**1.Rationale:** The course will enable the students to learn the principles, concepts and application of

| Programme | Automobile Engineering | Semester | III |
|---|---|---|---|
| Course Code | 20AT33P | Type of Course | Programme Core |
| Course Name | Thermal Engineering and Engine Testing | Contact Hours | 8 hours/week 104 hours/semester |
| Teaching Scheme | L:T:P :: 3:1:4 | Credits | 6 |
| CIE Marks | 60 | SEE Marks | 40 |

thermodynamic laws and air standard cycles which is needed to look after an IC engine. The operating behavior of an IC engine on test bed is the common purpose to learn various parameters like fuel consumption, various powers and efficiency. This course enables us to run internal combustion engines under realistic conditions and examine new combustion processes under part and full load conditions and various rotation speeds.

## 2. Course Outcomes/Skill Sets: At the end of the course the student will be able to:

| CO-01 | Explain the concept of thermodynamics and demonstrate its application through simple experiments. |
|---|---|
| CO-02 | Test lubrication and cooling systems and service or troubleshoot it for any problems identified. |
| CO-03 | Draw, label and compare SI and CI engines in terms of their operations, efficiency, fuel, speed, pressure and knocking. |
| CO-04 | Explain abnormal combustion process and demonstrate with experiments both how it occurs and its prevention for a given engine. |
| CO-05 | Conduct an engine performance test, draw its performance characteristics and measure friction power, air / fuel ratio and efficiencies. |

## 3. Course Content

| Week | CO | PO | Lecture (Knowledge Criteria) | Tutorial (Activity Criteria) | Practice (Performance Criteria) |
|---|---|---|---|---|---|
| | | | 3 hours/week | 1 hour/week | 4 hours/week (2 hours/batch twice in a week) |
| 1 | 1 | 1,2,3 | 1. **Fundamentals of thermodynamic** - System, surroundings, intensive and extensive property. 2. Laws of thermodynamics- Zeroth, First and Second law. 3. Gas Laws – Boyle's law - Charles's Law - Avogadro's law - Joule's law. | Refer Table 1 | 1.Illustration of system and surrounding using simple experiments/ Virtual simulations, Video demonstration & documentation. 2. Illustrate the principles of the laws of thermodynamics using simple experiments/ Virtual simulations, Video |

| | | | | | demonstration & documentation. |
|---|---|---|---|---|---|
| 2 | 1 | 1,2,3 | 1.Relationship between the two specific heats- characteristic gas constant R. Adiabatic index Y. <br> 2. Definition of enthalpy and entropy. <br> 3. **Introduction to thermodynamic processes** - PVT relations -work done, heat transfer, change in internal energy, change in enthalpy and entropy for constant volume and constant pressure process. | Problems on thermodynamic processes. | 1. Case study on enthalpy and entropy. <br> 2. Simple experiments on work and heat, Video demonstration & documentation. |
| 3 | 1 | 1,2,3 | 1. PVT relations -work done, heat transfer, change in internal energy, change in enthalpy and entropy for isothermal process. <br> 2. PVT relations -work done, heat transfer, change in internal energy, change in enthalpy and entropy for isentropic process. <br> 3. Air standard cycles. Types, assumptions made in air standard cycles. <br> Note: No derivations are needed. | Refer Table 1 | 1.Virtual exposure on thermodynamic processes. <br> **or** <br> Drawing of PV diagrams of process and cycles using software and find various parameters. <br> 2. Virtual exposure on thermodynamic processes/ Drawing of PV diagrams of process using software and find various parameters. |
| 4 | 1 | 1,2,3 | 1. Explanation of PV and T-S diagrams of Carnot cycle. <br> 2. Explanation of PV and T-S diagrams of Otto cycle. <br> 3. Explanation of PV and T-S diagrams of Diesel cycle. <br> Note: No derivations are needed. | Problems on Air standard cycles. | 1.Virtual exposure on the otto Cycle **or** Drawing of PV diagrams of cycles(otto) using any software and find various parameters. <br> 2.Virtual exposure on the Diesel Cycle <br> **or** |

