Gyanmanjari Innovative University

Syllabus
Gyanmanjari Institute of Technology
Semester- 3 (B.Tech.)

Subject: Engineering Thermodynamics - BET2ME13305

Type of course: Professional Core

Prerequisite: Basic Mathematics, Physics, Chemistry

Rationale:

This course provides fundamental knowledge of thermodynamics and its engineering applications. It enables students to understand energy interactions, thermodynamic laws, and processes in closed and open systems. The course develops the ability to analyze thermodynamic cycles, entropy, exergy, and refrigeration systems. It also introduces basic combustion calculations essential for thermal and energy engineering applications

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks		Total Marks
CI	T	P	C	SEE	CCE	
4	0	2	5	100	50	150

Legends: CI-Class Room Instructions; T – Tutorial; P - Practical; C – Credit; SEE - Semester End Evaluation; CCE-Continuous and Comprehensive Evaluation.

Course Content:

Sr. No	Course content	Hrs.	% Weightage
1	**Introduction of Thermodynamics** Macroscopic vs Microscopic Viewpoint, Thermodynamic System and Control Volume, Thermodynamic Properties, Processes and cycles, Homogeneous and Heterogeneous Systems, Thermodynamic Equilibrium, Quasi-Static Process, Pure Substance, Concept of Continuum, Thermostatics, Units and Dimensions, Zeroth Law of Thermodynamics, Measurement of Temperature- the Reference Points, Comparison of Thermometers, Ideal Gas, Gas Thermometers, Ideal Gas Temperature, Celsius Temperature Scale, Electrical Resistance Thermometer, Thermocouple, International Practical Temperature Scale.	18	20%

Practical:

1) Study and classification of thermodynamic systems and control volumes.
2) Identification of homogeneous and heterogeneous systems using laboratory samples.
3) Demonstration of thermodynamic equilibrium conditions.
4) Demonstration of quasi-static process using piston-cylinder arrangement
5) Study of thermodynamic properties using pressure, temperature, and volume measuring instruments.
6) Verification of Zeroth Law of Thermodynamics using thermal equilibrium setup
7) Measurement and comparison of temperature using different thermometers.
8) Calibration and comparison of Celsius and Kelvin temperature scales.
9) Study and operation of gas thermometers.
10) Study of electrical resistance thermometer (RTD).
11) Study and operation of thermocouple for temperature measurement.
12) Comparison of different temperature measurement devices based on accuracy and range.
13) Verification of ideal gas behavior using pressure-temperature relationship.
14) Determination of temperature using International Practical Temperature Scale (IPTS) references.
15) Preparation and interpretation of thermodynamic process and cycle diagrams (P–V and T–S diagrams).

Evaluation Method:

Sr. No.	Evaluation Methods	SEE	CCE
1.	**Thermodynamics Experimentation Technique:** - Students will research the allotted topic, covering its working principle, components, applications, and operation, prepare a PPT, and present it through a presentation or viva.	10	-
2.	**Thermodynamic System and Instrument Demonstration Technique:** - Students will demonstrate the working principle, operation, and applications of the allotted thermodynamic system, process, or temperature measuring instrument, and explain the related concepts through viva voce.	10	-
3.	**P–V and T–S Diagram:** Students will draw	-	5

	neat P–V and T–S diagrams of any five basic thermodynamic processes and mention one engineering application of each.		
4.	**Zeroth Law Demonstration:** Students will observe any two temperature measuring instruments, explain the application of Zeroth Law of Thermodynamics, and record their observations.	-	5
	Total	20	10

Examination Style:

1. Thermodynamics Experimentation Technique (10 Marks)
The faculty will allot one thermodynamics topic related to the course syllabus. Students are required to research the allotted topic and collect relevant information about its working principle, components, operation, and applications. Students will prepare a PPT based on their findings and present it to the class or appear for a viva. Marks will be awarded based on the accuracy and relevance of the collected information, quality of the PPT, presentation skills, understanding of the topic, and ability to answer questions during the viva.

