# SCHEME OF COURSE WORK (R- 2020)

**Course Details:**

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| **Course Title** | **Thermodynamics** | | |
| **Course Code** | **22ME1104** | **L T P C** | **: 3 0 0 3** |
| **Program:** | **B Tech** | | |
| **Branch:** | **Mechanical Engineering** | | |
| **Semester** | **III** | | |

**Course Outcomes (COs):** At the end of the course, the student will be able to

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| CO-1 | describe thermodynamic systems, properties and apply first law of thermodynamics to non-flow and flow processes |
| CO-2 | apply second law of thermodynamics and Carnot's principle to analyze the performance of heat engine, refrigerator and heat pump |
| CO-3 | determine the entropy changes in different applications to analyze the reversibility or irreversibility of a process |
| CO-4 | determine change in thermodynamic properties in a process using steam tables and Mollier chart |
| CO-5 | explain the importance of Maxwell and T-ds equations and analyze the performance of different air standard cycles |

**Program Outcomes (POs):** A graduate of mechanical engineering will be able to

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| PO-1 | Apply the knowledge of mathematics, science, engineering fundamentals to solve complex mechanical engineering problems. |
| PO-2 | Attain the capability to identify, formulate and analyse problems related to mechanical engineering. |
| PO-3 | Design solutions for mechanical system components and processes that meet the specified needs with appropriate consideration for public health and safety. |
| PO-4 | Perform analysis, conduct experiments and interpret data by using research methods such as design of experiments to synthesize the information and to provide valid conclusions.. |
| PO-5 | Select and apply appropriate techniques from the available resources and current mechanical engineering and software tools. |
| PO-6 | Carry out their professional practice in mechanical engineering by appropriately considering and weighing the issues related to society. |
| PO-7 | Understand the impact of the professional engineering solutions on environmental safety and legal issues. |
| PO-8 | Transform into responsible citizens by resorting to professional ethics and norms of the engineering practice. |
| PO-9 | Function effectively in individual capacity as well as a member in diverse teams and in multidisciplinary streams. |
| PO10 | Communicate fluently with the engineering community and society, and will be able to prepare reports and make presentations effectively. |
| PO11 | Apply knowledge of the engineering and management principles to managing projects and finance in multidisciplinary environments. |
| PO12 | Engage themselves in independent and life-long learning to continuing professional practice in their specialized areas of mechanical engineering. |

**Course Outcome** versus **Program Outcomes:**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
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| **CO-1** | 3 | 3 | | | | | | | | | | |
| **CO-2** | 3 | 3 | 3 | | | | 1 | | | | | |
| **CO-3** | 3 | 3 | 3 | | | | | | | | | |

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| **CO-4** | 3 | 3 | | | | | | | | | | |
| **CO-5** | 3 | 3 | 2 | | | | | | | | | |

*1: Slight (Low), 2: Moderate (Medium, 3:* Strong (High)

## Program Specific Objectives (PSOs):

The student must attain the knowledge and skills to

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| **PSO-1** | Design, analyse and optimize mechanical systems along with control mechanisms |
| **PSO-2** | Manufacture mechanical components by selecting effective processing methods and efficient tools |
| **PSO-3** | Design, analyse and evaluate thermal systems |

**Course Outcome** versus **Program Specific Outcomes:**

| **COs** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|
| **CO-1** | | | 3 |
| **CO-2** | | | 3 |
| **CO-3** | | | 3 |
| **CO-4** | | | 3 |
| **CO-5** | | | 3 |

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| **Assessment Methods:** | Assignment (10M)/ Quiz(10M) / Mid-Test(20M) / End Exam(70M) |

## Teaching-Learning and Evaluation

| **Week** | **CONTENTS** | **Course Outcomes** | **Sample questions** | **TEACHING-LEARNING STRATEGY** | **Assessment Method & Schedule** |
|---|---|---|---|---|---|
| **1** | **Unit - I**<br>Basic Concepts – Macroscopic and microscopic viewpoints, thermodynamic system and control volume – closed, open and isolated systems – intensive and extensive properties - | CO1 | Explain quasi static process | Lecture<br>Problem solving | Assignment-1<br>Quiz-1<br>Mid-1 |
| **2** | **Unit - I**<br>quasi-static process, point and path function, forms of energy, ideal gas and real gas, zeroth law of thermodynamics – measurement of temperature. | CO1 | Explain construction and working principle constant volume gas thermometer | Lecture | Assignment-1<br>Quiz-1<br>Mid-1 |
| **3** | **Unit - I**<br>First law of Thermodynamics: Joule's experiment – first law of thermodynamics, corollaries-perpetual motion machine of first | CO1 | Explain joule's experiment with neat sketch | Lecture<br>Problem solving | Assignment-1<br>Quiz-1<br>Mid-1 |
| | kind, first law applied to non-flow | | | | |

