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|------------------------------|----------------------------|
| <b>Branch Name:</b>          | Mechanical Engineering     |
| <b>Program Code:</b>         | ET402                      |
| <b>Course Title:</b>         | <b>Thermal Engineering</b> |
| <b>Course Code:</b>          | 2ET4020501                 |
| <b>Pre-requisite Course:</b> | -                          |

**Course Objectives:**

1. Analyze performance of ICEs by operating them and observing changes in thermodynamic properties during each stroke of ICEs
2. List characteristics and properties of alternate fuels used for ICEs.
3. Analyze the performance of Vapor Compression Refrigeration System (VCRS), by operating them and observing the changes in properties of refrigerant during each process on VCRS
4. Explain working of various air-conditioning equipments and aids including ducts and fans
5. Carryout maintenance task by using suitable tools and equipment

**TEACHING AND EVALUATION SCHEME:**

| Teaching Scheme (Hours per week) |          |           |        | Evaluation Scheme (Marks) |                       |                       |                       |
|----------------------------------|----------|-----------|--------|---------------------------|-----------------------|-----------------------|-----------------------|
| Lecture                          | Tutorial | Practical | Credit | Theory                    |                       | Practical             |                       |
|                                  |          |           |        | University Assessment     | Continuous Assessment | University Assessment | Continuous assessment |
| 3                                | --       | 2         | 4      | 60                        | 40                    | 20                    | 30                    |

**DETAILS OF COURSE CONTENTS:**

| SR. NO. | TOPIC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Total Hrs. | WEIGHTAGE in marks |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------------------|
| Unit-1  | <b>Internal Combustion Engines</b><br>1.1 IC Engine-concept (comparison with External Combustion engine- EC), classification, working principle and terminology used.<br>1.2 Main components of IC engine and their functions.<br>1.3 Petrol engines (Spark Ignition- SI) & diesel engines (Compression Ignition-CI)-two strokes and four strokes both:<br>1.3.1 Working principles.<br>1.3.2 Cycles on P-V and T-s diagram.<br>1.3.3 Elements-sketch, working and functions.<br>1.3.4 Various systems- cooling, fuel injection (includes carburetion, fuel pump, fuel injectors, Multi Point Fuel Injection (MPFI), etc.), ignition, governing (quality, quantity and hit and miss governing), exhaust, etc. | 11         | 28                 |

|         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |    |    |
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|         | <p>1.3.5 Comparison between SI &amp; CI Engines.</p> <p>1.3.6 Theoretical and actual valve timing diagrams.</p> <p>1.4 MPFI- need and working.</p> <p>1.5 Concept of scavenging and turbocharger.</p> <p>1.6 Concept of Common Rail Direct Injection System- (CRDI) for diesel engine.</p> <p>1.7 Performance testing of IC engines and its heat balance sheet (Simple numerical examples) with familiarization with testing as per BIS.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |    |    |
| Unit- 2 | <p><b>Alternatives fuels:</b></p> <p>2.1 Alternate Fuel Types, properties, compositions, advantages, disadvantages and implementation issues- includes mainly Compressed Natural Gas (CNG), Liquefied Petroleum Gas (LPG) and Biodiesel. Effect of these fuels from pollution point of view.</p> <p>2.2 Supply system requirement for CNG and LPG as alternate fuel in vehicle.</p> <p>2.3 Conversion devices/ kits for SI Engines- vaporizer/ PRV for fuel compatibility, piping and allied needs.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 02 | 04 |
| Unit 3  | <p><b>Refrigeration</b></p> <p>3.1 Introduction to refrigeration.</p> <p>3.2 Reversed Carnot cycle &amp; Bell column cycle. (Nonnumerical)</p> <p>3.3 Unit of refrigeration &amp; basic terminology.</p> <p>3.4 Vapor compression refrigeration cycle (VCRS), working with the help of P-V, T-s &amp; P-h diagrams.</p> <p>3.5 VCRS components, types, their construction, working, applications, (components include compressor- Reciprocating, Rotary, Screw and scroll; condensers- Air cooled and water cooled; evaporators- Dx type, flooded, shell and tube type; expansion devices -Automatic, thermostatic expansion valve and capillary tube, Highside float valve).</p> <p>3.6 Performance of VCRS based on coefficient of performance (COP), simple numerical.</p> <p>3.7 Effect of change in operating conditions (condenser pressure, evaporator pressure, sub cooling, superheating) on performance of VCRS &amp; its representation on P-h diagram (with suitable numerical examples).</p> <p>3.8 Application of VCRS: Ice Plant, cold storage, water cooler, domestic refrigerator, deep freeze- block diagram, components, working.</p> <p>3.9 Basic concept of Vapor absorption refrigeration system.</p> <p>3.10 Refrigerant classification, Desirable</p> | 10 | 20 |



|        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |    |    |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|
|        | properties of refrigerants, and properties & applications of commonly used refrigerants including R22, R134a, Hydro Carbon-HC and R717 (Ammonia), need of new refrigerants.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |    |    |
| Unit 4 | <b>Air-Conditioning</b><br>4.1 Introduction to air conditioning. Air conditioning- types and its applications.<br>4.2 Psychrometry- properties of air.<br>4.3 Representation of psychrometry properties on chart (simple numerical using chart).<br>4.4 Various air conditioning processes on psychrometric charts.<br>4.5 Dessert cooler, window and split air conditioners- components and working.<br>4.6 Ducts- need, types with applications, constructional materials, and installation, common troubles with their remedies.<br>4.7 Air conditioning fans- types, constructional features, applications and common troubles with their remedies. | 05 | 08 |