2. Thermodynamic System and Instrument Demonstration Technique (10 Marks)
The faculty will allot one thermodynamic system, thermodynamic process, or temperature measuring instrument from the course syllabus. Students are required to demonstrate its working principle, explain its operation and engineering applications, and identify its important components wherever applicable. Students should answer viva voce questions related to the allotted topic and demonstrate their conceptual understanding of the associated thermodynamic principles. Marks will be awarded based on the accuracy of the demonstration, explanation of working principle and applications, identification of components, conceptual understanding, and performance in the viva voce.

Continuous Assessment Examination

1. P–V and T–S Diagram Activity (5 Marks)
The faculty will allot any five basic thermodynamic processes from the course syllabus. Students are required to draw neat and properly labeled P–V and T–S diagrams for the allotted processes and identify the corresponding thermodynamic process. Students should explain the

	characteristics of each process and mention one suitable engineering application for each. Marks will be awarded based on the accuracy of the diagrams, correct identification of the processes, proper labeling, explanation of process characteristics, and selection of appropriate engineering applications **2. Zeroth Law Demonstration (5 Marks)** The faculty will provide any two temperature measuring instruments available in the laboratory. Students are required to observe and compare the instruments, explain their working principles, demonstrate the application of the Zeroth Law of Thermodynamics in temperature measurement, and record the observations. Students should discuss the suitability of each instrument for different engineering applications. Marks will be awarded based on the accuracy of observations, explanation of the Zeroth Law, understanding of the working principles, comparison of the instruments, and presentation of the recorded observations.		
2	**First Law of Thermodynamics** First Law for a Closed System Undergoing a Cycle, First Law for a Closed System Undergoing a Change of State, Energy-A Property of the System, Different Forms of Stored Energy, Specific Heat at Constant Volume, Enthalpy, Specific Heat at Constant Pressure, Energy of an Isolated System, Perpetual Motion Machine of the First Kind-PMM1, Limitations of the First Law, Control Volume, Steady Flow Process, Mass Balance and Energy Balance in a Simple Steady Flow (S.F.E.) Process, Comparison of S.F.E. Equation with Euler and Bernoulli Equations, Variable Flow Processes, Discharging and Charging a Tank. **Practical:** 16) Verification of First Law of Thermodynamics for a closed system. 17) Determination of specific heat at constant pressure (C_p). 18) Determination of specific heat at constant volume (C_v). 19) Study of different forms of stored energy in thermodynamic systems. 20) Demonstration of enthalpy change in a heating process. 21) Study of steady flow energy equation using flow apparatus. 22) Verification of mass balance in a steady flow process. 23) Experimental analysis of charging and discharging of an air tank. 24) Study of control volume and energy transfer in open systems. 25) Comparison of Bernoulli equation and steady flow energy equation using fluid flow setup. 26) Determination of energy balance in nozzle or diffuser apparatus. 27) Study of energy interaction in isolated systems.	18	20%

28) Demonstration and discussion of PMM1 concept using models/simulations.
29) Analysis of variable flow process using tank filling or emptying setup
30) Preparation and interpretation of energy balance diagrams for thermodynamic processes

Evaluation Method:

Sr. No.	Evaluation Methods	SEE	CCE
1	**First Law Experimentation Technique:** Students will perform the allotted experiment related to the First Law of Thermodynamics, record observations, carry out necessary calculations, analyze the results, and interpret the experimental outcomes.	10	-
2	**Energy System and Steady Flow Demonstration Technique:** Students will demonstrate the working principle, energy interaction, and engineering applications of the allotted thermodynamic system, control volume, steady flow apparatus, or energy transfer process, and explain the related concepts through viva voce.	10	-
3	**Energy Balance Diagram Activity:** Students will draw neat and properly labelled energy balance diagrams of any five thermodynamic devices/processes, identify heat, work, and mass interactions, and mention one engineering application of each.	-	5
4.	**First Law Application Activity:** Students will analyze the allotted thermodynamic device or process, identify the applicable form of the First Law of Thermodynamics, explain the energy interactions, and justify its engineering application.	-	5
	Total	20	10