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| 4 | **Unit - I**<br>first law applied to flow processes- limitations of first law of thermodynamics - Problems | CO1 | Derive steady flow energy equation | Lecture<br>Problem solving | Assignment-1<br>Quiz-1<br>Mid-1 |
| 5 | **Unit - II**<br>Second Law of Thermodynamics: Distinction between heat and work – cyclic heat engine – energy reservoirs – Kelvin-Planck statement of second law | CO2 | Problem on any one of the device | Lecture<br>Problem solving | Assignment-1<br>Quiz-1<br>Mid-1 |
| 6 | **Unit - II**<br>Clausius statement of second law – refrigerator and heat pump – equivalence of Kelvin-Planck and Clausius statements –<br>perpetual motion machines of second kind – | CO2 | Explain equivalence between Kelvin Planck and Clausius statements | Lecture<br>Problem solving | Assignment-1<br>Quiz-1<br>Mid-1 |
| 7 | **Unit - II** reversibility and irreversibility Carnot cycle – Carnot theorem – Carnot efficiency. | CO2 | Show that $(COP)_{HP} = (COP)_{R} + 1$ | Lecture<br>Problem solving | Assignment-1<br>Quiz-1<br>Mid-1 |
| 8 | **Unit - III**<br>Entropy: Clausius theorem - the property of entropy | CO3 | Explain Clausius inequality | Lecture<br>Problem solving | Assignment-2<br>Quiz-2<br>Mid-2 |
| 9 | **Mid Test - I** | | | | **Mid Test - I** |
| 10 | **Unit - III**<br>The inequality of Clausius – entropy change in an irreversible process – entropy principle – applications of entropy principle | CO3 | Establish inequality of Clausius<br>List out the reasons for irreversibility<br>Prove that adiabatic mixing of two fluids is irreversible | Lecture<br>Problem solving | Assignment-2<br>Quiz-2<br>Mid-2 |
| 11 | **Unit - III**<br>Maximum work obtainable from a finite body and a thermal energy reservoir – entropy transfer with heat flow - entropy generation in a closed and open systems. Definition of available energy, exergy and irreversibility -Problems | CO3 | Define entropy generation, exergy and anergy<br>Explain that entropy transfer with heat flow | | Assignment-2<br>Quiz-2<br>Mid-2 |
| 12 | **Unit - IV**<br>Properties of Pure Substances: Pure Substances – P-V-T surfaces – p-v , T-s and h-s diagram, Mollier chart – dryness fraction | CO4 | Explain P-V-T surface of pure substance | Lecture<br>Problem solving | Assignment-2<br>Quiz-2<br>Mid-2 |
| 13 | **Unit - IV**<br>property tables – analysis of steam undergoing various thermodynamic processes using Mollier chart – dryness fraction measurement. | CO4 | Explain separating throttling calorimeter with neat sketch | Lecture<br>Problem solving | Assignment-2<br>Quiz-2<br>Mid-2 |
| 14 | **Unit - V**<br>Thermodynamic Relations: Maxwell equations, T-ds equations, difference in heat capacities, ratio of heat capacities, energy equation, Joule-Thompson coefficient,<br>Clausius-Clapeyron equation. | CO5 | Derive Maxwell’s and TdS equations | Lecture<br>Problem solving | Assignment-2<br>Quiz-2<br>Mid-2 |
| 15 | **Unit - V**<br>Air Standard Cycle – Otto Cycle, Diesel Cycle: P-V and *T-s* diagrams - description and efficiencies | CO5 | Explain the working of Otto/Diesel/ cycle with help of P-V and T-S diagrams | Lecture | Assignment-2<br>Quiz-2<br>Mid-2 |

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| **16** | **Unit - V**<br>Air Standard Cycle – Dual Cycle: P-V and *T-s* diagrams - description and efficiencies mean effective pressures. Comparison of Otto, Diesel and dual cycles | CO5 | Explain the working of dual cycle with help of P-V and T-S diagrams | Lecture<br>Problem solving | Assignment-2<br>Quiz-2<br>Mid-2 |
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| **17** | **Unit - V**<br>Problems on Air Standard Cycle | CO5 | An ideal Otto cycle has a compression ratio of 8. At the beginning of the compression process, air is at 95 kPa and 27°C, and 750 kJ/kg of heat is transferred to air during the constant-volume heat-addition process.<br>determine<br>(a) the pressure and temperature at the end of the heat addition process, (b) the network output, (c) the thermal efficiency, and (d) the mean effective pressure for the cycle. | | Assignment-2<br>Quiz-2<br>Mid-2 |
| **18** | **Mid Test - II** | | | | **Mid Test - II** |
| **19/20** | **END EXAM** | | | | **END EXAM** |