| | | | | | Drawing of PV diagrams of cycles (Diesel) using any software and find various parameters. |
|---|---|---|---|---|---|
| 5 | 2 | 1,2,4 | 1.**Lubrication System**: Need-Types-Layout of pump feed system.<br>2. Oil Pump-Types- Gear pump- Rotor type- Vane type.<br>3. Oil filter- need- Types- Construction and working of cartridge type oil filter. | Refer Table 1 | 1. Find the Oil level and replace the engine oil and oil filter and Quality checking<br>2. Servicing of oil pumps and filters<br>**Note:** Prepare the trouble shooting chart. |
| 6 | 2 | 1,2,4 | 1.**Cooling System**: Need- types- Comparison- Layout of pump circulation system.<br><br>2. Construction and working of Water pump- radiator<br><br>3. Thermostat - Need-Types- Construction & Working of Wax type | Refer Table 1 | 1. Servicing of cooling system.<br>2. Servicing of water pump and radiator.<br>**Note:** Prepare the trouble shooting chart. |
| 7 | 3,4 | 1,2,4 | 1. **Combustion in engines** – Stages of combustion in SI engines and Diesel engines.<br>2. SI engine detonation & pre-ignition- process- effects<br>3. Controlling methods of SI engine detonation & pre-ignition. | Refer Table 1 | 1.Case study on detonation and preignition for SI engine and write a report on the study conducted.<br>2.Using engine scanner, identify the knocking in SI engine. |
| 8 | 3,4 | 1,2,4 | 1. CI engine detonation<br>2. Knocking- process- effects.<br>3. Controlling methods of CI engine detonation. | Refer Table 1 | 1.Case study on detonation and preignition for CI engine and write a report on the study conducted.<br>2.Using engine scanner, identify the knocking in CI engine. |
| 9 | 3,5 | 1,2,4 | 1.**Engine performance**-determination of IP- BP - MEP- | Refer Table 1 | 1. Determine the Compression pressure |

| | | | | | |
|---|---|---|---|---|---|
| | | | IMEP-BMEP- Engine Torque - piston speed.<br>2.Friction power- types of measuring friction power.<br>3. A/F ratio- Requirement of A/F ratio for different operating conditions of engine. | | and vacuum pressure of multi cylinder engine<br>2.To determine A/F Ratio on the four-stroke diesel engine. |
| 10 | 3,5 | 1,2,4 | 1. Volumetric efficiency. Methods for increasing volumetric efficiency.<br>2. Simple problems on IP, BP, IMEP, BEMP.<br>3. Simple problems on FP, A/F ratio and Volumetric efficiency. | Refer Table 1 | 1. To determine volumetric Efficiency on the four-stroke diesel engine.<br>2. To determine volumetric Efficiency on the four-stroke diesel engine. |
| 11 | 5 | 1,2,4,7 | 1. Determination of IP of a multicylinder engine using Morse test.<br>2. TFC-SFC- BSFC- ISFC-Importance.<br>3. Simple problems. | Study the latest technological changes in this course in this course and present the impact of these changes on industry. | 1. Conduct the experiment to determine indicated power of multicylinder engine using Morse test.<br>2. Conduct the experiment to determine indicated power of multicylinder engine using Morse test. |
| 12 | 3,5 | 1,2,4,7 | 1. Efficiency-Mechanical efficiency -Thermal efficiency- indicated thermal efficiency- brake thermal efficiency.<br>2. Methods to improve thermal efficiency of engine.<br>3. Simple problems. | Study the latest technological changes in this course in this course and present the impact of these changes on industry. | 1. Conduct experiment to determine the different efficiencies of two stroke SI engine at Constant load and constant speed condition<br>2. Conduct experiment to determine the different efficiencies of four stroke SI engine at Constant load and constant speed condition. |
| 13 | 3,5 | 1,2,4,7 | 1. Performance characteristics V/s Engine speed. | Study the latest technological changes in this | 1. Conduct experiment to determine the |

| | | 2. SI engine-Heat balance sheet. Performance Curves. Study of engine behavior using performance curves. 3. CI engine-Heat balance sheet and performance curves. Study of engine behavior using performance curves. | course in this course and present the impact of these changes on industry. | performance of four stroke SI engine at constant load and constant speed condition. Compute heat balance sheet for SI engine 2. Conduct experiment to determine the performance of four stroke CI engine at constant load and constant speed condition. Compute heat balance sheet for CI engine. |
|---|---|---|---|---|
| **Total in hours** | | 39 | 13 | 52 |