Examination Style:

1. First Law Experimentation Technique (10 Marks)

The faculty will allot one experiment related to the First Law of Thermodynamics from the course syllabus. Students are required to perform the experiment by following the prescribed procedure, record the experimental observations, carry out the necessary calculations, and interpret the obtained results. Students should demonstrate their understanding of the First Law by explaining the energy interactions involved, analysing the observations, and drawing appropriate conclusions. Marks will be awarded based on the correct experimental procedure, accuracy of observations and calculations, interpretation of results, and overall understanding of the experiment.

2. Energy System and Steady Flow Demonstration Technique (10 Marks)

The faculty will allot one thermodynamic system, control volume, steady flow apparatus, or energy transfer process from the course syllabus. Students are required to demonstrate its working principle, explain the associated energy interactions, identify the important components wherever applicable, and discuss its engineering applications. Students should answer viva voce questions related to the allotted topic and demonstrate their conceptual understanding of the First Law of Thermodynamics. Marks will be awarded based on the accuracy of the demonstration, explanation of energy interactions, identification of components, conceptual understanding, and performance in the viva voce.

Continuous Assessment Examination

1. Energy Balance Diagram Activity (5 Marks)

The faculty will allot any five thermodynamic devices or processes from the course syllabus. Students are required to draw neat and properly labelled energy balance diagrams indicating heat transfer, work transfer, mass flow, and energy interactions wherever applicable. Students should identify the device or process, explain the associated First Law principles, and mention one suitable engineering application for each. Marks will be awarded based on the accuracy of the diagrams, correct representation of energy interactions, proper labelling, explanation of the First Law concepts, and selection of appropriate engineering applications.

2. First Law Application Activity (5 Marks)

The faculty will allot one thermodynamic device or process such as a boiler, compressor, turbine, nozzle, diffuser, control volume, charging/discharging air tank, or isolated system from the course syllabus. Students are required to identify the applicable form of the First Law of Thermodynamics, explain the associated energy interactions, discuss the energy balance, and justify its engineering application. Marks will be awarded based on the correct identification of the thermodynamic process, explanation of energy interactions, application of the First Law,

<table>
<tr><td></td><td>conceptual understanding, and presentation.</td><td></td><td></td></tr>
<tr><td>3</td><td>
Second Law of Thermodynamics
Qualitative Difference between Heat and Work. Cyclic Heat Engine, Energy Reservoirs, Kelvin-Planck Statement of Second Law, Clausius' Statement of the Second Law, Refrigerator and Heat Pump, Equivalence of Kelvin-Planck and Clausius' Statements, Reversibility and Irreversibility, Causes of Irreversibility, Conditions for Reversibility. Carnot Cycle, Reversed Heat Engine, Carnot's Theorem, Corollary of Carnot's Theorem, Absolute Thermodynamic Temperature Scale, Efficiency of the Reversible Heat Engine, Equality of Ideal Gas Temperature and Kelvin Temperature, Types of Irreversibility

Practical:

31) Demonstration of qualitative difference between heat and work using thermal and mechanical systems.
32) Study of cyclic heat engine model and its working principle.
33) Demonstration of heat transfer between thermal energy reservoirs.
34) Experimental study of refrigerator and heat pump systems.
35) Determination of COP of a refrigerator.
36) Determination of COP of a heat pump.
37) Study of reversible and irreversible processes using expansion/compression setup.
38) Demonstration of causes of irreversibility in thermodynamic processes.
39) Verification of Carnot cycle using simulation or experimental model.
40) Study of reversed heat engine using refrigeration trainer setup.
41) Comparison of efficiency between reversible and irreversible heat engines.
42) Verification of relationship between Kelvin temperature scale and ideal gas temperature.
43) Preparation and analysis of P–V and T–S diagrams for Carnot cycle.
44) Study of entropy generation due to irreversibility through demonstrations/simulations.
45) Identification and classification of different types of irreversibility in practical systems.