#### LIST OF PRACTICAL:

| S. No. | Unit No. | Practical Exercises<br>(outcomes in Psychomotor Domain)                                                                                                                                                                                                                                                                                                                                                                                    | Approx. Hours. required |
|--------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| 1      | ALL      | <b>Preparatory Activity:</b><br>a. Student will recall and write basic thermodynamic units.<br>b. Teacher will demonstrate working of I.C. Engine.<br>i) Demonstrate and explain working and function of I.C. Engine.<br>ii) Demonstrate working of two stroke and four stroke engine.                                                                                                                                                     | 02                      |
| 2      | I        | <b>Demonstration of IC engine parts:</b><br>a. Demonstrate and explain dismantling, assembling, working and inspection of fuel pump, fuel injector, carburetor and multipoint fuel injection system.<br>b. Sketch and explain working of fuel pump, fuel injector, carburetor and multipoint fuel injection system.<br>c. List dismantling and assembling methods/ steps in logical sequence.<br>d. Record observations during inspection. | 04                      |
| 3      | I        | <b>Valve timing diagram:</b><br>a. Write specifications of IC engine undertaken for valve timing diagram.                                                                                                                                                                                                                                                                                                                                  | 02                      |



|   |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |    |
|---|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
|   |     | <ul style="list-style-type: none"> <li>b. Perform and record angles and strokes.</li> <li>c. Prepare valve timing diagram.</li> <li>b. Interpret valve timing diagram.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |    |
| 4 | I   | <b>Perform test and prepare heat balance sheet of IC Engine. (Petrol and Diesel-both separately);</b> <ul style="list-style-type: none"> <li>a. Write specifications of IC engine undertaken for test.</li> <li>b. Demonstrate and perform test on IC engine.</li> <li>c. Observe and record test parameters.</li> <li>d. Derive required parameters- Indicated Power (IP), Break Power (BP), fuel consumption for varying load, efficiency, etc.</li> <li>e. Observe and record parameters required for heat balance sheet (For full load conditions).</li> <li>f. Prepare heat balance sheet.</li> <li>g. Interpret test results and heat balance sheet.</li> </ul>                                                                       | 04 |
| 5 | III | <b>Refrigeration tubing operations:</b> <ul style="list-style-type: none"> <li>a. Demonstrate VCRS on any car/Bus from tubing point of view.</li> <li>b. Demonstrate various tubing tools and tubing operations.</li> <li>c. Perform various tubing operations.</li> <li>d. Sketch and explain VCRS demonstrated on any vehicle.</li> <li>e. Sketch and explain various tools used for refrigeration tubing.</li> <li>f. Describe tubing operations with neat sketches. Also state applications of each.</li> </ul>                                                                                                                                                                                                                         | 02 |
| 6 | III | <b>Leak detection, evacuation and refilling of the refrigerant:</b> <ul style="list-style-type: none"> <li>a. Demonstrate leak detection, evacuation and refilling of refrigerant.</li> <li>b. Demonstrate working of equipment / tools / instruments / devices used to demonstrate leak detection, evacuation and refilling of refrigerant.</li> <li>c. Explain various leak detection techniques.</li> <li>d. Sketch and explain working of equipment / tools / instruments / devices used to demonstrate leak detection, evacuation and refilling of refrigerant.</li> <li>e. List and explain the steps followed to perform leak detection, evacuation and refilling of refrigerant.</li> <li>f. Conclude your observations.</li> </ul> | 04 |
| 7 | III | <b>COP of VCRS:</b> <ul style="list-style-type: none"> <li>a. Sketch block diagram of VCRS.</li> <li>b. Write specifications of each component of VCRS taken for performance. (Of compressor, condenser, expansion device and evaporator).</li> <li>d. Perform, observe and record the parameters required to determine refrigeration effect (RE), work done (WD), mass flow rate and COP.</li> </ul>                                                                                                                                                                                                                                                                                                                                       | 02 |