**\* PO= Program Outcome as listed and defined in year 1 curriculum and PO – CO mapping with strength (Low/Medium/High) has to be mapped by the course Co-Ordinator. (Above only suggestive).**

**TABLE 1: Suggestive Activities for Tutorials**: (The List is only shared as an Example and not inclusive of all possible activities of the course. Student and Faculty are encouraged to choose activities that are relevant to the topic and on the availability of such resources at their institution).

| Sl. No. | Suggested Activity |
|---|---|
| 1 | Prepare and submit a report on applications of Laws of Thermodynamics in automobile engines as an assignment. |
| 2 | Collect information regarding maximizing volumetric efficiency of an IC engine by referring to one of the journal papers and present the details collected. |
| 3 | Collect/download information from the internet regarding how different efficiencies affect the engine performance and prepare a report as an assignment. |
| 4 | Collect/download information and present the techniques used to reduce frictional power to improve engine performance. |
| 5 | Visit nearby KSRTC workshop/depot and collect information regarding abnormal combustion/detonation or knock and prepare a report and submit as an assignment. |
| 6 | Visit nearby car service centre/showroom and make a note of fault codes detected using engine onboard diagnostic tools and submit a report on procedure used for diagnosing the fault codes. |

## 4. CIE and SEE Assessment Methodologies

| Sl. No | Assessment | Test Week | Duration In minutes | Max marks | Conversion |
|---|---|---|---|---|---|
| 1. | CIE-1 Written Test | 5 | 80 | 30 | Average of three tests 30 |
| 2. | CIE-2Written Test | 9 | 80 | 30 | |
| 3 | CIE-3Written Test | 13 | 80 | 30 | |
| 4. | CIE-4 Skill Test-Practice | 6 | 180 | 100 | |

| 5 | CIE-5 Skill Test-Practice | 12 | 180 | 100 | Average of two skill tests 20 |
| 6 | CIE-6 Portfolio continuous evaluation of Activity through Rubrics | 1-13 | | 10 | 10 |
| | | | Total CIE Marks | | 60 |
| | Semester End Examination (Practice) | | 180 | 100 | 40 |
| | | | | Total Marks | **100** |

## 5. a) Format for CIE written Test

| Course Name | **Thermal Engineering and Engine Testing** | Test | I/II/III | Sem | III/IV |
|---|---|---|---|---|---|
| Course Code | **20AT33P** | Duration | 80 Min | Marks | 30 |

**Note:** Answer any one full question from each section. Each full question carries 10 marks.

| Section | | Assessment Questions | Cognitive Levels | Course Outcome | Marks |
|---|---|---|---|---|---|
| I | 1 | | | | |
| | 2 | | | | |
| II | 3 | | | | |
| | 4 | | | | |
| III | 5 | | | | |
| | 6 | | | | |

Note for the Course coordinator: Each question may have one, two or three subdivisions. Optional questions in each section carry the same weightage of marks, Cognitive level and course outcomes.

## 5. b) CIE Skill Test-I Scheme of Evaluation

| SL. No. | CO | Particulars/Dimension | Marks |
|---|---|---|---|
| 1 | 1 | Question on Concepts of Thermodynamics /Processes<br><br>a) PV diagram or cycle<br>**b)** Illustration of the stated law or any one cycle | 30 |
| 2 | 2 | One skill-oriented question on "lubrication system" for the given case.<br><br>a) Fault detection - 10 m<br>b) Troubleshooting/ Servicing - 20 m | 30 |
| 3 | 2 | One skill-oriented question on "cooling system" for the given case.<br><br>a) Fault detection - 10 m<br>b) Troubleshooting/ Servicing - 20 m | 30 |
| 4 | 1,2 | Portfolio evaluation on practical sessions (1-6 week) | 10 |
| | | **Total Marks** | **100** |

## 5. C) CIE Skill Test-II Scheme of Evaluation

| SL. No. | CO | Particulars/Dimension | | Marks |
|---|---|---|---|---|
| 1 | 3,4 | One skill-oriented question on "combustion process, measure and prevent abnormal combustion" for the given case.<br><br>c) Analyse the situation based on given case.<br>d) Measure the parameters | - 10 m<br>– 30 m | 40 |
| 2 | 3,5 | One skill-oriented question on "performance characteristics of an internal combustion engines, efficiency etc." for the given case.<br><br>c) Tabular Column to note down the parameters<br>d) Formulas adopted<br>e) Conduction of experiment<br>f) Calculation & Result | - 05 m<br>-05 m<br>-20 m<br>-20 m | 50 |
| 3 | 3,4,5 | Portfolio evaluation on practical sessions (7-12 week) | | 10 |
| | | **Total Marks** | | **100** |