Evaluation Method:

<table>
<tr><th>Sr. No.</th><th>Evaluation Methods</th><th>SEE</th><th>CCE</th></tr>
<tr><td>1.</td><td>Second Law Experimentation Technique: Students will perform the allotted experiment</td><td>10</td><td>-</td></tr>
</table>
</td><td>18</td><td>20%</td></tr>
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	related to the Second Law of Thermodynamics, record observations, carry out necessary calculations, analyze the results, and interpret the experimental outcomes.		
2	**Heat Engine and Refrigeration System Demonstration Technique:** Students will demonstrate the working principle, operation, and engineering applications of the allotted heat engine, refrigerator, heat pump, Carnot cycle model, or reversible/irreversible thermodynamic process, and explain the related concepts through viva voce.	10	-
3.	**Carnot Cycle Representation Activity:** Students will draw neat and properly labelled P–V and T–S diagrams of the Carnot cycle, identify the thermodynamic processes involved, and mention one engineering application.	-	5
4.	**Second Law System Analysis Activity:** Students will analyze the allotted thermodynamic system or process, identify the application of the Second Law of Thermodynamics, explain the causes of irreversibility or entropy generation (where applicable), and justify its engineering application.	-	5
	Total	20	10

Examination Style:

1. Second Law Experimentation Technique (10 Marks)

The faculty will allot one experiment related to the Second Law of Thermodynamics from the course syllabus. Students are required to perform the experiment by following the prescribed procedure, record the experimental observations, carry out the necessary calculations, and interpret the obtained results. Students should demonstrate their understanding of the Second Law by explaining the heat and work interactions, analysing the observations, and drawing appropriate conclusions. Marks will be awarded based on the correct experimental procedure, accuracy of observations and calculations, interpretation of results, and overall understanding of the experiment.

2. Heat Engine and Refrigeration System Demonstration Technique (10 Marks)

	The faculty will allot one heat engine, refrigerator, heat pump. Carnot cycle model, or reversible/irreversible thermodynamic process from the course syllabus. Students are required to demonstrate its working principle, explain its operation and engineering applications, identify the important components wherever applicable, and discuss the associated Second Law concepts. Students should answer viva voce questions related to the allotted topic and demonstrate their conceptual understanding of the Second Law of Thermodynamics. Marks will be awarded based on the accuracy of the demonstration, explanation of the working principle and applications, identification of components, conceptual understanding, and performance in the viva voce. **Continuous Assessment Examination** **1. Carnot Cycle Representation Activity (5 Marks)** The faculty will allot the Carnot cycle from the course syllabus. Students are required to draw neat and properly labelled P–V and T–S diagrams, identify the four thermodynamic processes involved, indicate heat addition, heat rejection, and work interaction, and mention one suitable engineering application. Marks will be awarded based on the accuracy of the diagrams, correct identification of the processes, proper labelling, explanation of cycle characteristics, and selection of an appropriate engineering application. **2. Second Law System Analysis Activity (5 Marks)** The faculty will allot one thermodynamic system or process such as a heat engine, refrigerator, heat pump, Carnot cycle, reversed heat engine, or reversible/irreversible process from the course syllabus. Students are required to identify the application of the Second Law of Thermodynamics, explain the heat and work interactions, analyze the causes of irreversibility or entropy generation (where applicable), and justify its engineering application. Marks will be awarded based on the correct identification of the thermodynamic process, explanation of the Second Law principles, analysis of irreversibility or entropy generation, conceptual understanding, and presentation.		
4	**Entropy** Introduction, Two Reversible Adiabatic Paths Cannot Interact Each Other, Clausius' Theoram, The Property of Entropy, Principle of Caratheodory, The Inequality of Clausius, Entropy Change in an Irreversible Process, Entropy Principle, Applications of Entropy	18	20%

