challenges.</p> <p>1.3 Introduction to scientific management- Taylor's &amp; Fayol's principles of management</p> <p>1.4 Levels &amp; functions of management at supervisory level.</p> <p>1.5 Self management skills: Self awareness, self discipline, self motivation, goal setting, time management, decision making, stress management, work life balance and multitasking</p> <p>1.6 Overview of Managerial Skills: negotiation skills, team management, conflict resolution, feedback, leadership</p> | <p>Presentations</p> <p>Case Study</p> <p>Interactive session</p> <p>Quiz competition</p> <p>Mixed Picture Puzzle</p> |

**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.                                                                                                                  |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| 2     | <p>TLO 2.1 Identify the appropriate creativity technique for new product development</p> <p>TLO 2.2 Describe the new product development process for a product / service</p> <p>TLO 2.3 Comprehend the importance of various strategic steps Product Management</p> <p>TLO 2.4 Elaborate Agile product management</p> <p>TLO 2.5 Explain the significance of the Project Management</p> <p>TLO 2.6 Describe the various tools of project management</p> | <p><b>Unit - II Product, Operations and Project Management</b></p> <p>2.1 Creativity and innovation management: creativity techniques - brainstorming, checklist, reverse brainstorming, morphological analysis, six thinking hats.</p> <p>2.2 New product development, change management</p> <p>2.3 Product Management -meaning, strategic steps for sustainable design of a product</p> <p>2.4 Agile product management- concept, benefits, principles and manifesto</p> <p>2.5 Project Management: importance, areas within project management, 4Ps and phases</p> <p>2.6 Tools of Project Management: PERT and CPM, GANTT &amp; Chart Overview of Estimate and Budget</p> | <p>Presentations</p> <p>Case Study</p> <p>Video</p> <p>Demonstrations</p> <p>Presentations</p> <p>Role Play</p>                                 |
| 3     | <p>TLO 3.1 Understand the importance of quality management tools</p> <p>TLO 3.2 Explain the importance of various techniques for optimization and waste minimization</p> <p>TLO 3.3 State the importance of ISO quality standards</p> <p>TLO 3.4 Describe ERP</p> <p>TLO 3.5 State the importance of ISO</p> <p>TLO 3.6 Recognize the importance of customer satisfaction as a competitive advantage</p>                                                | <p><b>Unit - III Management Practices</b></p> <p>3.1 Quality circle, kaizen, Six Sigma, TQM</p> <p>3.2 5S, Kanban card system, TPM, Lean Manufacturing: Meaning, Steps and Importance</p> <p>3.3 Quality Standards and ISO: Meaning, ISO 9001:2016, ISO 14000, OSHA 2020</p> <p>3.4 The overview of ERP along with example</p> <p>3.5 Service quality and customer/client satisfaction, servicescape</p>                                                                                                                                                                                                                                                                      | <p>Presentation</p> <p>Case study</p> <p>Interactive session</p> <p>Quiz</p> <p>Video</p> <p>Demonstration</p> <p>Lecture Using Chalk-Board</p> |
| 4     | <p>TLO 4.1 Explain the importance of marketing techniques</p> <p>TLO 4.2 Explain the importance of needs, wants and desires in marketing</p> <p>TLO 4.3 Interpret the traditional and digital marketing techniques</p> <p>TLO 4.4 Plan different aspects of an event management</p>                                                                                                                                                                     | <p><b>Unit - IV Marketing Management</b></p> <p>4.1 Marketing management: meaning, significance, Seven P's of Marketing</p> <p>4.2 Needs, wants and demands in marketing. Customer relationship management</p> <p>4.3 Types of marketing: traditional and digital marketing</p> <p>4.4 Event management: types, different aspects of event management, crisis management</p>                                                                                                                                                                                                                                                                                                  | <p>Case Study</p> <p>Interactive session based video</p> <p>Role Play</p> <p>Flipped Classroom</p> <p>Presentations</p>                         |

**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.                                                                                             |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| 5     | TLO 5.1 State the importance of supply chain and logistics management<br>TLO 5.2 Explain the components of supply chain and logistics Management<br>TLO 5.3 Describe the role of information technology in supply chain & logistics management<br>TLO 5.4 State the significance of Human Resource Management<br>TLO 5.5 Analyze the various methods of recruitment, selection and training for an organization<br>TLO 5.6 List the qualities of a successful supervisor | <b>Unit - V Supply Chain &amp; Human Resource Management</b><br>5.1 The overview of Supply Chain and logistics Management<br>5.2 Components of Supply Chain and logistics Management<br>5.3 Role of information technology in supply chain & logistics management<br>5.4 Overview of Human Resource Management- Meaning, significance, scope and principles<br>5.5 Recruitment, selection and training of human resources. Chalk Circle<br>5.6 Qualities of a successful supervisor /team leader and types of leadership | Presentations<br>Video<br>Demonstrations<br>Case Study<br>Collaborative learning<br>Video<br>Demonstrations<br>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.

**Quizzes**

- Participate in online quizzes related to areas of management .

**Assignment**

**MANAGEMENT****Course Code : 315301**

- 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 judicious 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          |
| <b>Grand Total</b> |      |                                            |             | <b>45</b>      | <b>20</b> | <b>22</b> | <b>28</b> | <b>70</b>   |

**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 |

**MANAGEMENT****Course Code : 315301**

|     |   |   |   |   |   |   |   |  |  |  |
|-----|---|---|---|---|---|---|---|--|--|--|
| 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 World             | 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     | <a href="https://www.debonogroup.com/services/core-programs/six-thinking-hats/">https://www.debonogroup.com/services/core-programs/six-thinking-hats/</a>                                                                                 | Six Thinking Hats        |
| 2     | <a href="https://hbr.org/1981/09/managing-human-resources">https://hbr.org/1981/09/managing-human-resources</a>                                                                                                                           | HR Management            |
| 3     | <a href="https://theproductmanager.com/topics/agile-product-management/">https://theproductmanager.com/topics/agile-product-management/</a>                                                                                               | Agile Product Management |
| 4     | <a href="https://www.cdlogistics.ca/freight-news/the-5-components-of-supply-chain-management">https://www.cdlogistics.ca/freight-news/the-5-components-of-supply-chain-management</a>                                                     | Supply Chain Management  |
| 5     | <a href="https://www.infosectrain.com/blog/understanding-the-concepts-of-gantt-chart-and-critical-path-methodology-cpm">https://www.infosectrain.com/blog/understanding-the-concepts-of-gantt-chart-and-critical-path-methodology-cpm</a> | PERT, CPM, GANTT Chart   |
| 6     | <a href="https://www.simplilearn.com/best-management-tools-article">https://www.simplilearn.com/best-management-tools-article</a>                                                                                                         | Management Tools         |
| 7     | <a href="https://www.psychometrica.in/free-online-psychometric-tests.html">https://www.psychometrica.in/free-online-psychometric-tests.html</a>                                                                                           | Psychometric Tests       |
| 8     | <a href="https://www.investopedia.com/terms/e/erp.asp">https://www.investopedia.com/terms/e/erp.asp</a>                                                                                                                                   | ERP                      |
| 9     | <a href="https://asq.org/quality-resources/quality-management-system">https://asq.org/quality-resources/quality-management-system</a>                                                                                                     | QMS                      |
| 10    | <a href="https://testlify.com/test-library/creative-thinking/">https://testlify.com/test-library/creative-thinking/</a>                                                                                                                   | Psychometric Tests       |
| 11    | <a href="https://www.mindtools.com/">https://www.mindtools.com/</a>                                                                                                                                                                       | Management Skills        |
| 12    | <a href="https://www.investopedia.com/terms/d/digital-marketing.asp">https://www.investopedia.com/terms/d/digital-marketing.asp</a>                                                                                                       | 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

**MANAGEMENT****Course Code : 315301****MSBTE Approval Dt. 24/02/2025****Semester - 5 / 6, K Scheme**

**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 |           |     |     |     |                  |     |   |   |             |       |       | Total Marks |       |
|-------------|-----------------------------|------|-------------------|--------------------------|-----|-----|-----|-----|-----|---------|-------------------|-----------|-----|-----|-----|------------------|-----|---|---|-------------|-------|-------|-------------|-------|
|             |                             |      |                   | Actual Contact Hrs./Week |     |     |     |     |     |         | Paper Duration    | Theory    |     |     |     | Based on LL & TL |     |   |   | Based on SL |       |       |             |       |
|             |                             |      |                   | CLTLLLSLHNLH             |     |     |     |     |     |         |                   | Practical |     |     |     | SLA              |     |   |   |             |       |       |             |       |
|             |                             |      |                   |                          |     |     |     |     |     |         |                   |           |     |     |     |                  |     |   |   |             |       |       |             |       |
|             |                             |      |                   |                          |     |     |     |     |     |         |                   |           |     |     |     |                  |     |   |   |             |       |       |             |       |
|             |                             |      |                   |                          |     |     |     |     |     |         |                   | CL        | TL  | LL  | SL  | H                | N   | L | H | FA-TH       | SA-TH | Total |             | FA-PR |
| Max         | Max                         | Max  | Min               | Max                      | Min | Max | Min | 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   |       |             |       |

**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

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     | <p>TLO 1.1 List the principles of modern design concepts for designing Auto component.</p> <p>TLO 1.2 Describe the modes of failure with relevant examples.</p> <p>TLO 1.3 Explain component design procedure.</p> <p>TLO 1.4 Describe the standards used in the design of the given automobile component.</p> <p>TLO 1.5 Explain effects of aesthetics and ergonomics on shape and size of an automobile component.</p> <p>TLO 1.6 List environmental consideration in design of automobile components.</p> | <p><b>Unit - I Design Principles and Practices</b></p> <p>1.1 Component design – Concept and modern design considerations (Concurrent engineering, Design for manufacturing, Design for assembly).</p> <p>1.2 Modes of failure of different automotive components.</p> <p>1.3 Basic requirements of automobile components, Basic automobile component design procedure.</p> <p>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.</p> <p>1.5 Ergonomic and aesthetic considerations in automobile component design (shape, size and color).</p> <p>1.6 Environmental consideration in component design.</p> | <p>Lecture Using Chalk-Board</p> <p>Case Study</p> <p>Video</p> <p>Demonstrations</p> <p>Presentations</p> |
| 2     | <p>TLO 2.1 State different types of loads acting on automobile components.</p> <p>TLO 2.2 Describe stresses induced in the given components.</p> <p>TLO 2.3 State torsional equation for solid and hollow shafts.</p> <p>TLO 2.4 Describe SN curve.</p> <p>TLO 2.5 Illustrate suitable remedies to reduce stress concentration for the given component with justification.</p> <p>TLO 2.6 List criteria affecting selection of factor of safety.</p>                                                         | <p><b>Unit - II Fundamentals of Design</b></p> <p>2.1 Types of loads-Static, Dynamic, Impact, Shock .</p> <p>2.2 Types of stresses-Normal and Shear stresses, Crushing stress, Bearing pressure, Bending stresses (Simple numerical only).</p> <p>2.3 Torsion of shafts, Modulus of rigidity, Torsional equation, (Simple numerical on solid, hollow shafts only).</p> <p>2.4 Fatigue, Endurance limit, SN Curve.</p> <p>2.5 Stress concentration, causes and remedies.</p> <p>2.6 Working stress, factor of safety, selection of factor of safety.</p>                                                                                                                                                                                                                                                          | <p>Lecture Using Chalk-Board</p> <p>Presentations</p> <p>Video</p> <p>Demonstrations</p>                   |

**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.                                                               |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| 3     | TLO 3.1 Describe design procedure for threaded joint in a tie rod.<br>TLO 3.2 Calculate friction lining dimensions of a clutch plate.<br>TLO 3.3 Describe design procedure for a propeller shaft and universal coupling.<br>TLO 3.4 Explain design procedure of parallel and transverse fillet welded joints for axially loaded symmetrical sections. | <b>Unit - III Design of chassis components</b><br>3.1 Design of threaded joint in a tie rod.<br>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).<br>3.3 Design of propeller shaft, Universal coupling design (Shaft diameter, pin diameter and empirical relations).<br>3.4 Design of welded joints in automobile manufacturing, Design of parallel and transverse fillet welds, axially loaded symmetrical Section. | Lecture Using Chalk-Board<br>Presentations<br>Video<br>Demonstrations<br>Flipped Classroom   |
| 4     | TLO 4.1 Explain valve spring design procedure.<br>TLO 4.2 Explain design procedure for IC engine piston and piston pin.<br>TLO 4.3 Describe design procedure of connecting rod.                                                                                                                                                                       | <b>Unit - IV Design of Engine components</b><br>4.1 Materials for valve spring with justification, IC engine valve spring terminology, Design procedure of valve spring.<br>4.2 Materials for piston and piston pin with justification, IC engine piston design procedure (For strength), Piston pin design procedure (Simple numerical only).<br>4.3 Materials for connecting rod with justification, Design procedure of connecting rod cross section (Simple numerical only).                                                                                                                              | Lecture Using Chalk-Board<br>Video<br>Demonstrations<br>Presentations                        |
| 5     | TLO 5.1 Describe design procedure a front axle cross section for given load condition<br>TLO 5.2 Describe design procedure of a full floating rear axle cross section for given load condition.                                                                                                                                                       | <b>Unit - V Design of Axles</b><br>5.1 Material for axle with justification, Design procedure for front axle beam cross section (Simple numerical only).<br>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<br>Video<br>Demonstrations<br>Presentations<br>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.<br>LLO 3.2 List the ergonomic and aesthetic aspects identified components under LLO 3.1.<br>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          |