|                    |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |    |
|--------------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
|                    |     | e. Determination RE, WD, mass flow rate and COP.<br>f. Plot the actual VCRS cycle on P-h chart and T-s diagram.<br>g. Interpret the performance.                                                                                                                                                                                                                                                                                                                                                 |    |
| 8                  | III | <b>Determination of properties of air:</b><br>a. List and define various properties of air.<br>b. List, sketch, demonstrate and explain working of various psychometric instruments.<br>c. Perform, observe and record the properties.<br>d. Calculate properties (Teacher will assign) of air from the readings taken.<br>e. Given the data (Teacher will assign the data for four To five processes.), plot the processes on psychometric chart.                                               | 02 |
| 9                  | III | <b>Determination of capacity of window / split air-conditioner.</b><br>a. Sketch block diagram of setup.<br>b. Perform, observe and record the parameters required to determine the capacity.<br>c. Determine the capacity.<br>d. Thumb rules to estimate the capacity.                                                                                                                                                                                                                          | 02 |
| 10                 | IV  | <b>Industrial visit: (ANY TWO)</b><br>1. Visit cold storage plant, ice plant and air-conditioning plant to observe VCRS, different kinds of ducting.<br>2. Visit any Industry working on I C Engine manufacturing/ running or power plant working on<br><b>I C Engine. (D.G. Power Plant.)</b><br>3. Visit any petrol/ diesel/ CNG/ LPG station and study different fuel filling systems along with different parameters affected.<br>4. Student will visit and prepare industrial visit report. | 04 |
| <b>Total Hours</b> |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 28 |

#### LIST OF REFERENCES:

| Sr. No. | Title of Books                            | Author                   | Publication                 |
|---------|-------------------------------------------|--------------------------|-----------------------------|
| 01      | Heat Engines.                             | Pandya and Shah.         | Charotar Publishing House.  |
| 02      | Thermodynamics and Heat power Engineering | Mathur and Mehta.        | Tata Mcgraw- Hill.          |
| 03      | Heat Engines.                             | D. A. Wrangham.          | Cambridge University Press. |
| 04      | Thermal Engineering.                      | R K Rajput.              | Laxmi. Publications         |
| 05      | A Text book of Thermal Engineering.       | R S Khurmi & J.K. Gupta. | S Chand & Co.               |
| 06      | I C Engine                                | Domkundwar               |                             |
| 07      | I C Engine                                | Mathur and Sharma.       | Dhanpat Rai Pub.            |

|    |                                                   |                    |                          |
|----|---------------------------------------------------|--------------------|--------------------------|
| 08 | Principles of Refrigeration                       | Dossat             | Pearson Education        |
| 09 | Refrigeration and Air conditioning                | Arora & Domkundwar | Khanna publication       |
| 10 | A Text Book of Air Refrigeration and Conditioning | R S Khurmi         | Eurasia Publishing House |
| 11 | Thermal engineering                               | P.L. Ballaney      | Khanna Publication       |
| 12 | Thermal Science and Engineering                   | Dr. D.S. Kumar     | S.K. Kataria& Sons.      |
| 13 | Refrigeration & Air Conditioning.                 | R. K. Rajput       | S.K. Kataria & Sons.     |

**Course Learning Outcomes (CLO):** On completion of this course, the students will be able to:

| CLO  | Description                                                                                                                            | Bloom's Taxonomy Level                     |
|------|----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|
| CLO1 | Learn about internal combustions engines and its types with various systems                                                            | 1 Remembering<br>2 Understanding           |
| CLO2 | Analyze performance of ICEs by operating them and observing changes in thermodynamic properties during each stroke of ICEs             | 2 Understand,<br>3 Applying,<br>4 Analyze, |
| CLO3 | Identify and know the characteristics & properties of alternate fuels used for IC Engines                                              | 2 Understanding<br>3 Applying              |
| CLO4 | Analyze the performance of VCERS by operating them and observing the changes in properties of refrigerant during each process on VCERS | 3 Applying,<br>2 Understanding             |
| CLO5 | Explain working of various air-conditioning equipments and aids including ducts and fans                                               | 2 Understanding<br>3 Applying              |
| CLO6 | Carryout maintenance task by using suitable tools and equipment                                                                        | 3 Applying,<br>2 Understanding             |

| Course Learning Outcomes | Program Outcomes(Pos) |     |     |     |     |     |     |     |     |      |      |      | Program Specific Outcomes(PSOs) |      |      |
|--------------------------|-----------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|---------------------------------|------|------|
|                          | PO1                   | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1                            | PSO2 | PSO3 |
| CLO1                     | M                     |     |     |     |     |     | L   |     |     |      |      |      | L                               |      |      |
| CLO2                     | L                     | M   | L   |     |     |     | L   |     |     |      |      |      | H                               | L    | L    |
| CLO3                     | L                     |     |     |     |     |     | L   |     |     |      |      |      | M                               | L    |      |
| CLO4                     | M                     |     | L   | L   |     |     |     |     |     |      |      |      | M                               | L    |      |
| CLO5                     | L                     | M   | L   |     |     | L   |     |     |     |      |      |      | L                               |      |      |
| CLO6                     | M                     |     |     |     |     |     |     |     |     |      |      |      | M                               |      | L    |