Principle, Entropy Transfer Mechanisms, Entropy Generation in a Closed System, Entropy Generation in an Open System, First and Second laws Combined, Reversible Adiabatic Work in a Steady Flow System, Entropy and Direction: The Second Law- A Directional Law of nature, Entropy and Disorder, Absolute Entropy, Entropy and Information Theory, Postulatory Thermodynamics

Practical:

46) Verification of entropy change in reversible and irreversible processes.
47) Study of entropy transfer during heat transfer processes.
48) Experimental analysis of entropy generation in a closed system.
49) Experimental analysis of entropy generation in an open system.
50) Verification of Clausius inequality using thermodynamic process data.
51) Study of reversible adiabatic expansion and compression process.
52) Determination of reversible adiabatic work in steady flow systems.
53) Demonstration of entropy increase and direction of natural processes.
54) Comparison of reversible and irreversible processes using P–V and T–S diagrams.
55) Analysis of entropy change during heating and cooling processes.
56) Verification of combined First and Second Laws for thermodynamic systems.
57) Study of entropy-disorder relationship using molecular behavior models/simulations.
58) Demonstration of entropy concepts using thermodynamic simulation software.
59) Preparation and interpretation of T–S diagrams for various thermodynamic processes.
60) Analysis of entropy balance for simple engineering systems

Evaluation Method:

Sr. No.	Evaluation Methods	SEE	CCE
1.	**Entropy Experimentation Technique:** Students will perform the allotted experiment related to entropy, record observations, carry out necessary calculations, analyze the results, and interpret the experimental outcomes.	10	-
2.	**Entropy Process and System Demonstration Technique:** Students will demonstrate the working principle, entropy transfer mechanism,	10	-

	entropy generation, reversible/irreversible process, or steady flow entropy analysis of the allotted thermodynamic system, and explain the related concepts through viva voce.		
3.	**T–S Diagram and Entropy Balance Activity:** Students will draw neat and properly labelled T–S diagrams of any five thermodynamic processes, identify the entropy transfer and entropy generation, and mention one engineering application of each.	-	5
4	**Entropy Principle and Engineering System Analysis Activity:** Students will analyze the allotted thermodynamic system or process, explain entropy generation, Clausius inequality, or entropy balance, and justify its engineering application.	-	5
	Total	20	10

Examination Style:

1. Entropy Experimentation Technique (10 Marks)

The faculty will allot one experiment related to entropy from the course syllabus. Students are required to perform the experiment by following the prescribed procedure, record the experimental observations, carry out the necessary calculations, and interpret the obtained results. Students should demonstrate their understanding of entropy by explaining the entropy transfer, entropy generation, or entropy balance involved in the experiment, analysing the observations, and drawing appropriate conclusions. Marks will be awarded based on the correct experimental procedure, accuracy of observations and calculations, interpretation of results, and overall understanding of the experiment.

2. Entropy Process and System Demonstration Technique (10 Marks)

The faculty will allot one thermodynamic system, entropy transfer mechanism, reversible or irreversible process, entropy generation setup, or steady flow entropy analysis model from the course syllabus. Students are required to demonstrate its working principle, explain the associated entropy interactions, identify the important components wherever applicable, and discuss its engineering applications. Students should answer viva voce questions related to the allotted topic and demonstrate