**AUTOMOBILE COMPONENT DESIGN****Course Code : 316346**

| <b>Practical / Tutorial / Laboratory Learning Outcome (LLO)</b>                                                                                                                                                                                                                                           | <b>Sr No</b> | <b>Laboratory Experiment / Practical Titles / Tutorial Titles</b> | <b>Number of hrs.</b> | <b>Relevant COs</b> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------------------------------------------------------------|-----------------------|---------------------|
| 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.<br>LLO 5.2 Specify material properties for components given in LLO 5.1 with relevant justification.                | 5            | *Automobile component materials.                                  | 2                     | CO1<br>CO2          |
| LLO 6.1 Measure dimensions of given propeller shaft and Universal coupling.<br>LLO 6.2 Select relevant materials from design data book.<br>LLO 6.3 Select relevant design procedure.<br>LLO 6.4 Calculate dimensions.<br>LLO 6.5 Modify dimensions.<br>LLO 6.6 Prepare CAD drawing.                       | 6            | *Propeller shaft and universal coupling design                    | 6                     | CO3                 |
| LLO 7.1 Measure dimensions of given piston.<br>LLO 7.2 Select relevant materials from design data book.<br>LLO 7.3 Select relevant design procedure.<br>LLO 7.4 Calculate dimensions.<br>LLO 7.5 Modify dimensions.<br>LLO 7.6 Prepare CAD drawing.                                                       | 7            | *Piston design                                                    | 6                     | CO4                 |
| LLO 8.1 Measure dimensions of given front axle beam.<br>LLO 8.2 Select relevant materials from design data book.<br>LLO 8.3 Select relevant design procedure.<br>LLO 8.4 Calculate dimensions of I section.<br>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.<br>LLO 9.2 Select relevant materials from design data book.<br>LLO 9.3 Select relevant design procedure.<br>LLO 9.4 Calculate the dimensions of the section.<br>LLO 9.5 Modify the dimensions for preparation of drawing.                             | 9            | *Rear axle design.                                                | 4                     | CO5                 |
| <b>Note : Out of above suggestive LLOs -</b> <ul style="list-style-type: none"> <li>• '*' Marked Practicals (LLOs) Are mandatory.</li> <li>• Minimum 80% of above list of lab experiment are to be performed.</li> <li>• Judicial mix of LLOs are to be performed to achieve desired outcomes.</li> </ul> |              |                                                                   |                       |                     |

**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 judicious 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          |
| <b>Grand Total</b> |      |                                 |             | <b>60</b>      | <b>14</b> | <b>32</b> | <b>24</b> | <b>70</b>   |

**X. ASSESSMENT METHODOLOGIES/TOOLS****Formative assessment (Assessment for Learning)**

- Continuous assessment based on process and product related performance indicators

**Summative Assessment (Assessment of Learning)**

**AUTOMOBILE COMPONENT DESIGN****Course Code : 316346**

- End semester examination

**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                                     | 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     | <a href="https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3283358">https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3283358</a>                                                                                 | Environment consideration in Auto component design |
| 2     | <a href="https://www.youtube.com/watch?v=9_R7M49Atz4">https://www.youtube.com/watch?v=9_R7M49Atz4</a>                                                                                                                 | Aesthetics and Ergonomics in Design                |
| 3     | <a href="https://www.youtube.com/watch?v=-hLwyhDRcJM">https://www.youtube.com/watch?v=-hLwyhDRcJM</a>                                                                                                                 | Design of fillet welds                             |
| 4     | <a href="https://www.youtube.com/watch?v=LhUclxBUV_E">https://www.youtube.com/watch?v=LhUclxBUV_E</a>                                                                                                                 | Fatigue testing procedure                          |
| 5     | <a href="https://www.youtube.com/watch?v=ZwqBia_gRGo&amp;list=PLg9TnucUbzBW3tt1AtCBxcz6Hr1YqQYwQ&amp;index=1">https://www.youtube.com/watch?v=ZwqBia_gRGo&amp;list=PLg9TnucUbzBW3tt1AtCBxcz6Hr1YqQYwQ&amp;index=1</a> | Design of piston in IC engine                      |
| 6     | <a href="https://www.youtube.com/watch?v=PvIm35eiI78">https://www.youtube.com/watch?v=PvIm35eiI78</a>                                                                                                                 | Use of Design data book                            |
| 7     | <a href="https://www.youtube.com/watch?v=-FG9AVYqF0U">https://www.youtube.com/watch?v=-FG9AVYqF0U</a>                                                                                                                 | Modes of failure                                   |
| 8     | <a href="https://www.youtube.com/watch?v=yQGiwshQab8">https://www.youtube.com/watch?v=yQGiwshQab8</a>                                                                                                                 | Methods of reducing stress concentration           |

**AUTOMOBILE COMPONENT DESIGN****Course Code : 316346**

| Sr.No                                                                                                                                                                                                              | Link / Portal | Description |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------|
| <b>Note :</b>                                                                                                                                                                                                      |               |             |
| <ul style="list-style-type: none"><li>Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students</li></ul> |               |             |

**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 | Paper Duration | Assessment Scheme |        |     |    |    |                  |       |       |     |             | Total Marks |       |     |       |     |     |
|-------------|----------------------------------------------------|------|-------------------|--------------------------|----|----|----|---|---------|----------------|-------------------|--------|-----|----|----|------------------|-------|-------|-----|-------------|-------------|-------|-----|-------|-----|-----|
|             |                                                    |      |                   | Actual Contact Hrs./Week |    |    | SL | H |         |                | NL                | Theory |     |    |    | Based on LL & TL |       |       |     | Based on SL |             |       |     |       |     |     |
|             |                                                    |      |                   | CL                       | TL | LL |    |   |         |                |                   |        |     |    |    | Practical        |       |       |     | SLA         |             |       |     |       |     |     |
|             |                                                    |      |                   |                          |    |    |    |   |         |                |                   |        |     |    |    | FA-TH            | SA-TH | Total |     |             |             | FA-PR |     | SA-PR |     |     |
|             |                                                    |      |                   |                          |    |    |    |   |         |                |                   |        |     |    |    |                  |       | Max   | Max |             |             | Max   | Min | Max   | Min | Max |
| 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     | <p>TLO 1.1 Define different properties of fluids.</p> <p>TLO 1.2 Classify different fluid flows.</p> <p>TLO 1.3 Classify different pressures.</p> <p>TLO 1.4 List different device for measurement of pressure.</p> <p>TLO 1.5 Determine different parameters by using Bernoulli 's theorem.</p> <p>TLO 1.6 Calculate different Hydraulic Coefficients.</p> | <p><b>Unit - I Overview of Fluid Mechanics</b></p> <p>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.</p> <p>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</p> <p>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.</p> | <p>Lecture Using Chalk-Board Presentations Video Demonstrations Model Demonstration</p> |

| 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     | <p>TLO 2.1 Explain construction and working of different pumps.</p> <p>TLO 2.2 State significance of NPSH.</p> <p>TLO 2.3 Select pumps on the basis of pressure, discharge, field of application and economy.</p> <p>TLO 2.4 Differentiate the given Positive Displacement pumps.</p>                            | <p><b>Unit - II Hydraulic Machinery</b></p> <p>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.</p> <p>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)</p> <p>2.3 Submersible Pump: Construction, working and application</p> <p>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.</p>                                                                                                                     | Lecture Using Chalk-Board Presentations Video Demonstrations Model Demonstration |
| 3     | <p>TLO 3.1 Draw layout of automobile hydraulic and pneumatic system.</p> <p>TLO 3.2 Explain the constructional and working of the given hydraulic and pneumatic actuator with neat sketch.</p> <p>TLO 3.3 Explain hydraulic and pneumatic valves with neat sketch.</p> <p>TLO 3.4 Classify different valves.</p> | <p><b>Unit - III Basic Components of Hydraulic and Pneumatic Systems</b></p> <p>3.1 General layout of oil hydraulics and pneumatics system.</p> <p>3.2 Hydraulic Actuators-hydraulic cylinders (Single, double and telescopic)-Construction and working, hydraulic motors (gear and piston type)-construction and working.</p> <p>3.3 Pneumatic Actuators-Pneumatic cylinders (single and double acting)-construction and working, air motors (vane and piston type)-construction and working.</p> <p>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.</p> | Lecture Using Chalk-Board Presentations Video Demonstrations Model Demonstration |
| 4     | <p>TLO 4.1 Explain with sketch the functions of the given accessory for hydraulic systems.</p> <p>TLO 4.2 Compare the given accessories of pneumatic/hydraulic systems.</p> <p>TLO 4.3 Select accessories based on Material Compatibility, type of sealing (Static/ dynamic), Shape and Design.</p>              | <p><b>Unit - IV Accessories of hydraulic and Pneumatic systems</b></p> <p>4.1 Hydraulic filters and strainers- Full flow and proportional types, function and working, difference between filters and strainers.</p> <p>4.2 Pneumatic Filters-Screen type and mechanical type, function and working, FRL unit.</p> <p>4.3 Hoses and connectors for Hydraulic and Pneumatic systems- Types, construction and application.</p> <p>4.4 Seal and gasket for hydraulic and pneumatic systems- Types, function and construction of commonly use seals and gasket materials.</p> <p>4.5 Concept of Intensifiers and accumulators.</p>                                                                                                                                                                                                                                                                         | 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     | <p>TLO 5.1 Draw ISO symbols (ISO 1219-1:2012) used in Pneumatic Hydraulic circuits.</p> <p>TLO 5.2 Draw simple hydraulic and pneumatic circuits.</p> <p>TLO 5.3 Draw specified circuit using the given components for the given application.</p> <p>TLO 5.4 Name different components of Hydro-pneumatic systems.</p> <p>TLO 5.5 Write procedure for Maintenance of Hydraulic, Pneumatic and hydro-pneumatic systems.</p> <p>TLO 5.6 Diagnose different faults in hydraulic and pneumatics systems.</p> | <p><b>Unit - V Hydraulic and Pneumatic Circuits and systems</b></p> <p>5.1 ISO symbols (ISO 1219-1:2012) used in Pneumatic Hydraulic circuits.</p> <p>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.</p> <p>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).</p> <p>5.4 Simple hydro-pneumatic circuits and system-Hydro-pneumatic rams, Brake booster of truck/bus, Pin lift of pneumatic mounding machines.</p> <p>5.5 Maintenance of Hydraulic, Pneumatic and hydro-pneumatic systems.</p> <p>5.6 Troubleshooting of hydraulic and pneumatics systems.</p> | 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 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------------------------------------------------------------------------------------------------------------|----------------|--------------|
| <p>LLO 1.1 Identify various components of available hydraulic brake.</p> <p>LLO 1.2 Check the condition of various components of hydraulic brake.</p> <p>LLO 1.3 Do the necessary remedial action based on condition observed.</p> | 1     | Hydraulic circuit and components of automobile hydraulic brakes relevant to Pascal's law.                        | 2              | CO1          |
| <p>LLO 2.1 Calculate total energy available at different sections of a pipe layout.</p> <p>LLO 2.2 Verify Bernoulli's theorem.</p>                                                                                                 | 2     | *Measurement of total energy available at different sections of a pipe layout to verify Bernoulli's theorem      | 2              | CO1          |
| <p>LLO 3.1 Measure the manometric head (Hm) at different flow rates</p> <p>LLO 3.2 Calculate overall efficiency of centrifugal pump</p> <p>LLO 3.3 Plot performance characteristics based on the results</p>                       | 3     | *Determination of overall efficiency of Centrifugal pump using Centrifugal pump test rig                         | 2              | CO2          |
| <p>LLO 4.1 Identify various components of centrifugal pump</p> <p>LLO 4.2 Check the condition of various components of centrifugal pump</p> <p>LLO 4.3 Do the necessary remedial action based on condition observed.</p>           | 4     | Assembly and dismantling of the centrifugal pump to prepare a troubleshooting chart.                             | 2              | CO2          |
| <p>LLO 5.1 Calculate overall efficiency of reciprocating pump</p> <p>LLO 5.2 Calculate percentage slip of reciprocating pump</p>                                                                                                   | 5     | *Determination of overall efficiency and percentage slip of Reciprocating pump using Reciprocating pump test rig | 2              | CO2          |

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| <b>Practical / Tutorial / Laboratory Learning Outcome (LLO)</b>                                                                                                                                                               | <b>Sr No</b> | <b>Laboratory Experiment / Practical Titles / Tutorial Titles</b>                      | <b>Number of hrs.</b> | <b>Relevant COs</b> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|----------------------------------------------------------------------------------------|-----------------------|---------------------|
| LLO 6.1 Identify various components of available reciprocating pump.<br>LLO 6.2 Check the condition of various components of reciprocating pump.<br>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.<br>LLO 7.2 Check the condition of various components of lubricating oil pump.<br>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.<br>LLO 8.2 Check the condition of various components of air motor.<br>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.<br>LLO 9.2 Check the condition of various components of used valve.<br>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.<br>LLO 10.2 Clean hydraulic and pneumatic filters used in the system.<br>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.<br>LLO 11.2 Check the effectiveness of seals and gaskets by identifying leaks.<br>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                 |
| LLO 12.1 List ISO symbols used in Pneumatic Hydraulic circuits.<br>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.<br>LLO 13.2 Choose different components for Meter-in and Meter-Out Hydraulic circuits.<br>LLO 13.3 Connect and Test the circuit for the correct operation.           | 13           | *Construction and actuation of the Meter-in and Meter-Out hydraulic circuits.          | 2                     | CO5                 |
| LLO 14.1 Draw Sequencing Hydraulic circuits.<br>LLO 14.2 Choose different components for Sequencing Hydraulic circuits.<br>LLO 14.3 Connect and Test the circuit for the correct operation.                                   | 14           | *Development of any suitable sequencing hydraulic circuit                              | 2                     | CO5                 |

| <b>Practical / Tutorial / Laboratory Learning Outcome (LLO)</b>                                                                                                                                                                                                                                           | <b>Sr No</b> | <b>Laboratory Experiment / Practical Titles / Tutorial Titles</b>               | <b>Number of hrs.</b> | <b>Relevant COs</b> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|---------------------------------------------------------------------------------|-----------------------|---------------------|
| LLO 15.1 Draw Sequencing Pilot Control Pneumatic circuits.<br>LLO 15.2 Choose different components for Pilot Control Pneumatic circuit.<br>LLO 15.3 Connect and Test the circuit for the correct operation.                                                                                               | 15           | Construction and actuation of the pilot control pneumatic circuit.              | 2                     | CO5                 |
| LLO 16.1 Select a Hydraulic and Pneumatic simulation software.<br>LLO 16.2 Represent the Hydraulic and Pneumatic circuit using the software's graphical interface and connecting the components.<br>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                 |
| <b>Note : Out of above suggestive LLOs -</b> <ul style="list-style-type: none"> <li>• '*' Marked Practicals (LLOs) Are mandatory.</li> <li>• Minimum 80% of above list of lab experiment are to be performed.</li> <li>• Judicial mix of LLOs are to be performed to achieve desired outcomes.</li> </ul> |              |                                                                                 |                       |                     |