## 6. Rubrics for Assessment of Activity (Qualitative Assessment)

| Sl. No. | Dimension | Beginner | Intermediate | Good | Advanced | Expert | Students Score |
|---|---|---|---|---|---|---|---|
| | | 2 | 4 | 6 | 8 | 10 | |
| 1 | | Descriptor | Descriptor | Descriptor | Descriptor | Descriptor | 8 |
| 2 | | Descriptor | Descriptor | Descriptor | Descriptor | Descriptor | 6 |
| 3 | | Descriptor | Descriptor | Descriptor | Descriptor | Descriptor | 2 |
| 4 | | Descriptor | Descriptor | Descriptor | Descriptor | Descriptor | 2 |
| | | | | | Average Marks= (8+6+2+2)/4=4.5 | | **5** |

*Note:* Dimension and Descriptor shall be defined by the respective course coordinator as per the activities

## 7. Reference:

| Sl. No. | Description |
|---|---|
| 1 | Thermal Engineering by R.S. Khurmi (S Chand & Co) |
| 2 | I C Engines by Mathur &Sharma (Danapat Rai & sons) |
| 3 | Thermal Engineering by R K Hegde and Niranjan Murthy (Sapna Publications) |
| 4 | Internal Combustion Engines by N Ganeshan (Tata MCgraw-Hill) |
| 5 | Thermal Engineering by Kodanda Ramanna |
| 6 | Automobile Engineering by Kirpal Singh (Vol 1 and II) |
| 7 | Basic and Applied thermodynamics by P.K. Nag (Tata MCgraw-Hill) |

## 8. SEE Scheme of Evaluation

| SL. No. | CO | Particulars/Dimension | Marks |
|---|---|---|---|
| | | | |

| | | One skill-oriented question on "lubrication/cooling system" for the given case. | | |
|---|---|---|---|---|
| 1 | 1,2,3,4 | a) Fault detection      - 10 m <br> b) Troubleshooting/ Servicing      - 20 m <br><br> OR <br><br> One skill-oriented question on "combustion process, measure and prevent abnormal combustion" for the given case. <br><br> a) Analyse the situation based on given case.      - 10 m <br> **b)** Measure the parameters      - 20 m | | 30 |
| 2 | 3,5 | One skill-oriented question on "performance characteristics of an internal combustion engines, efficiency etc." for the given case. <br><br> g) Tabular Column to note down the parameters      - 05 m <br> h) Formulas adopted      -05 m <br> i) Conduction of experiment      -20 m <br> j) Calculation & Result      -10 m | | 40 |
| 3 | 1,2,3,4,5 | Portfolio evaluation on practical sessions (1-13 week) | | 10 |
| 4 | 1,2,3,4,5 | Viva-voce | | 20 |
| | | | **Total Marks** | **100** |

**NOTE: Use same format of evaluation for CIE skill test. Portfolio evaluation of practical session should be considered from "Week 1-6" for 1st CIE and "Week 7-12" for 2nd CIE each 10 marks.**

## 9. Equipment/software list with Specification for a batch of 20 students

| Sl. No. | Particulars | Specification | Quantity |
|---|---|---|---|
| 1 | Electronically controlled multi cylinder 4 stroke petrol engine in working condition | | 1 |
| 2 | Multi-cylinder petrol engine with electric dynamometer test rig, suitable to determine the performance parameters, morse test and heat balance sheet. | | 1 |
| 3 | 4-stroke multicylinder Diesel engine with hydraulic dynamometer test rig suitable to determine the performance parameters, morse test and heat balance sheet. | | 1 |
| 4 | Single cylinder Diesel engine with Dynamometer test rig. | | 1 |
| 5 | Single cylinder 4 stroke Petrol engine with Dynamometer test rig | | 1 |
| 6 | Computerized Diesel / petrol engine test rig | | 1 |
| 7 | Engine scanner | | 1 |
| 8 | Onboard diagnostic tools like OBD2 scanner. | | 1 |