	their conceptual understanding of entropy, Clausius theorem, and the Second Law of Thermodynamics. Marks will be awarded based on the accuracy of the demonstration, explanation of entropy concepts, identification of components, conceptual understanding, and performance in the viva voce. **Continuous Assessment Examination** **1. T–S Diagram and Entropy Balance Activity (5 Marks)** The faculty will allot any five thermodynamic processes from the course syllabus. Students are required to draw neat and properly labelled T–S diagrams, identify the entropy transfer and entropy generation occurring during each process, explain the characteristics of each process, and mention one suitable engineering application for each. Marks will be awarded based on the accuracy of the diagrams, correct representation of entropy transfer and entropy generation, proper labelling, conceptual explanation, and selection of appropriate engineering applications. **2. Entropy Principle and Engineering System Analysis Activity (5 Marks)** The faculty will allot one thermodynamic system or process such as a closed system, open system, heat transfer process, reversible adiabatic process, irreversible process, or steady flow device from the course syllabus. Students are required to explain the entropy transfer mechanism, analyze entropy generation or Clausius inequality (where applicable), apply the entropy principle and entropy balance, and justify its engineering application. Marks will be awarded based on the correct application of entropy principles, analysis of entropy generation or entropy balance, conceptual understanding, engineering justification, and presentation.		
5	**Properties of Gases and Gas Mixtures** Avogadro's Law, Equation of State of a Gas, Ideal Gas, Gas Compression, Equations of State, Virial Expansions, Law of Corresponding States, Other Equations of State, Properties of Mixtures of Gases- Dalton's Law of Partial Pressures, Internal Energy, Enthalpy and Specific Heats of Gas Mixtures, Entropy of Gas Mixtures, Gibbs Function of a Mixture of Inert Ideal Gases. **Practical:**	18	20%

21) Determination of [illegible] of a gas using gas samples
22) Verification of ideal gas equation using pressure-volume-temperature relationship
23) Experimental study of gas compression process
24) Determination of thermodynamic properties of gases using equation of state
25) Study of P-V relationship for ideal and real gases
26) Verification of Dalton's Law of Partial Pressures for gas mixtures
27) Determination of partial pressure in gas mixtures.
28) Determination of internal energy and enthalpy variation of gases
29) Calculation and analysis of specific heats of gas mixtures
30) Study of entropy change in gas mixtures
31) Preparation and interpretation of P-V and T-S diagrams for gas processes
32) Analysis of compressibility behaviour of gases using compressibility charts
33) Study of law of corresponding states using generalized gas behaviour data
34) Experimental analysis of thermodynamic properties of inert gas mixtures
35) Determination and interpretation of Gibbs function for ideal gas mixtures

Evaluation Method:

Sr. No.	Evaluation Methods	SEE	CCE
1.	**Gas Properties and Equation of State Experimentation Technique:** Students will perform the allotted experiment related to gas properties, equations of state, gas compression, or gas mixtures, record observations, carry out necessary calculations, analyse the results, and interpret the experimental outcomes.	10	-
2.	**Gas Behaviour and Thermodynamic Property Demonstration Technique:** Students will demonstrate the working principle, gas compression process, equation of state, gas mixture behaviour, thermodynamic property determination, or Gibbs function analysis of the allotted system, and explain the related concepts through viva voce.	10	-
3.	**P-V and T-S Diagram with Gas Behaviour Activity:** Students will draw neat and properly labelled P-V and T-S diagrams of any five gas processes, identify the thermodynamic behaviour of gases, and mention one	-	5

	engineering application of each		
4	**Gas Mixture and Engineering System Analysis Activity:** Students will analyze the allotted gas system or gas mixture, explain Avogadro's Law, Dalton's Law, equation of state, thermodynamic properties, compressibility behaviour, or Gibbs function, and justify its engineering application.	-	5
	Total	20	10

Examination Style:

1. Gas Properties and Equation of State Experimentation Technique (10 Marks)

The faculty will allot one experiment related to properties of gases, equations of state, gas compression, or gas mixtures from the course syllabus. Students are required to perform the experiment by following the prescribed procedure, record the experimental observations, carry out the necessary calculations, and interpret the obtained results. Students should demonstrate their understanding of gas behaviour by explaining the applicable gas laws, equation of state, thermodynamic properties, compressibility behaviour, or gas mixture characteristics involved in the experiment, analysing the observations, and drawing appropriate conclusions. Marks will be awarded based on the correct experimental procedure, accuracy of observations and calculations, interpretation of results, and overall understanding of the experiment.