## **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 judicious 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 m <sup>3</sup> /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               |
| 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 1/4" 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          |

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| Sr.No              | Unit | Unit Title                                     | Aligned COs | Learning Hours | R-Level   | U-Level   | A-Level   | Total Marks |
|--------------------|------|------------------------------------------------|-------------|----------------|-----------|-----------|-----------|-------------|
| 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          |
| <b>Grand Total</b> |      |                                                |             | <b>45</b>      | <b>14</b> | <b>22</b> | <b>34</b> | <b>70</b>   |

**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**

| 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                    |

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| Sr.No | Author                       | Title                                     | Publisher with ISBN Number                                                          |
|-------|------------------------------|-------------------------------------------|-------------------------------------------------------------------------------------|
| 7     | Ilango.S.<br>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     | <a href="https://www.youtube.com/watch?v=_bfcdRhY7Rw">https://www.youtube.com/watch?v=_bfcdRhY7Rw</a>                                                                                         | Working Principle of Venturimeter                     |
| 2     | <a href="https://www.youtube.com/watch?v=iRdJHPFVHwM">https://www.youtube.com/watch?v=iRdJHPFVHwM</a>                                                                                         | Orifice Meter Working Principle                       |
| 3     | <a href="https://www.youtube.com/watch?v=3zEdtkuNYLU">https://www.youtube.com/watch?v=3zEdtkuNYLU</a>                                                                                         | Pitot Tube Working Animation                          |
| 4     | <a href="https://www.youtube.com/watch?v=IiE8skW8btE">https://www.youtube.com/watch?v=IiE8skW8btE</a>                                                                                         | Centrifugal Pump                                      |
| 5     | <a href="https://www.youtube.com/watch?v=41vb6T42_Tk">https://www.youtube.com/watch?v=41vb6T42_Tk</a>                                                                                         | Reciprocating Pump animation                          |
| 6     | <a href="https://www.youtube.com/watch?v=ri5QydTx3AQ">https://www.youtube.com/watch?v=ri5QydTx3AQ</a>                                                                                         | Reciprocating Pump animation                          |
| 7     | <a href="https://www.youtube.com/watch?v=Dim0fLFIFog&amp;list=PLIMdd_mE4yZGWJ32cgnK2-bs44Gpj81xi">https://www.youtube.com/watch?v=Dim0fLFIFog&amp;list=PLIMdd_mE4yZGWJ32cgnK2-bs44Gpj81xi</a> | Introduction to Oil Hydraulics and Pneumatics         |
| 8     | <a href="https://www.youtube.com/watch?v=9cO78SgZkXc">https://www.youtube.com/watch?v=9cO78SgZkXc</a>                                                                                         | Single Acting Cylinder/Actuator Animation             |
| 9     | <a href="https://www.youtube.com/watch?v=mDLf7pe_Zug">https://www.youtube.com/watch?v=mDLf7pe_Zug</a>                                                                                         | Telescopic Cylinder/Actuator Animation                |
| 10    | <a href="https://www.youtube.com/watch?v=sTrEGXXSLSA">https://www.youtube.com/watch?v=sTrEGXXSLSA</a>                                                                                         | Hydraulic Motors Summary of Features                  |
| 11    | <a href="https://www.youtube.com/watch?v=2UoDHqIMGB8">https://www.youtube.com/watch?v=2UoDHqIMGB8</a>                                                                                         | Types Of Pneumatic Actuators                          |
| 12    | <a href="https://www.youtube.com/watch?v=jbOdnEwUYOw">https://www.youtube.com/watch?v=jbOdnEwUYOw</a>                                                                                         | Flow Control Valves in Hydraulics                     |
| 13    | <a href="https://www.youtube.com/watch?v=LfWTyn8UT5M">https://www.youtube.com/watch?v=LfWTyn8UT5M</a>                                                                                         | Pressure Control Valves                               |
| 14    | <a href="https://www.youtube.com/watch?v=JlYbKgsgrxY">https://www.youtube.com/watch?v=JlYbKgsgrxY</a>                                                                                         | Directional Control Valves                            |
| 15    | <a href="https://www.youtube.com/watch?v=VGWua73ArFs">https://www.youtube.com/watch?v=VGWua73ArFs</a>                                                                                         | Types of hydraulic Filters                            |
| 16    | <a href="https://www.youtube.com/watch?v=4BoGenyK45w">https://www.youtube.com/watch?v=4BoGenyK45w</a>                                                                                         | Hydraulic accumulators, Classifications, Applications |
| 17    | <a href="https://www.youtube.com/watch?v=_EbJv2T_OU">https://www.youtube.com/watch?v=_EbJv2T_OU</a>                                                                                           | Industrial Hydraulic Circuit                          |
| 18    | <a href="https://www.youtube.com/watch?v=kbLyD-ATOZ8">https://www.youtube.com/watch?v=kbLyD-ATOZ8</a>                                                                                         | Oil Hydraulic Circuits                                |
| 19    | <a href="https://www.youtube.com/watch?v=JnFOFa7J-Ms">https://www.youtube.com/watch?v=JnFOFa7J-Ms</a>                                                                                         | 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

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Programme Name/s | : Architecture Assistantship/ Automobile Engineering./ Agricultural Engineering/ Architecture/<br>Fashion & Clothing Technology/ Dress Designing & Garment Manufacturing/ Food Technology/ Instrumentation & Control/<br>Instrumentation/ Interior Design & Decoration/ Interior Design/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/<br>Printing Technology/ Surface Coating Technology/ Textile Technology/ Travel and Tourism/<br>Textile Manufactures |
| Programme Code   | : AA/ AE/ AL/ AT/ DC/ DD/ FC/ IC/ IS/ IX/ IZ/ ME/ MK/ ML/ MU/ PG/ PN/ SC/ TC/ TR/ TX                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Semester         | : Fourth / Fifth / Sixth                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Course Title     | : ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Course Code      | : 314014                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

**I. RATIONALE**

Entrepreneurship and Startup is introduced in this curriculum to develop the entrepreneurship traits among the students before they enter into the professional life. By exposing and interacting with entrepreneurship and startup eco-system, student will develop the entrepreneurial mind set. The innovative thinking with risk taking ability along with other traits are to be inculcated in the students through micro projects and training. This exposure will be instrumental in orienting the students in transforming them to be job generators after completion of Diploma in Engineering.

**II. INDUSTRY / EMPLOYER EXPECTED OUTCOME**

- Develop project proposals for launching small scale enterprises and starts up.

**III. COURSE LEVEL LEARNING OUTCOMES (COS)**

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

- CO1 - Identify one's entrepreneurial traits.
- CO2 - Use information collected from stakeholder for establishing/setting up/founding starts up
- CO3 - Use support systems available for Starts up
- CO4 - Prepare project plans to manage the enterprise effectively

**IV. TEACHING-LEARNING & ASSESSMENT SCHEME**

| Course Code | Course Title                              | Abbr | Course Category/s | Learning Scheme          |    |    |    |    | Credits | Assessment Scheme |        |       |       |                  |       |    |       |             |     |    |     |     |     | Total Marks |
|-------------|-------------------------------------------|------|-------------------|--------------------------|----|----|----|----|---------|-------------------|--------|-------|-------|------------------|-------|----|-------|-------------|-----|----|-----|-----|-----|-------------|
|             |                                           |      |                   | Actual Contact Hrs./Week |    |    | SL | NL |         | Paper Duration    | Theory |       |       | Based on LL & TL |       |    |       | Based on SL |     |    |     |     |     |             |
|             |                                           |      |                   | CL                       | TL | LL |    |    |         |                   |        |       |       | Practical        |       |    |       |             |     |    |     |     |     |             |
|             |                                           |      |                   |                          |    |    |    |    |         |                   | FA-TH  | SA-TH | Total |                  | FA-PR |    | SA-PR |             | SLA |    |     |     |     |             |
|             |                                           |      |                   |                          |    |    |    |    |         |                   |        |       |       |                  |       |    |       |             |     |    | Max | Max | Max |             |
| 314014      | ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS | EDS  | AEC               | 1                        | -  | 2  | 1  | 4  | 2       | -                 | -      | -     | -     | -                | 50    | 20 | 25@   | 10          | 25  | 10 | 100 |     |     |             |

**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 Compare advantages and disadvantages of Entrepreneurship<br>TLO 1.2 Identify entrepreneurial traits through self-analysis<br>TLO 1.3 Compare risk associated with different type of enterprise                                                                                                                                                                                                                                        | <b>Unit - I Introduction to Entrepreneurship Development</b><br>1.1 Entrepreneurship as a career – charms, advantages, disadvantages , scope- local and global<br>1.2 Traits of successful entrepreneur: consistency, creativity, initiative, independent decision making, assertiveness, persuasion, persistence, information seeking, handling business communication, commitment to work contract, calculated risk taking, learning from failure<br>1.3 Types of enterprises and their features : manufacturing, service and trading                                                                                                                                                                                                                                                                                                                                 | Presentations<br>Lecture Using Chalk-Board |
| 2     | TLO 2.1 Explain Important factors essential for selection of product/service and selection of process<br>TLO 2.2 Suggest suitable place for setting up the specified enterprise on the basis of given data/circumstances with justification.<br>TLO 2.3 Suggest steps for the selection process of an enterprise for the specified product or service with justification.<br>TLO 2.4 Plan a market study /survey for the specified enterprise | <b>Unit - II Startup Selection Process</b><br>2.1 Product/Service selection: Process, core competence, product/service life cycle, new product/ service development process, mortality curve, creativity and innovation in product/ service modification / development<br>2.2 Process selection: Technology life cycle, forms and cost of transformation, factors affecting process selection, location for an industry, material handling.<br>2.3 Market study procedures: questionnaire design, sampling, market survey, data analysis<br>2.4 Getting information from concerned stakeholders such as Maharashtra Centre for Entrepreneurship Development[MCED], National Institute for Micro, Small and Medium Enterprises [NI-MSME], Prime Minister Employment Generation Program [PMEGP], Directorate of Industries[DI], Khadi Village Industries Commission[KVIC] | Presentations<br>Lecture Using Chalk-Board |

**ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS****Course Code : 314014**

| 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     | <p>TLO 3.1 Explain categorization of MSME on the basis of turnover and investment</p> <p>TLO 3.2 Describe support system provided by central and state government agencies</p> <p>TLO 3.3 State various schemes of government agencies for promotion of entrepreneurship</p> <p>TLO 3.4 Describe help provided by the non-governmental agencies for the specified product/service</p> <p>TLO 3.5 Compute breakeven point, ROI and ROS for the specified business enterprise, stating the assumptions made</p>                                                                                      | <p><b>Unit - III Support System for Startup</b></p> <p>3.1 Categorization of MSME, ancillary industries</p> <p>3.2 Support systems- government agencies: MCED, NI-MSME, PMEGP, DI, KVIC</p> <p>3.3 Support agencies for entrepreneurship guidance, training, registration, technical consultation, technology transfer and quality control, marketing and finance.</p> <p>3.4 Breakeven point, return on investment (ROI) and return on sales (ROS).</p>                                                                                                                                                                                                                                                                        | <p>Presentations</p> <p>Lecture Using Chalk-Board</p> |
| 4     | <p>TLO 4.1 Explain key elements for the given business plan with respect to their purpose/size</p> <p>TLO 4.2 Justify USP of the given product/ service from marketing point of view.</p> <p>TLO 4.3 Formulate business policy for the given product/service.</p> <p>TLO 4.4 Choose relevant negotiation techniques for the given product/ service with justification</p> <p>TLO 4.5 Identify risks that you may encounter for the given type of business/enterprise with justification.</p> <p>TLO 4.6 Describe role of the incubation centre and accelerators for the given product/service.</p> | <p><b>Unit - IV Managing Enterprise</b></p> <p>4.1 Techno commercial Feasibility study, feasibility report preparation and evaluation criteria</p> <p>4.2 Ownership, Capital, Budgeting, Matching entrepreneur with the project</p> <p>4.3 Unique Selling Proposition [U.S.P.]: Identification, developing a marketing plan.</p> <p>4.4 Preparing strategies of handling business: policy making, negotiation and bargaining techniques</p> <p>4.5 Risk Management: Planning for calculated risk taking, initiation with low cost projects, integrated futuristic planning, definition of startup cycle, ecosystem, angel investors, venture capitalist</p> <p>4.6 Incubation centers and accelerators : Role and procedure</p> | <p>Presentations</p> <p>Lecture Using Chalk-Board</p> |

**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 Collect information of successful entrepreneurial traits                                                                    | 1     | *Preparation of report on entrepreneurship as a career     | 2              | CO1          |
| LLO 2.1 Identify different traits as an entrepreneur from various field<br>LLO 2.2 Suggest different traits from identified problem | 2     | Case study on 'Traits of Entrepreneur'                     | 2              | CO1          |
| LLO 3.1 Explore probable risks for identified enterprise.                                                                           | 3     | *Case study on 'Risks associated with enterprise'          | 2              | CO1          |
| LLO 4.1 Identify new product for development<br>LLO 4.2 Prepare a newly developed product                                           | 4     | *Preparation of report on 'Development of new Product'     | 2              | CO1<br>CO2   |

**ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS****Course Code : 314014**

| <b>Practical / Tutorial / Laboratory Learning Outcome (LLO)</b>                                                                                                                                                                                                                                           | <b>Sr No</b> | <b>Laboratory Experiment / Practical Titles / Tutorial Titles</b>                          | <b>Number of hrs.</b> | <b>Relevant COs</b>      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------------------------------------------------------------------------------------|-----------------------|--------------------------|
| LLO 5.1 Identify Process for development of product for new startup                                                                                                                                                                                                                                       | 5            | Preparation of Report on ' Process selection ' for new startup                             | 2                     | CO1<br>CO2<br>CO3        |
| LLO 6.1 Develop questioner for market survey                                                                                                                                                                                                                                                              | 6            | *Market survey for setting up new Start up                                                 | 2                     | CO2<br>CO3               |
| LLO 7.1 Interpret the use of Technology Life Cycle                                                                                                                                                                                                                                                        | 7            | A Case study on ' Technology life cycle ' of any successful entrepreneur.                  | 2                     | CO3                      |
| LLO 8.1 Use information related to support of startups from Government and non-government agencies'<br>LLO 8.2 Prepare report for setting up startup                                                                                                                                                      | 8            | *Preparation of report on 'Information for setting up new startup' from MCED/MSME/KVIC etc | 2                     | CO3<br>CO4               |
| LLO 9.1 Compute ROI of successful enterprise.                                                                                                                                                                                                                                                             | 9            | Case study on 'Return on Investment (ROI)' of any successful startup                       | 2                     | CO3                      |
| LLO 10.1 Calculate of ROS of any successful enterprise                                                                                                                                                                                                                                                    | 10           | Case study on 'Return on sales (ROS)' of any successful startup                            | 2                     | CO3                      |
| LLO 11.1 Calculate Brake even point of any enterprise                                                                                                                                                                                                                                                     | 11           | Preparation of report on 'Brake even point calculation' of any enterprise.                 | 2                     | CO3<br>CO4               |
| LLO 12.1 Prepare feasibility report of given business                                                                                                                                                                                                                                                     | 12           | *Preparation of report on 'feasibility of any Techno-commercial business"                  | 2                     | CO4                      |
| LLO 13.1 Plan a USP of any enterprise.                                                                                                                                                                                                                                                                    | 13           | *A case study based on 'Unique selling Proposition (USP) of any successful enterprise      | 2                     | CO4                      |
| LLO 14.1 Prepare a project report using facilities of Atal Incubation center.                                                                                                                                                                                                                             | 14           | *Prepare project report for starting new startup using 'Atal incubation center (AIC)       | 2                     | CO1<br>CO2<br>CO3<br>CO4 |
| <b>Note : Out of above suggestive LLOs -</b> <ul style="list-style-type: none"> <li>• '*' Marked Practicals (LLOs) Are mandatory.</li> <li>• Minimum 80% of above list of lab experiment are to be performed.</li> <li>• Judicial mix of LLOs are to be performed to achieve desired outcomes.</li> </ul> |              |                                                                                            |                       |                          |

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

- Prepare a ' Women entrepreneurship business plan ' Choose relevant government scheme for the product/service
- Prepare a 'Pitch- desk' for your start up
- Prepare a business plan for a. Market research b. Advertisement agency c. Placement Agency d. Repair and Maintenance agency e. Tour and Travel agency
- Prepare a 'Social entrepreneurship business plan, plan for CSR funding.
- Prepare a business plan for identified projects by using entrepreneurial eco system for the same (Schemes, incentives, incubators etc.)

**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 judicious 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     | Computers with internet and printer facility | 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    | Introduction to Entrepreneurship Development | CO1         | 5              | 0        | 0        | 0        | 0           |
| 2                  | II   | Startup Selection Process                    | CO2         | 4              | 0        | 0        | 0        | 0           |
| 3                  | III  | Support System for Startup                   | CO3         | 3              | 0        | 0        | 0        | 0           |
| 4                  | IV   | Managing Enterprise                          | CO4         | 3              | 0        | 0        | 0        | 0           |
| <b>Grand Total</b> |      |                                              |             | <b>15</b>      | <b>0</b> | <b>0</b> | <b>0</b> | <b>0</b>    |

**X. ASSESSMENT METHODOLOGIES/TOOLS**

**Formative assessment (Assessment for Learning)**

**Summative Assessment (Assessment of Learning)**

- End of Term Examination - Viva-voce

**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                   | 2                                            | 2                     | 2                                     | -                      | -                                                                      | 3                       | 2                       |                                     |       |       |
| CO2                   | 2                                            | 2                     | 2                                     | 2                      | -                                                                      | 3                       | 2                       |                                     |       |       |
| CO3                   | 2                                            | 2                     | 2                                     | 2                      | -                                                                      | 3                       | 2                       |                                     |       |       |
| CO4                   | 2                                            | 2                     | 2                                     | 2                      | -                                                                      | 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     | Dr. Nishith Dubey, Aditya Vyas , Annu Soman , Anupam Singh | Un- boxing Entrepreneurship your self help guide to setup a successful business | Indira Publishing House ISBN- 2023,978-93-93577-70-2                       |
| 2     | Gujral, Raman                                              | Reading Material of Entrepreneurship Awareness Camp                             | Entrepreneurship Development Institute of India (EDI), GOI, 2016 Ahmedabad |
| 3     | Chitale, A K                                               | Product Design and Manufacturing                                                | PHI Learning, New Delhi, 2014; ISBN: 9788120348738                         |
| 4     | Charantimath, Poornima                                     | Entrepreneurship Development Small Business Entrepreneurship                    | Pearson Education India, New Delhi; ISBN: 9788131762264                    |
| 5     | Khanka, S.S.                                               | Entrepreneurship and Small Business Management                                  | S.Chand and Sons, New Delhi, ISBN: 978-93-5161-094-6                       |

**XIII. LEARNING WEBSITES & PORTALS**

| Sr.No                                                                                                                                                                                                                              | Link / Portal                                                                                                                                                                                                                                                                                                                                     | Description                                                                             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| 1                                                                                                                                                                                                                                  | <a href="http://www.mced.nic.in/allproduct.aspx">http://www.mced.nic.in/allproduct.aspx</a>                                                                                                                                                                                                                                                       | MCED Product and Plan Details                                                           |
| 2                                                                                                                                                                                                                                  | <a href="http://niesbud.nic.in/Publication.html">http://niesbud.nic.in/Publication.html</a>                                                                                                                                                                                                                                                       | The National Institute for Entrepreneurship and Small Business Development Publications |
| 3                                                                                                                                                                                                                                  | <a href="http://niesbud.nic.in/docs/1standardized.pdf">http://niesbud.nic.in/docs/1standardized.pdf</a>                                                                                                                                                                                                                                           | Courses : The National Institute for Entrepreneurship and Small Business Development    |
| 4                                                                                                                                                                                                                                  | <a href="https://www.nabard.org/content1.aspx?id=23andcatid=23andmid=530">https://www.nabard.org/content1.aspx?id=23andcatid=23andmid=530</a>                                                                                                                                                                                                     | Government Schemes                                                                      |
| 5                                                                                                                                                                                                                                  | <a href="https://www.nabard.org/Tenders.aspx?cid=501andid=24">https://www.nabard.org/Tenders.aspx?cid=501andid=24</a>                                                                                                                                                                                                                             | NABARD - Information Centre                                                             |
| 6                                                                                                                                                                                                                                  | <a href="http://www.startupindia.gov.in/pdf/file.php?title=Startup%20India%20Action%20Planandtype=Actionandq=Action%20Plan.pdfandcontent_type=Actionandsubmenupoint=action">http://www.startupindia.gov.in/pdf/file.php?title=Startup%20India%20Action%20Planandtype=Actionandq=Action%20Plan.pdfandcontent_type=Actionandsubmenupoint=action</a> | Start Up India                                                                          |
| 7                                                                                                                                                                                                                                  | <a href="http://www.ediindia.org/institute.html">http://www.ediindia.org/institute.html</a>                                                                                                                                                                                                                                                       | About - Entrepreneurship Development Institute of India (EDII)                          |
| 8                                                                                                                                                                                                                                  | <a href="http://www.nstedb.com/training/training.htm">http://www.nstedb.com/training/training.htm</a>                                                                                                                                                                                                                                             | NSTEDB - Training                                                                       |
| <b>Note :</b> <ul style="list-style-type: none"> <li>Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students</li> </ul> |                                                                                                                                                                                                                                                                                                                                                   |                                                                                         |

**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 |     |                |        |     |       |     |                  |     |     |     |             | Total Marks |     |
|-------------|---------------------------------------------|------|-------------------|--------------------------|----|----|-----------|-------|---------|-------------------|-----|----------------|--------|-----|-------|-----|------------------|-----|-----|-----|-------------|-------------|-----|
|             |                                             |      |                   | Actual Contact Hrs./Week |    |    |           |       |         | SLH               | NLH | Paper Duration | Theory |     |       |     | Based on LL & TL |     |     |     | Based on SL |             |     |
|             |                                             |      |                   | CL                       | TL | LL | Practical |       |         |                   |     |                | FA-PR  |     | SA-PR |     | SLA              |     |     |     |             |             |     |
|             |                                             |      |                   |                          |    |    | FA-TH     | SA-TH |         |                   |     |                | Total  | Max | Min   | Max | Min              | Max | Min |     |             |             |     |
|             |                                             |      |                   |                          |    |    |           |       |         |                   |     |                |        |     |       |     |                  |     |     | Max | Min         |             | Max |
| 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     | <p>TLO 1.1 State the function of electrical components in the given circuit.</p> <p>TLO 1.2 Describe the operation of the given circuit protection device.</p> <p>TLO 1.3 Describe the test procedure of the given circuit.</p> <p>TLO 1.4 Describe the impact of integrating a smart wiring harness with Flexible Data-rate Controller Area Network (CAN-FD) on modern vehicles.</p> | <p><b>Unit - I Electrical Components, Circuit Protection Devices, and Smart Wiring Systems</b></p> <p>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.</p> <p>1.2 Testing of circuit defects: Open circuit, short circuit, short to ground, voltage drop.</p> <p>1.3 Smart Wiring Harness &amp; Flexible Data-rate Controller Area Network (CAN-FD) – Evolution from traditional wiring harness to high-speed communication networks.</p> <p>1.4 Wiring diagrams: Headlight, turn indicators, Horn, Windshield wiper, Stop light.</p> | <p>Lecture Using Chalk-Board</p> <p>Video Demonstrations</p> <p>Model Demonstration</p> |
| 2     | <p>TLO 2.1 Describe working of the given type of battery.</p> <p>TLO 2.2 List the causes of battery failure based on given symptoms.</p> <p>TLO 2.3 Explain working of Computer/ ECM -controlled alternator.</p> <p>TLO 2.4 Explain working of the computer controlled charging system.</p>                                                                                           | <p><b>Unit - II Automotive Batteries and Charging System</b></p> <p>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.</p> <p>2.2 Standard procedure of battery charging.</p> <p>2.3 Battery failure: Types and causes</p> <p>2.4 Charging system: Charging system circuit, Alternator – Principle of working, Construction and working, Computer/ Electronic Control Module (ECM) controlled alternator.</p>                                                                                                                                                                                                                                                          | <p>Lecture Using Chalk-Board</p> <p>Video Demonstrations</p> <p>Model Demonstration</p> |

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

| 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 Describe working of the given cranking system aggregates.<br>TLO 3.2 State remedial measures for starting system trouble with justification.<br>TLO 3.3 Explain working of the computer-controlled ignition system. | <b>Unit - III Cranking and Ignition System</b><br>3.1 Cranking system: solenoid-operated starter circuit, components and their functions.<br>3.2 Types of starter drive: overrunning clutch and Integrated Starter Generator (ISG) system. Stop-Start System: components and working.<br>3.3 Computer-controlled cranking system.<br>3.4 Starter motor components, working principle.<br>3.5 Cranking system: Symptoms and troubleshooting.<br>3.6 Computer controlled ignition system: operation with block diagram. | Lecture Using Chalk-Board<br>Video<br>Demonstrations<br>Model<br>Demonstration             |
| 4     | TLO 4.1 Describe working of the given transducer on engine.<br>TLO 4.2 Describe testing procedure of the given transducer.<br>TLO 4.3 Describe diagnosis procedure of the given sensors using scan tool.                    | <b>Unit - IV Automotive Transducers and On Board Diagnostics (OBD) -II System</b><br>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.<br>4.2 OBD II procedure for body computer and relevant transducers: Function, diagnosis and procedure to erase fault code.                                                    | Video<br>Demonstrations<br>Demonstration<br>Site/Industry<br>Visit<br>Flipped<br>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.<br>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.<br>LLO 2.2 Troubleshoot fault in wiring harness.                                               | 2     | Troubleshooting of the faults in automobile circuit/ wiring harness. | 2              | CO1          |
| LLO 3.1 Perform battery specific gravity test.<br>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.<br>LLO 4.2 Perform battery drain test.                                                                                                                     | 4     | Battery load test and battery drain test.                            | 2              | CO2          |
| LLO 5.1 Inspect the battery visually.<br>LLO 5.2 Test the battery terminals and clamps.<br>LLO 5.3 Test the battery voltage.<br>LLO 5.4 Perform battery charging.                             | 5     | *Regular maintenance of battery.                                     | 2              | CO2          |
| LLO 6.1 Dismantle the given alternator.<br>LLO 6.2 Examine the internal components of alternator.<br>LLO 6.3 Assemble the given alternator.<br>LLO 6.4 Measure alternator drive belt tension. | 6     | *Dismantle and assemble the alternator.                              | 2              | CO2          |

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

| <b>Practical / Tutorial / Laboratory Learning Outcome (LLO)</b>                                                                                                                                                          | <b>Sr No</b> | <b>Laboratory Experiment / Practical Titles / Tutorial Titles</b>          | <b>Number of hrs.</b> | <b>Relevant COs</b> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|----------------------------------------------------------------------------|-----------------------|---------------------|
| LLO 7.1 Test the Continuity of the stator windings.<br>LLO 7.2 Test the Continuity of rotor winding.<br>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.<br>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.<br>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.<br>LLO 10.2 Identify the components of starter motor.<br>LLO 10.3 Assemble the starter motor.                                                                                | 10           | *Dismantle and assemble the starter motor.                                 | 2                     | CO3                 |
| LLO 11.1 Perform the Current Draw Test.<br>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.<br>LLO 12.2 Perform the No-Crank Test.<br>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.<br>LLO 13.2 Make use of a stroboscope for measuring ignition timing.<br>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                 |
| LLO 15.1 Make use of a diagnostic scan tool.<br>LLO 15.2 Diagnose faults in body control functions.<br>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 judicious 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 50°C 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 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                   |
| 5     | Stroboscope/ Timing gun: Ignition Advance: 0 to 45°, 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 50°C, 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;<br>Screw driver set, Pliers: Nose plier, Circlip plier, Grip plier ;<br>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           |

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

| Sr.No              | Unit | Unit Title                                                       | Aligned COs | Learning Hours | R-Level  | U-Level  | A-Level  | Total Marks |
|--------------------|------|------------------------------------------------------------------|-------------|----------------|----------|----------|----------|-------------|
| 4                  | IV   | Automotive Transducers and On Board Diagnostics (OBD) -II System | CO4         | 6              | 0        | 0        | 0        | 0           |
| <b>Grand Total</b> |      |                                                                  |             | <b>30</b>      | <b>0</b> | <b>0</b> | <b>0</b> | <b>0</b>    |

**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**

| 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: -<br>*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. Makesh Kumar | Automotive Electrical & Electronics Concepts                                             | Year: 2025, Notion Press, ISBN-13: 979-8896991731                          |

**XIII . LEARNING WEBSITES & PORTALS**

| Sr.No | Link / Portal                                                                                                               | Description                                                                              |
|-------|-----------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| 1     | <a href="https://www.youtube.com/watch?v=mEJEHxlb9o">https://www.youtube.com/watch?v=mEJEHxlb9o</a>                         | How to Use Wiring Diagrams for Car Electrical Diagnosis and Repair                       |
| 2     | <a href="https://www.youtube.com/watch?v=0ihkfUbdsk">https://www.youtube.com/watch?v=0ihkfUbdsk</a>                         | Circuit Breakers and Fuses Explanation                                                   |
| 3     | <a href="https://www.youtube.com/watch?v=wWGyUpUsZkU">https://www.youtube.com/watch?v=wWGyUpUsZkU</a>                       | What is Can bus cable, construction, application Automotive ECU to MCU wiring connection |
| 4     | <a href="https://www.youtube.com/watch?v=hObLx1XJPPM">https://www.youtube.com/watch?v=hObLx1XJPPM</a>                       | Working Principle of Lead Acid Battery                                                   |
| 5     | <a href="https://www.youtube.com/watch?v=nrxmQhbZUTc&amp;t=780s">https://www.youtube.com/watch?v=nrxmQhbZUTc&amp;t=780s</a> | The Battery Basics: Understanding Lithium-Ion, Lead-Acid Battery                         |
| 6     | <a href="https://www.youtube.com/watch?v=cxkVxi9P0EA">https://www.youtube.com/watch?v=cxkVxi9P0EA</a>                       | Battery Rating                                                                           |
| 7     | <a href="https://www.youtube.com/watch?v=v4JGYu4aaEc">https://www.youtube.com/watch?v=v4JGYu4aaEc</a>                       | Causes and Types of Battery Failure                                                      |
| 8     | <a href="https://www.youtube.com/watch?v=V7EFAvFPOhw&amp;t=25s">https://www.youtube.com/watch?v=V7EFAvFPOhw&amp;t=25s</a>   | Battery Maintenance                                                                      |
| 9     | <a href="https://www.youtube.com/watch?v=Gc1hWC3XQIO">https://www.youtube.com/watch?v=Gc1hWC3XQIO</a>                       | Hydrometer Test of Lead Acid Battery                                                     |
| 10    | <a href="https://www.youtube.com/watch?v=YrNRaPP7EKU">https://www.youtube.com/watch?v=YrNRaPP7EKU</a>                       | Battery Terminal Test                                                                    |
| 11    | <a href="https://www.youtube.com/watch?v=jdSKlg80DjU">https://www.youtube.com/watch?v=jdSKlg80DjU</a>                       | Alternator Working Principle                                                             |
| 12    | <a href="https://www.youtube.com/watch?v=EVPOI5wgZ4o">https://www.youtube.com/watch?v=EVPOI5wgZ4o</a>                       | Alternator Testing                                                                       |
| 13    | <a href="https://www.youtube.com/watch?v=INUikOnGlAE">https://www.youtube.com/watch?v=INUikOnGlAE</a>                       | PCM (Computer) Controlled Alternators                                                    |
| 14    | <a href="https://www.youtube.com/watch?v=1bK0De9XOP0">https://www.youtube.com/watch?v=1bK0De9XOP0</a>                       | Alternator Testing                                                                       |
| 15    | <a href="https://www.youtube.com/watch?v=9UKg71wa0e4">https://www.youtube.com/watch?v=9UKg71wa0e4</a>                       | Alternator Belt Tension                                                                  |
| 16    | <a href="https://www.youtube.com/watch?v=Lfvig36a3og&amp;t=20s">https://www.youtube.com/watch?v=Lfvig36a3og&amp;t=20s</a>   | SHVS mild hybrid + DUALJET                                                               |
| 17    | <a href="https://www.youtube.com/watch?v=arWoIjk6seA&amp;t=17s">https://www.youtube.com/watch?v=arWoIjk6seA&amp;t=17s</a>   | How electrical and ignition systems work                                                 |
| 18    | <a href="https://www.youtube.com/watch?v=4dPXUzYiGmQ">https://www.youtube.com/watch?v=4dPXUzYiGmQ</a>                       | Camshaft Position Sensor Explained with Animation                                        |
| 19    | <a href="https://www.youtube.com/watch?v=CpmOv83HYhQ">https://www.youtube.com/watch?v=CpmOv83HYhQ</a>                       | Throttle Position Sensor Explained with Animation                                        |
| 20    | <a href="https://www.youtube.com/watch?v=OhShoU_E-0g&amp;t=394s">https://www.youtube.com/watch?v=OhShoU_E-0g&amp;t=394s</a> | OBD2 Explained - A Simple Intro                                                          |
| 21    | <a href="https://www.youtube.com/watch?v=YGG9VLzeMk8&amp;t=11s">https://www.youtube.com/watch?v=YGG9VLzeMk8&amp;t=11s</a>   | 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 |        |       |     |       |                  |     |     |     |             |    | 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   | 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          |

**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.<br>TLO 1.2 Draw template for 2D sketch.                                                                                 | <b>Unit - I Working in 2D environment</b><br>1.1 Drawing tool: Line, Construction line, Rectangle, Polygon, Circle, Arc, Ellipse, Spline, etc.<br>1.2 Editing tool: Trim, Delete, Extend, Erase, Mirror, etc.<br>1.3 Modify tool: Chamfer, Fillet, Copy, Move, pattern etc.<br>1.4 Linear, angular dimensions. Dimensioning constraint and Geometrical constraint.<br>1.5 Drawing template: prepare drawing template consisting of Name plate boundary lines and projection symbol. | Presentations<br>Video<br>Demonstrations<br>Hands-on                        |
| 2     | TLO 2.1 Draw 3D models of given components.<br>TLO 2.2 Modify 3D models of given components<br>TLO 2.3 Draw Auxiliary planes                                         | <b>Unit - II Development of solid models</b><br>2.1 Working in 3D environment: planes, Creating 3D Solid Models of simple machine parts.<br>2.2 Part tool: Extrude, Hole, Revolve, Rib, Sweep, swept blend, Pattern, etc.<br>2.3 Part Modify tool: Chamfer, Round, Copy, Move, Draft, etc.<br>2.4 Creating parts using auxiliary plane.                                                                                                                                             | Presentations<br>Video<br>Demonstrations<br>Hands-on                        |
| 3     | TLO 3.1 Assemble given 3D components.<br>TLO 3.2 Produce exploded view of given assembly drawing.                                                                    | <b>Unit - III Computer Aided Assembly</b><br>3.1 Assembly drawing: preparation of assembly drawing by using assembly tool.<br>3.2 Relative degrees of freedom and constraints of assembly.<br>3.3 Rotational and translational motions of assembly. Constraining motions.<br>3.4 Exploded view: Explode the assembly.                                                                                                                                                               | Presentations<br>Video<br>Demonstrations<br>Hands-on<br>Site/Industry Visit |
| 4     | TLO 4.1 Generate production drawing from given assembly.<br>TLO 4.2 Prepare part list.<br>TLO 4.3 Setup printing parameters.<br>TLO 4.4 Plot Production Drawing.     | <b>Unit - IV Plotting and Drafting 3D Assembly</b><br>4.1 Generate orthographic projection of assembly Projections – Generate various views- Sectional, Auxiliary and Isometric Views.<br>4.2 Bill of Materials – Prepare part lists, Name plate on sheet.<br>4.3 Printer selection, paper size, orientation.<br>4.4 Page set up and plotting drawing.                                                                                                                              | Presentations<br>Video<br>Demonstrations<br>Hands-on                        |
| 5     | TLO 5.1 Select suitable material for printing part using 3D printer.<br>TLO 5.2 Create slices in Slicer software.<br>TLO 5.3 Print given component using 3D printer. | <b>Unit - V Additive Manufacturing</b><br>5.1 3D printing file formats<br>5.2 Selection of material<br>5.3 Printing parameter setting: temperature, wall thickness, infill percentage. Orientation etc<br>5.4 Need of Supports, types of support<br>5.5 Slicing layers using software<br>5.6 Exporting and printing                                                                                                                                                                 | Presentations<br>Video<br>Demonstrations<br>Hands-on<br>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 |
|----------------------------------------------------------|-------|------------------------------------------------------------|----------------|--------------|
|----------------------------------------------------------|-------|------------------------------------------------------------|----------------|--------------|

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

| <b>Practical / Tutorial / Laboratory Learning Outcome (LLO)</b>                   | <b>Sr No</b> | <b>Laboratory Experiment / Practical Titles / Tutorial Titles</b>                                                                                                                                                                                                                                                                                  | <b>Number of hrs.</b> | <b>Relevant COs</b>      |
|-----------------------------------------------------------------------------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------------|
| 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.<br>LLO 2.2 Plot given components.        | 2            | *Drawing and plotting two given simple 2D geometries using sketcher commands.                                                                                                                                                                                                                                                                      | 4                     | CO1<br>CO4               |
| LLO 3.1 Draw given simple 3D components.<br>LLO 3.2 Plot given components.        | 3            | Drawing and plotting the given two simple 3-D drawings using 3D modeling commands.                                                                                                                                                                                                                                                                 | 4                     | CO1<br>CO2<br>CO4        |
| LLO 4.1 Draw given complex 3D components.<br>LLO 4.2 Plot given components.       | 4            | Drawing and plotting the given two Complex 3-D drawings using 3D modeling commands.                                                                                                                                                                                                                                                                | 4                     | CO1<br>CO2<br>CO4        |
| LLO 5.1 Develop 3D model of given components.<br>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<br>CO2<br>CO4        |
| LLO 6.1 Develop 3D model of given components.<br>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<br>CO2<br>CO4        |
| LLO 7.1 Develop 3D model of given components.<br>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<br>CO2<br>CO4        |
| LLO 8.1 Develop 3D model of given components.<br>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<br>CO2<br>CO4        |
| LLO 9.1 Assemble given 3D components.<br>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<br>CO2<br>CO3<br>CO4 |
| LLO 10.1 Develop 3D model of given components.<br>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<br>CO2<br>CO4        |

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| <b>Practical / Tutorial / Laboratory Learning Outcome (LLO)</b>                                                                                                                                                                                                                                    | <b>Sr No</b> | <b>Laboratory Experiment / Practical Titles / Tutorial Titles</b>                                                                                                                                                                                                                                                                                         | <b>Number of hrs.</b> | <b>Relevant COs</b>      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------------|
| LLO 11.1 Develop 3D model of given components.<br>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<br>CO2<br>CO4        |
| LLO 12.1 Develop 3D model of given components.<br>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<br>CO2<br>CO4        |
| LLO 13.1 Develop 3D model of given components.<br>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<br>CO2<br>CO4        |
| LLO 14.1 Assemble given 3D components.<br>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<br>CO2<br>CO3<br>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                      |
| <b>Note : Out of above suggestive LLOs -</b> <ul style="list-style-type: none"> <li>*1 Marked Practicals (LLOs) Are mandatory.</li> <li>Minimum 80% of above list of lab experiment are to be performed.</li> <li>Judicial mix of LLOs are to be performed to achieve desired outcomes.</li> </ul> |              |                                                                                                                                                                                                                                                                                                                                                           |                       |                          |

## **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 judicious 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     | <a href="https://archive.nptel.ac.in/courses/112/102/112102304/">https://archive.nptel.ac.in/courses/112/102/112102304/</a> | NPTEL: Engineering graphics and design                                         |
| 2     | <a href="https://www.3ds.com/store/cad/solid-modeling">https://www.3ds.com/store/cad/solid-modeling</a>                     | Dassault systems: What is solid modeling and why is it so essential to design? |
| 3     | <a href="https://youtu.be/5DxUK-n16sg?si=BU9HGgRC3jcfaChY">https://youtu.be/5DxUK-n16sg?si=BU9HGgRC3jcfaChY</a>             | Screw Jack Assembly Design                                                     |
| 4     | <a href="https://www.youtube.com/watch?v=vjX4PDJcFOI">https://www.youtube.com/watch?v=vjX4PDJcFOI</a>                       | Solid modeling                                                                 |
| 5     | <a href="https://www.youtube.com/watch?v=JjKs-lePIPY">https://www.youtube.com/watch?v=JjKs-lePIPY</a>                       | How to Read & Create 3d Models from 2d Drawings                                |
| 6     | <a href="https://archive.nptel.ac.in/courses/112/103/112103306/">https://archive.nptel.ac.in/courses/112/103/112103306/</a> | NPTEL: Fundamentals of additive manufacturing Technologies                     |
| 7     | <a href="https://youtu.be/iM2qhc-cmV4?si=57xSDJX_yfROg4rb">https://youtu.be/iM2qhc-cmV4?si=57xSDJX_yfROg4rb</a>             | Assembly Introduction Types Catia V5.                                          |
| 8     | <a href="https://youtu.be/f94CnlQ0eq4?si=EuDF4ehMaphCH88M">https://youtu.be/f94CnlQ0eq4?si=EuDF4ehMaphCH88M</a>             | 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/<br>Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/<br>Computer Technology/<br>Computer Engineering/ Civil & Rural Engineering/ Construction Technology/<br>Computer Science & Engineering/<br>Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./<br>Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/<br>Computer Hardware & Maintenance/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/<br>Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/<br>Production Engineering/<br>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 |                |           |       |       |     |                  |     |       |     |             |     | Total Marks |     |     |
|-------------|------------------|------|-------------------|--------------------------|----|----|----|---|---------|-------------------|----------------|-----------|-------|-------|-----|------------------|-----|-------|-----|-------------|-----|-------------|-----|-----|
|             |                  |      |                   | Actual Contact Hrs./Week |    |    | SL | H |         | NL                | Paper Duration | Theory    |       |       |     | Based on LL & TL |     |       |     | Based on SL |     |             |     |     |
|             |                  |      |                   | CL                       | TL | LL |    |   |         |                   |                | Practical |       |       |     | Based on SL      |     |       |     |             |     |             |     |     |
|             |                  |      |                   |                          |    |    |    |   |         |                   |                | 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**

| <b>PROJECT ASSESSMENT</b>        |                                                              |                                                           |                                                             |                                                                  |
|----------------------------------|--------------------------------------------------------------|-----------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------------------------|
| Project Title:                   |                                                              |                                                           |                                                             |                                                                  |
| <b>Project Assessment Rubric</b> |                                                              |                                                           |                                                             |                                                                  |
| 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. |

|                                                                    | 9-10 marks.                                                                                                                  | 6-8 marks.                                                                                                 | 4-5 marks.                                                                                    | 0-3 marks                                                              |
|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| <b>Project related Requirement Analysis &amp; Designing</b>        | 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.                 |
| <b>Developing a Solution with proper justifications , Teamwork</b> | 9-10 marks.<br>Developed the critical solution modules with Innovation, optimized design and worked very well with the team. | 6-8 marks.<br>Developed some solutions with higher complexity and worked well with the team.               | 4-5 marks.<br>Attempted to develop few solutions and worked with the team.                    | 0-3 marks<br>No contribution in developing a solution and in the team. |
| <b>Project Report Writing</b>                                      | 9-10 marks.<br>Worked very well to submit an excellent project report .                                                      | 6-8 marks.<br>Worked well to submit the project report with covering all the aspects of a standard report. | 4-5 marks.<br>Tried to submit the project report but standard of report was not satisfactory. | 0-3 marks<br>No contribution in project report writing.                |
| <b>Project Presentation</b>                                        | 9-10 marks.<br>Presented the project work flawlessly.                                                                        | 6-8 marks.<br>Presented the project work very nice.                                                        | 4-5 marks.<br>Presented the project work not so well.                                         | 0-3 marks<br>Presentation skill is not up to the mark.                 |
| <b>Project Group Members</b>                                       |                                                                                                                              |                                                                                                            |                                                                                               |                                                                        |
| <b>ROLL NUMBER/Enrollment Number</b>                               |                                                                                                                              |                                                                                                            |                                                                                               |                                                                        |
| <b>NAME</b>                                                        |                                                                                                                              |                                                                                                            |                                                                                               |                                                                        |
|                                                                    |                                                                                                                              |                                                                                                            |                                                                                               |                                                                        |
|                                                                    |                                                                                                                              |                                                                                                            |                                                                                               |                                                                        |
|                                                                    |                                                                                                                              |                                                                                                            |                                                                                               |                                                                        |
|                                                                    |                                                                                                                              |                                                                                                            |                                                                                               |                                                                        |
|                                                                    |                                                                                                                              |                                                                                                            |                                                                                               |                                                                        |
|                                                                    |                                                                                                                              |                                                                                                            |                                                                                               |                                                                        |
|                                                                    |                                                                                                                              |                                                                                                            |                                                                                               |                                                                        |
| <b>Comments (if any)</b>                                           |                                                                                                                              |                                                                                                            |                                                                                               |                                                                        |

**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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| 5.     | Chapter-5 Details of designs, working and processes                        |          |
| 6.     | Chapter-6 Results and Applications                                         |          |
| 7.     | REFERENCES                                                                 |          |

## 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 fulfillment for the***Diploma Course in**< **PROGRAMME NAME** >*Of the **Maharashtra State Board of Technical Education** at our Polytechnic during the Academic Year 20 -20 .**The Project is completed by a group consisting of \_\_\_\_\_ Persons under the guidance of the Faculty Guide*

|                                                  |                                                                |                                                         |
|--------------------------------------------------|----------------------------------------------------------------|---------------------------------------------------------|
| <b>Faculty Name and Signature<br/>(Internal)</b> | <b>Faculty Name and Signature<br/>(External if applicable)</b> | <b>HOD Name and Signature with<br/>Department Stamp</b> |
| <b>Date and Time</b>                             |                                                                |                                                         |

**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 |    |    | SL | LH |         | Paper Duration    | Theory    |       |       |     | Based on LL & TL |     |       |     | Based on SL |     | Total Marks |
|             |                                   |      |                   | CL                       | TL | LL |    |    |         |                   | Practical |       |       |     | Based on SL      |     |       |     |             |     |             |
|             |                                   |      |                   |                          |    |    |    |    |         |                   | FA-TH     | SA-TH | Total |     | FA-PR            |     | SA-PR |     | SLA         |     |             |
|             |                                   |      |                   |                          |    |    |    |    |         |                   |           |       | Max   | Max | 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         |

**ALTERNATIVE FUELS FOR AUTOMOBILES****Course Code : 316348****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     | <p>TLO 1.1 Describe the current energy scenario in the India and world.</p> <p>TLO 1.2 Explain the necessity of alternative fuels for automobiles.</p> <p>TLO 1.3 Classify different types of alternative fuels based on their sources and properties.</p> <p>TLO 1.4 Identify the essential properties of alternative fuels for automotive applications.</p> <p>TLO 1.5 Compare alternative fuels with conventional fuels.</p> <p>TLO 1.6 Suggest a suitable alternative fuel for the given engine.</p> | <p><b>Unit - I Introduction to Alternative Fuels</b></p> <p>1.1 Current energy scenario in world and India.</p> <p>1.2 Necessity of the alternative fuels for an automobile.</p> <p>1.3 Types of alternative fuels.</p> <p>1.4 Essential properties of alternative fuels.</p> <p>1.5 Comparison with conventional fuels</p> <p>1.6 Alternative fuels for SI engines</p> <p>1.7 Alternative fuels for CI engines.</p> <p>1.8 Government policies and regulations.</p>                                                                                                                                                   | <p>Case Study</p> <p>Presentations</p> <p>Chalk-Board</p> <p>Cooperative Learning</p> <p>Collaborative learning</p>             |
| 2     | <p>TLO 2.1 Define various properties of the alcohol.</p> <p>TLO 2.2 Describe emulsification process of alcohol and diesel.</p> <p>TLO 2.3 Describe effect of alcohol blending with gasoline on engine performance and emission characteristics.</p> <p>TLO 2.4 Describe fuel supply system modifications required to use a ethanol as an alternative fuel.</p>                                                                                                                                           | <p><b>Unit - II Alcohols</b></p> <p>2.1 Sources of methanol and ethanol, methods of its production.</p> <p>2.2 Properties of methanol and ethanol as engine fuels.</p> <p>2.3 Use of alcohols in SI and CI engines.</p> <p>2.4 Engine performance by using blends of ethanol/methanol with gasoline.</p> <p>2.5 Emulsification of alcohol and diesel.</p> <p>2.6 Improvement/Change in emission characteristics with respect to percentage blending of alcohol with gasoline.</p> <p>2.7 Recent advances in vehicles running on alcohols related to materials, fuel supply systems, and emission reduction system.</p> | <p>Case Study</p> <p>Collaborative learning</p> <p>Cooperative Learning</p> <p>Chalk-Board</p> <p>Lecture Using Chalk-Board</p> |

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

| <b>Sr.No</b> | <b>Theory Learning Outcomes (TLO's) aligned to CO's.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Suggested Learning Pedagogies.</b>                                                                                                                      |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3            | <p>TLO 3.1 Define various properties of the biodiesel.</p> <p>TLO 3.2 List different sources of biodiesels.</p> <p>TLO 3.3 Compare various types of biodiesels on the basis of their chemical compositions.</p> <p>TLO 3.4 Describe effects of biodiesel as an alternative fuel on the engine performance.</p> <p>TLO 3.5 Describe various biodiesel production methods.</p>                                                                                                                                                                                                                                                                          | <p><b>Unit - III Biodiesels</b></p> <p>3.1 Sources of vegetable oils for engine applications.</p> <p>3.2 Materials required for Biodiesel Production.</p> <p>3.3 Methods of Biodiesel Production.</p> <p>3.4 Properties of Diesel - biodiesel blends.</p> <p>3.5 Effect of biodiesel and diesel - biodiesel blends on overall performance of an engine.</p> <p>3.6 Recent advances in vehicles running on biodiesel related to material, fuel supply and emission reduction system.</p> <p>3.7 Economics of Biodiesel Production.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <p>Case Study</p> <p>Cooperative Learning</p> <p>Collaborative learning</p> <p>Lecture Using Chalk-Board</p> <p>Presentations</p>                          |
| 4            | <p>TLO 4.1 List the properties of LPG/CNG/Biogas as a fuel for an automobile.</p> <p>TLO 4.2 Distinguish LPG and CNG on the basis of their chemical composition, fuel consumption, cost, emission etc.</p> <p>TLO 4.3 Describe effect of various properties of the CNG on engine performance.</p> <p>TLO 4.4 Draw engine performance curves for CNG operated vehicles.</p> <p>TLO 4.5 Compare the properties of LPG, CNG and Biogas.</p> <p>TLO 4.6 Prepare the list of modifications required in engine systems to use LPG/CNG/Biogas as an alternative fuel.</p> <p>TLO 4.7 Compare the engine performance using LPG, CNG and Biogas as a fuel.</p> | <p><b>Unit - IV LPG, CNG and Biogas</b></p> <p>4.1 Properties of CNG as engine fuels.</p> <p>4.2 Combustion and emission characteristics of the CNG.</p> <p>4.3 Effect of CNG on the engine performance.</p> <p>4.4 Storage, cost and safety of CNG.</p> <p>4.5 Bio CNG - production, properties and its vehicular applications.</p> <p>4.6 Properties of LPG as an engine fuel.</p> <p>4.7 Combustion and emission characteristics of the LPG.</p> <p>4.8 Effect of LPG on engine performance.</p> <p>4.9 Storage, cost and safety of LPG.</p> <p>4.10 Recent advances in vehicles running on LPG for enhancing performance, efficiency and environmental sustainability.</p> <p>4.11 Comparison of LPG, CNG and biogas on the basis of various parameters and properties.</p> <p>4.12 Introduction to Biogas plant.</p> <p>4.13 Processes during biogas generation.</p> <p>4.14 Factors affecting biogas formation.</p> <p>4.15 Effect of Biogas on vehicle performance.</p> <p>4.16 Modifications required in existing engine systems to use the biogas as a fuel.</p> | <p>Case Study</p> <p>Lecture Using Chalk-Board</p> <p>Collaborative learning</p> <p>Presentations</p> <p>Cooperative Learning</p> <p>Flipped Classroom</p> |
| 5            | <p>TLO 5.1 Enlist the properties of the hydrogen as a fuel for automobile.</p> <p>TLO 5.2 Describe various challenges associated with the hydrogen storage and transportation.</p> <p>TLO 5.3 Describe various safety precautions of the hydrogen storage.</p>                                                                                                                                                                                                                                                                                                                                                                                        | <p><b>Unit - V Hydrogen</b></p> <p>5.1 Properties of hydrogen as an alternative fuel.</p> <p>5.2 Production methods of hydrogen.</p> <p>5.3 Challenges associated with hydrogen as a fuel for IC engine and its solutions.</p> <p>5.4 Different methods of using hydrogen in SI and CI engines.</p> <p>5.5 Performance, emission and combustion characteristics of hydrogen as a fuel.</p> <p>5.6 Safety aspects of hydrogen storage.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <p>Case Study</p> <p>Cooperative Learning</p> <p>Lecture Using Chalk-Board</p> <p>Presentations</p> <p>Collaborative learning</p> <p>Flipped Classroom</p> |

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

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

| <b>Practical / Tutorial / Laboratory Learning Outcome (LLO)</b>                                                                                                                                                                                                                                                  | <b>Sr No</b> | <b>Laboratory Experiment / Practical Titles / Tutorial Titles</b>                                          | <b>Number of hrs.</b> | <b>Relevant COs</b> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|------------------------------------------------------------------------------------------------------------|-----------------------|---------------------|
| LLO 1.1 Select most suitable alternative fuels for the given applications.<br>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                 |
| LLO 2.1 Prepare the ethanol gasoline blend on the basis of volume.<br>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.<br>LLO 3.2 Conduct a performance test on a two or four wheeler engine using ethanol-gasoline blends.<br>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<br>LLO 4.2 Conduct a performance test on an engine using an alcohol-diesel emulsion.<br>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.<br>LLO 5.2 Conduct a performance test on an engine using diesel - biodiesel blends.<br>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.<br>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.<br>LLO 7.2 Measure the vehicle performance with CNG.<br>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.<br>LLO 8.2 Measure the engine performance with CNG.<br>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.<br>LLO 9.2 Draw a layout of LPG fuel supply system.                                                                                                                                                                                                      | 9            | Demonstration of LPG Kit.                                                                                  | 2                     | CO4                 |

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

| <b>Practical / Tutorial / Laboratory Learning Outcome (LLO)</b>                                                                                                                                                                                                                                           | <b>Sr No</b> | <b>Laboratory Experiment / Practical Titles / Tutorial Titles</b>                     | <b>Number of hrs.</b> | <b>Relevant COs</b> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|---------------------------------------------------------------------------------------|-----------------------|---------------------|
| LLO 10.1 Identify the various components of the CNG kit.<br>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.<br>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.<br>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.<br>LLO 13.2 Conduct a performance test on an engine using diesel blends.<br>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.<br>LLO 14.2 Draw a layout of hydrogen fuel supply system.                                                                                                                                                                        | 14           | *Demonstration of hydrogen operated vehicle.                                          | 2                     | CO5                 |
| <b>Note : Out of above suggestive LLOs -</b> <ul style="list-style-type: none"> <li>• '*' Marked Practicals (LLOs) Are mandatory.</li> <li>• Minimum 80% of above list of lab experiment are to be performed.</li> <li>• Judicial mix of LLOs are to be performed to achieve desired outcomes.</li> </ul> |              |                                                                                       |                       |                     |

**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 judicious 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          |
| <b>Grand Total</b> |      |                                   |             | <b>60</b>      | <b>14</b> | <b>32</b> | <b>24</b> | <b>70</b>   |

**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     | <a href="https://www.youtube.com/watch?v=VnGH2EScMDE">https://www.youtube.com/watch?v=VnGH2EScMDE</a> | IC engine fuels - types, requirement and characteristics, Alternative Fuels                    |
| 2     | <a href="https://www.youtube.com/watch?v=iSfI_OtSKxs">https://www.youtube.com/watch?v=iSfI_OtSKxs</a> | Alternate Fuels and Sustainable Transportation                                                 |
| 3     | <a href="https://www.youtube.com/watch?v=k6JH0Jl7rx8">https://www.youtube.com/watch?v=k6JH0Jl7rx8</a> | Bio-based Fuels                                                                                |
| 4     | <a href="https://www.youtube.com/watch?v=5pL_3hKar2U">https://www.youtube.com/watch?v=5pL_3hKar2U</a> | Effects of ethanol/gasoline fuel blends on nitrogen oxides emissions in spark-ignition engines |
| 5     | <a href="https://www.youtube.com/watch?v=rldwVGmmy4">https://www.youtube.com/watch?v=rldwVGmmy4</a>   | Transesterification of Vegetable Oil and Alcohol to Produce Ethyl Esters (Biodiesel)           |
| 6     | <a href="https://www.youtube.com/watch?v=8gpF8s915Gc">https://www.youtube.com/watch?v=8gpF8s915Gc</a> | How CNG Fuel System Works?                                                                     |
| 7     | <a href="https://www.youtube.com/watch?v=GdW2DtMQgJA">https://www.youtube.com/watch?v=GdW2DtMQgJA</a> | How does a Diesel LPG engine work?                                                             |

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

| <b>Sr.No</b>                                                                                                                                                                                                                       | <b>Link / Portal</b>                                                                                  | <b>Description</b>                                                                                    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| 8                                                                                                                                                                                                                                  | <a href="https://www.youtube.com/watch?v=3bhMTDSPP7E">https://www.youtube.com/watch?v=3bhMTDSPP7E</a> | Upgrading Biogas for its application as a fuel for I C engine                                         |
| 9                                                                                                                                                                                                                                  | <a href="https://www.youtube.com/watch?v=SRt1KOP9a2g">https://www.youtube.com/watch?v=SRt1KOP9a2g</a> | How Does A Hydrogen Car Work   Future Technology                                                      |
| 10                                                                                                                                                                                                                                 | <a href="https://www.youtube.com/watch?v=shhrBXwEmTw">https://www.youtube.com/watch?v=shhrBXwEmTw</a> | How Does A Hydrogen Car Work   Future Technology Part 1                                               |
| 11                                                                                                                                                                                                                                 | <a href="https://www.youtube.com/watch?v=nPsbolmB6Qo">https://www.youtube.com/watch?v=nPsbolmB6Qo</a> | <a href="https://www.youtube.com/watch?v=shhrBXwEmTw">https://www.youtube.com/watch?v=shhrBXwEmTw</a> |
| <b>Note :</b> <ul style="list-style-type: none"> <li>Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students</li> </ul> |                                                                                                       |                                                                                                       |

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

**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 | Paper Duration | Assessment Scheme |       |       |     |                  |     |       |     |             |     | Total Marks |
|-------------|-----------------------------|------|-------------------|--------------------------|----|----|-----|-----|---------|----------------|-------------------|-------|-------|-----|------------------|-----|-------|-----|-------------|-----|-------------|
|             |                             |      |                   | Actual Contact Hrs./Week |    |    | SLH | NLH |         |                | Theory            |       |       |     | Based on LL & TL |     |       |     | Based on SL |     |             |
|             |                             |      |                   | CL                       | TL | LL |     |     |         |                |                   |       |       |     | Practical        |     |       |     |             |     |             |
|             |                             |      |                   |                          |    |    |     |     |         |                | 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     | <p>TLO 1.1 Explain the vapour compression refrigeration cycle and its key components</p> <p>TLO 1.2 Distinguish between controlled and uncontrolled ventilation systems on the basis of given parameters</p> <p>TLO 1.3 Explain the effects of air movement, wind chill factor, odor problems, and humidity on human comfort.</p> <p>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.</p> <p>TLO 1.5 Describe handling and disposal of refrigerant in automobile safely</p>                                                                                                                                                                                                                                                                                                                                                          | <p><b>Unit - I Overview of HVAC System</b></p> <p>1.1 Vapour compression refrigeration cycle and Basic components</p> <p>1.2 Uncontrolled and controlled ventilation</p> <p>1.3 Human comfort factors: comfort zone, air movement, wind chill factor, odor problems and effects of humidity.</p> <p>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</p> <p>1.5 Environmental and safety aspects in heating, ventilation and air conditioning systems.</p>                                                                                                                                                                                                                                                            | <p>Lecture Using Chalk-Board</p> <p>Presentations</p> <p>Demonstration</p> <p>Video</p> <p>Demonstrations</p>                                   |
| 2     | <p>TLO 2.1 Explain the operational flow of air and refrigerant within the system.</p> <p>TLO 2.2 Explain the function and operation of the given component of air conditioning system</p> <p>TLO 2.3 Differentiate between reciprocating, scroll, and rotary vane compressors in terms of design, application, and performance.</p> <p>TLO 2.4 Explain the properties of refrigerants used in automotive AC systems</p> <p>TLO 2.5 List different refrigerants used in AC system</p> <p>TLO 2.6 Explain the operation of the electromagnetic clutch in controlling compressor engagement.</p> <p>TLO 2.7 Explain with sketch the construction and working of the given type of metering device of vehicle air conditioning system.</p> <p>TLO 2.8 Explain the throttling action, modulating action, and controlling action in an automotive air conditioning system.</p> <p>TLO 2.9 Explain the working of automotive heating systems in given situation</p> | <p><b>Unit - II AC System Components</b></p> <p>2.1 General layout of automotive air conditioning system , constructional details.</p> <p>2.2 Types of AC Systems: AC system with thermostatic expansion valve with components evaporator, compressor, condenser, receiver drier, thermostatic expansion valve &amp; its type (internally equalized, externally equalized).</p> <p>2.3 Throttling action, modulating action and controlling action, remote bulb.</p> <p>2.4 AC system with orifice tube with components evaporator, accumulator, compressor, condenser, fixed orifice Tube.</p> <p>2.5 Types of compressor - Scroll compressor, rotary vane compressors.</p> <p>2.6 Construction and working of electromagnetic clutch.</p> <p>2.7 Drive systems for compressor for IC engine &amp; electric vehicle.</p> <p>2.8 Types of automobile refrigerants, properties.</p> | <p>Lecture Using Chalk-Board</p> <p>Model</p> <p>Demonstration</p> <p>Presentations</p> <p>Video</p> <p>Demonstrations</p> <p>Demonstration</p> |

**AUTOMOBILE AIR CONDITIONING****Course Code : 316349**

| <b>Sr.No</b> | <b>Theory Learning Outcomes (TLO's) aligned to CO's.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Suggested Learning Pedagogies.</b>                                                                                      |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| 3            | <p>TLO 3.1 Explain the functions of the air intake section, core section, and distribution section in an automotive air conditioning system.</p> <p>TLO 3.2 Explain the purpose and operation of air filters and air blowers in AC systems.</p> <p>TLO 3.3 Select case and duct system for the given seating capacity of vehicle with justification.</p> <p>TLO 3.4 Explain with sketch the construction and working of the given type of duct.</p> <p>TLO 3.5 Explain the components and operation of a rear cooling system for given Vehicle.</p>                                                                                                             | <p><b>Unit - III Case and Duct System</b></p> <p>3.1 Air intake section, core section, and distribution section</p> <p>3.2 Air filter and air blower in A.C. system</p> <p>3.3 Downstream, upstream, split and hybrid case &amp; duct systems, case &amp; duct System in electric vehicle.</p> <p>3.4 Construction and working of rear cooling system</p> <p>3.5 Air Conditioning system in electric vehicle &amp; hybrid Vehicles</p> <p>3.6 Heating system: Construction working and functions of I.C, engine vehicle and electric vehicle</p>                                                                                                                                                                                                                      | <p>Lecture Using Chalk-Board</p> <p>Video</p> <p>Demonstrations</p> <p>Presentations</p> <p>Demonstration</p>              |
| 4            | <p>TLO 4.1 Explain the components and operation of vacuum control systems and electronic temperature control systems.</p> <p>TLO 4.2 Explain the function and operation of given vacuum operated device.</p> <p>TLO 4.3 Explain the function and operation of given switch used in automotive air conditioning systems.</p> <p>TLO 4.4 State the purpose and location of given sensor used in automotive air conditioning systems.</p> <p>TLO 4.5 Explain the function and operation of given AC control devices used in automotive air conditioning systems.</p> <p>TLO 4.6 Compare manual climate control systems and electronic climate control systems.</p> | <p><b>Unit - IV Vehicle Climate Control Systems</b></p> <p>4.1 System controls – Vacuum control system and electronic temperature control system.</p> <p>4.2 Vacuum operated devices i.e. vacuum reserve tank, vacuum restrictor, vacuum motor, check valve and check relays.</p> <p>4.3 Switches - High-Side temperature switch, low-side temperature switch, high-pressure switch, low- pressure switch, pressure regulator and superheat switch.</p> <p>4.4 Sensors- Sunload sensor, outside temperature sensor and in-car temperature sensor.</p> <p>4.5 A.C. Control devices: aspirator, blower motor speed control, heater control, and time delay relay for heater control.</p> <p>4.6 Manual climate control system and automatic climate control system.</p> | <p>Lecture Using Chalk-Board</p> <p>Model</p> <p>Demonstration</p> <p>Presentations</p> <p>Video</p> <p>Demonstrations</p> |

**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.                                                                                      |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| 5     | <p>TLO 5.1 List potential faults of AC systems using visual and acoustic methods.</p> <p>TLO 5.2 Write the operating procedure of manifold gauge to measure low-side and high-side pressures in an air conditioning system.</p> <p>TLO 5.3 Describe the procedure to perform a temperature test.</p> <p>TLO 5.4 Explain different leak detection tests and their applications.</p> <p>TLO 5.5 Describe the procedure to check hoses and connectors of an air conditioning system.</p> <p>TLO 5.6 Write the procedure of evacuation and charging procedures for refrigerant charging.</p> <p>TLO 5.7 List common symptoms and faults in an air conditioning system, compressor, electromagnetic clutch and heating system.</p> | <p><b>Unit - V HVAC System Diagnostic and Repair Procedures</b></p> <p>5.1 Inspection of A.C. System: Visual and acoustic, sight glass.</p> <p>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, Nitrogen leak tester.</p> <p>5.3 Leak test and Temperature test, Evacuation, Charging of refrigerant and Moisture removal.</p> <p>5.4 Proper use and safety precautions when working with hoses and connectors.</p> <p>5.5 Symptoms, Faults, Causes and Remedies in compressor and electromagnetic clutch.</p> <p>5.6 Maintenance of the heating system in IC engine vehicle and electric vehicle: Fault diagnosis, remedial action.</p> | <p>Lecture Using Chalk-Board</p> <p>Site/Industry Visit</p> <p>Video</p> <p>Demonstrations</p> <p>Presentations</p> |

**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 different processes used in vapour compression cycle Draw the vapour compression cycle P-V and H-S diagram, compressor, 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<br>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<br>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.<br>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.<br>LLO 5.2 Clean and inspect the compressor components for wear and damage<br>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<br>LLO 6.2 Draw various components of the case & duct system in ic vehicle/electric vehicle                                      | 6     | Types of Case Duct system                                                                                | 2              | CO3          |

**AUTOMOBILE AIR CONDITIONING****Course Code : 316349**

| <b>Practical / Tutorial / Laboratory Learning Outcome (LLO)</b>                                                                                                                                                                                                                                           | <b>Sr No</b> | <b>Laboratory Experiment / Practical Titles / Tutorial Titles</b> | <b>Number of hrs.</b> | <b>Relevant COs</b> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------------------------------------------------------------|-----------------------|---------------------|
| LLO 7.1 Identify the different types of air blowers and air filters used in HVAC systems.<br>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<br>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<br>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.<br>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                 |
| LLO 11.1 Prepare the vehicle's AC system for temperature testing by ensuring it is properly charged with the appropriate refrigerant<br>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<br>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.<br>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.<br>LLO 14.2 Carry out repairing of faulty heating system components, ensuring compliance with manufacturer specifications.                                                                  | 14           | Troubleshoot of heating system                                    | 2                     | CO5                 |
| <b>Note : Out of above suggestive LLOs -</b> <ul style="list-style-type: none"> <li>• '*' Marked Practicals (LLOs) Are mandatory.</li> <li>• Minimum 80% of above list of lab experiment are to be performed.</li> <li>• Judicial mix of LLOs are to be performed to achieve desired outcomes.</li> </ul> |              |                                                                   |                       |                     |

**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 judicious 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 Gauge (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          |

**AUTOMOBILE AIR CONDITIONING****Course Code : 316349**

| Sr.No              | Unit | Unit Title                                   | Aligned COs | Learning Hours | R-Level   | U-Level   | A-Level   | Total Marks |
|--------------------|------|----------------------------------------------|-------------|----------------|-----------|-----------|-----------|-------------|
| 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          |
| <b>Grand Total</b> |      |                                              |             | <b>60</b>      | <b>14</b> | <b>26</b> | <b>30</b> | <b>70</b>   |

**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, 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  |

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| Sr.No | Author            | Title                              | Publisher with ISBN Number                        |
|-------|-------------------|------------------------------------|---------------------------------------------------|
| 6     | Arora; Domkundwar | Refrigeration and Air-Conditioning | Dhanpatrai & Son's, New Delhi ISBN: 9780000229663 |

**XIII . LEARNING WEBSITES & PORTALS**

| Sr.No | Link / Portal                                                                                                                                             | Description                                      |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| 1     | <a href="https://www.youtube.com/watch?v=nHZEAc08sE8">https://www.youtube.com/watch?v=nHZEAc08sE8</a>                                                     | Understanding working of HVAC system.            |
| 2     | <a href="https://www.youtube.com/watch?v=I5rrZSu4PxQ">https://www.youtube.com/watch?v=I5rrZSu4PxQ</a>                                                     | Understanding the working of Car AC              |
| 3     | <a href="https://www.youtube.com/watch?v=Pdq8JA1ct6s">https://www.youtube.com/watch?v=Pdq8JA1ct6s</a>                                                     | Procedure to Recharge refrigerant in AC System   |
| 4     | <a href="https://www.youtube.com/watch?v=F5w3lR88fqQ">https://www.youtube.com/watch?v=F5w3lR88fqQ</a>                                                     | Procedure to evacuate refrigerant from AC System |
| 5     | <a href="https://www.2carpros.com/articles/re-charge-an-air-conditioner-system">https://www.2carpros.com/articles/re-charge-an-air-conditioner-system</a> | Evacuation and charging of A.C. System           |
| 6     | <a href="https://www.youtube.com/watch?v=Yyf30wStUE4">https://www.youtube.com/watch?v=Yyf30wStUE4</a>                                                     | Leak Detection in A.C. System                    |
| 7     | <a href="https://www.youtube.com/watch?v=WncHNLdU4EA">https://www.youtube.com/watch?v=WncHNLdU4EA</a>                                                     | Trouble diagnosis of A.C. System                 |
| 8     | <a href="https://www.youtube.com/watch?v=FzbM0YoUZgo">https://www.youtube.com/watch?v=FzbM0YoUZgo</a>                                                     | Cleaning air conditioner evaporator              |
| 9     | <a href="https://www.youtube.com/watch?v=rulXlnG2Unk">https://www.youtube.com/watch?v=rulXlnG2Unk</a> for Servicing of Compressor in car                  | Servicing of Compressor in car                   |
| 10    | <a href="https://www.youtube.com/watch?v=UW1GDioa0kE">https://www.youtube.com/watch?v=UW1GDioa0kE</a>                                                     | 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

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

**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 | Paper Duration | Assessment Scheme |           |       |       |     |                  |     |       |     |             | Total Marks |     |
|-------------|--------------|------|-------------------|--------------------------|----|----|----|---|---------|----------------|-------------------|-----------|-------|-------|-----|------------------|-----|-------|-----|-------------|-------------|-----|
|             |              |      |                   | Actual Contact Hrs./Week |    |    | SL | H |         |                | NLH               | Theory    |       |       |     | Based on LL & TL |     |       |     | Based on SL |             |     |
|             |              |      |                   | CL                       | TL | LL |    |   |         |                |                   | Practical |       |       |     |                  |     |       |     |             |             |     |
|             |              |      |                   |                          |    |    |    |   |         |                |                   | FA-TH     | SA-TH | Total |     | FA-PR            |     | SA-PR |     | SLA         |             |     |
|             |              |      |                   |                          |    |    |    |   |         |                |                   |           |       | Max   | Max | 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     | <p>TLO 1.1 State the importance of digital electronics in automotive applications.</p> <p>TLO 1.2 Explain the relationship between Voltage, current, resistance and power using Ohm's Law.</p> <p>TLO 1.3 Solve simple circuit problems involving series and parallel configurations.</p> <p>TLO 1.4 List the types of diodes used in automotive applications.</p> <p>TLO 1.5 Describe the purpose of given instrumentation system in Automotive application.</p> | <p><b>Unit - I Automotive Digital Electronics &amp; Instrumentations</b></p> <p>1.1 Introduction to Automotive Electronics.</p> <p>1.2 Overview of Electrical Principles: Voltage, current, resistance, and power. Ohm's Law and basic circuit analysis (Series and Parallel Circuits.)</p> <p>1.3 Application of Zener Diode, Photo diode and LED in Automobiles.</p> <p>1.4 Binary number system.</p> <p>1.5 Instrumentation - Digital Cockpit, Heads Up Display.</p> | <p>Lecture Using Chalk-Board</p> <p>Video Demonstrations</p> <p>Site/Industry Visit</p> |

| 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     | <p>TLO 2.1 Explain the function of computer Electronic Control Module (ECM) using block diagram.</p> <p>TLO 2.2 Select the relevant type of computer memory (s) used in automobiles with justification.</p> <p>TLO 2.3 Compare open loop and closed loop control system in automotive application on basis of given parameters.</p> <p>TLO 2.4 Explain multiplexing improves communication in modern vehicle systems.</p> <p>TLO 2.5 Describe the working of a given network system used in vehicle communication.</p> <p>TLO 2.6 Explain Controller Area Network (CAN) Bus is preferred over Local Interconnect Network (LIN) Bus in critical automotive applications.</p> | <p><b>Unit - II Automotive Computer Networks</b></p> <p>2.1 Computer Electronic Control Module (ECM): Processor, Control unit, Clock, Input/Output devices</p> <p>2.2 Computer Memory: - Types:- RAM,ROM,PROM,EPROM,EEPROM,KAM</p> <p>2.3 Control Theory: Open Loop and Closed loop system in automotive application.</p> <p>2.4 Multiplexing: - Principle of multiplexing.</p> <p>2.5 Vehicle Network System: - The principle of Controller Area Network (CAN) Bus, Local Interconnect Network (LIN) Bus.</p> | <p>Lecture Using Chalk-Board</p> <p>Video Demonstrations</p> <p>Site/Industry Visit</p> |
| 3     | <p>TLO 3.1 Describe with sketch the construction of the given automotive sensors.</p> <p>TLO 3.2 Analyze the output signals of given automotive sensors.</p> <p>TLO 3.3 Describe with sketch the construction of the given automotive actuators.</p> <p>TLO 3.4 Examine the input signals of given automotive actuators.</p>                                                                                                                                                                                                                                                                                                                                                | <p><b>Unit - III Automotive Sensors and Actuators</b></p> <p>3.1 Automotive Sensors: -Construction and working of Accelerator pedal position sensor, Speed sensor – Cam shaft, Crank shaft, wheel speed. Knock sensor, Lambda sensor.</p> <p>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.</p>                      | <p>Lecture Using Chalk-Board</p> <p>Video Demonstrations</p> <p>Site/Industry Visit</p> |

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| 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     | <p>TLO 4.1 Describe working of given power train control systems with block diagram.</p> <p>TLO 4.2 Illustrate the given motion control system functions with the help of a block diagram.</p> <p>TLO 4.3 Inspect the components of safety control systems.</p> <p>TLO 4.4 Explain necessity of given safety/motion control system with justification.</p>                           | <p><b>Unit - IV Automotive Control Systems</b></p> <p>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.</p> <p>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,</p> <p>4.3 Safety systems: Automatic emergency braking. Lane departure warning, Blind spot monitoring</p> | <p>Lecture Using Chalk-Board</p> <p>Video</p> <p>Demonstrations</p> <p>Site/Industry Visit</p> |
| 5     | <p>TLO 5.1 Describe with flow chart the six-step approach in testing given component.</p> <p>TLO 5.2 Illustrate the diagnostic procedure of given electronic control systems.</p> <p>TLO 5.3 Recommend procedure of stand-alone diagnosis of the given electronic components.</p> <p>TLO 5.4 Measure signals of given sensors and actuators using suitable measuring instrument.</p> | <p><b>Unit - V Diagnostic Techniques in Automotive Systems</b></p> <p>5.1 The "Six step" approach of component testing.</p> <p>5.2 On board diagnostic (OBD-II) procedure of Turbo Stratified Injection (TSI) system.</p> <p>5.3 Emission Related Diagnosis: - Oxygen Sensor, Air mass flow sensor, Throttle position sensor, MAP Sensor, Coolant Temperature Sensor.</p> <p>5.4 Measuring Instruments:- Digital multi-meters, Scan tool.</p>                                                                                                                                                                        | <p>Lecture Using Chalk-Board</p> <p>Video</p> <p>Demonstrations</p> <p>Site/Industry Visit</p> |

**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.<br>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<br>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          |
| LLO 4.1 Measure the oxygen sensor feedback and other relevant engine parameters to evaluate the system's performance.<br>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          |

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| <b>Practical / Tutorial / Laboratory Learning Outcome (LLO)</b>                                                                                                                                                                                                                                                                            | <b>Sr No</b> | <b>Laboratory Experiment / Practical Titles / Tutorial Titles</b>                  | <b>Number of hrs.</b> | <b>Relevant COs</b> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|------------------------------------------------------------------------------------|-----------------------|---------------------|
| LLO 5.1 Capture the waveform output from the Accelerator pedal position sensor using an oscilloscope.<br>LLO 5.2 Interpret the waveform to identify any irregularities, such as noise, flatlines, or unexpected voltage levels.<br>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.<br>LLO 6.2 Verify the measured resistance values of CKP with the manufacturer's specifications to detect possible sensor failure.<br>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.<br>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.<br>LLO 8.2 Measure the Voltage or Resistance of the Idle Speed Actuator.<br>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.<br>LLO 9.2 Measure the Voltage or Resistance of the EGR Actuator.<br>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.<br>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<br>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                 |
| LLO 12.1 Interpret the DTCs to identify faults related to Lane Departure Warning.<br>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.<br>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                 |

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| Practical / Tutorial / Laboratory Learning Outcome (LLO)                                                                                                                                                                                                                                          | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles           | Number of hrs. | Relevant COs |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----------------------------------------------------------------------|----------------|--------------|
| LLO 14.1 Connect the OBD-II scan tool to the CRDI engine and ensure communication with the ECU<br>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          |
| <b>Note : Out of above suggestive LLOs -</b> <ul style="list-style-type: none"> <li>* Marked Practicals (LLOs) Are mandatory.</li> <li>Minimum 80% of above list of lab experiment are to be performed.</li> <li>Judicial mix of LLOs are to be performed to achieve desired outcomes.</li> </ul> |       |                                                                      |                |              |

## 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     | 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 50°C 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 $\Omega$ to 200 M $\Omega$ ; 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 $\Omega$ ; 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 50°C, 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          |
| <b>Grand Total</b> |      |                                                   |             | <b>60</b>      | <b>14</b> | <b>22</b> | <b>34</b> | <b>70</b>   |

**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 |

**AUTOTRONICS****Course Code : 316350**

| Sr.No | Author            | Title                                                                               | Publisher with ISBN Number                                                |
|-------|-------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| 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                                                                                                                                                                                                                                  | <a href="https://www.youtube.com/watch?v=Fljk_j6VUHE">https://www.youtube.com/watch?v=Fljk_j6VUHE</a>                                                                                         | Introduction to the course; Current and Voltage; Kirchhoff's Current and Voltage laws |
| 2                                                                                                                                                                                                                                  | <a href="https://www.youtube.com/watch?v=RogF0ohkMJ4&amp;list=PLdD-IdNhF9PE7kpHawAmk1Z8p9XLBbEU-">https://www.youtube.com/watch?v=RogF0ohkMJ4&amp;list=PLdD-IdNhF9PE7kpHawAmk1Z8p9XLBbEU-</a> | Vehicle Network System                                                                |
| 3                                                                                                                                                                                                                                  | <a href="https://www.youtube.com/watch?v=ceIykzivaw4">https://www.youtube.com/watch?v=ceIykzivaw4</a>                                                                                         | Automotive Sensors & Actuators.                                                       |
| 4                                                                                                                                                                                                                                  | <a href="https://www.youtube.com/watch?v=R5YfLySWQAc">https://www.youtube.com/watch?v=R5YfLySWQAc</a>                                                                                         | Automotive Sensors & Actuators.                                                       |
| 5                                                                                                                                                                                                                                  | <a href="https://www.youtube.com/watch?v=RR8LsMBwL2I">https://www.youtube.com/watch?v=RR8LsMBwL2I</a>                                                                                         | OBD-II                                                                                |
| 6                                                                                                                                                                                                                                  | <a href="https://www.youtube.com/watch?v=KzF8ieiJ9UY">https://www.youtube.com/watch?v=KzF8ieiJ9UY</a>                                                                                         | Power train control system                                                            |
| 7                                                                                                                                                                                                                                  | <a href="https://www.youtube.com/watch?v=DaLmofF5iWU">https://www.youtube.com/watch?v=DaLmofF5iWU</a>                                                                                         | malfunction affecting engine performance during starting and idling.                  |
| 8                                                                                                                                                                                                                                  | <a href="https://www.youtube.com/watch?v=PEBeRtuA6CE">https://www.youtube.com/watch?v=PEBeRtuA6CE</a>                                                                                         | Heads-up Display                                                                      |
| <b>Note :</b> <ul style="list-style-type: none"> <li>Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students</li> </ul> |                                                                                                                                                                                               |                                                                                       |

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