2. Gas Behaviour and Thermodynamic Property Demonstration Technique (10 Marks)

The faculty will allot one gas property, gas compression process, equation of state, gas mixture analysis, compressibility chart, thermodynamic property determination, or Gibbs function model from the course syllabus. Students are required to demonstrate its working principle, explain the associated thermodynamic concepts, identify the important parameters wherever applicable, and discuss its engineering applications. Students should answer viva voce questions related to the allotted topic and demonstrate their conceptual understanding of Avogadro's Law, equations of state, Dalton's Law of Partial Pressures, gas mixtures, and thermodynamic properties. Marks will be awarded based on the accuracy of the demonstration, explanation of concepts, identification of parameters, conceptual understanding, engineering applications, and performance in the viva voce.

Continuous Assessment Examination

1. P–V and T–S Diagram with Gas Behavior Activity (5 Marks)
The faculty will allot any five gas processes from the course syllabus. Students are required to draw neat and properly labelled P–V and T–S diagrams, explain the thermodynamic characteristics of each process, identify the variation of pressure, volume, temperature, or entropy wherever applicable, and mention one suitable engineering application for each. Marks will be awarded based on the accuracy of the diagrams, correct representation of thermodynamic processes, proper labelling, conceptual explanation, and selection of appropriate engineering applications.

2. Gas Mixture and Engineering System Analysis Activity (5 Marks)
The faculty will allot one gas system or gas mixture such as an ideal gas, real gas, gas compression process, gas mixture, inert gas mixture, or engineering thermodynamic application from the course syllabus. Students are required to explain the equation of state, apply Avogadro's Law or Dalton's Law wherever applicable, analyse thermodynamic properties such as internal energy, enthalpy, entropy, specific heats, compressibility behaviour, or Gibbs function, and justify its engineering application. Students may also be asked to interpret generalized gas behaviour charts, compressibility charts, or engineering case studies related to gas mixtures. Marks will be awarded based on the correct application of gas laws and thermodynamic principles, analysis of gas properties, conceptual understanding, engineering justification, and presentation.

Suggested Specification table with Marks:

Distribution of Theory Marks (Revised Bloom's Taxonomy)						
Level	Remembrance (R)	Understanding (U)	Application (A)	Analyze (N)	Evaluate (E)	Create (C)
Weightage %	15 %	25 %	30 %	15 %	10 %	5 %

Course Outcome:

After learning the course, the students should be able to:

CO1	Explain the fundamentals of thermodynamics and temperature measurement.
CO2	Apply the First Law of Thermodynamics to engineering systems.
CO3	Analyze thermodynamic systems using the Second Law of Thermodynamics.
CO4	Evaluate entropy changes and entropy balance in thermodynamic processes.
CO5	Analyze the properties of gases and gas mixtures for engineering applications.

Instructional Method:

The course delivery method will depend upon the requirement of content and the needs of students. The teacher, in addition to conventional teaching methods by black board, may also use any tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

From the content 10% topics are suggested for flipped mode instruction.

Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses, Virtual Laboratory

The internal evaluation will be done on the basis of Active Learning Assignment.

Reference Books:

[1] Engineering Thermodynamics, P K. Nag, McGraw Hill Education (India)

[2] Engineering Thermodynamics, R. K. Rajput, Laxmi Publications

[3] Engineering Thermodynamics, Onkar Singh, New Age International Publishers

[4] Thermodynamics: An Engineering Approach, Yunus A. Çengel and Michael A. Boles, McGraw Hill Education

[5] Fundamentals of Engineering Thermodynamics, Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner and Margaret B. Bailey, Wiley India Pvt. Ltd.

[6] Engineering Thermodynamics, P Chattopadhyay, Oxford University Press India

Module 1: Introduction of Thermodynamics

Signal Analysis (10 marks)		
Criteria	Description	Marks
Research & Content Quality	Collects relevant and accurate information about the allotted topic, including its working principle, components, operation, and applications.	5
PPT, Presentation & Viva	Prepares and presents the PPT effectively, demonstrates understanding of the topic, and answers questions appropriately during the presentation or viva.	5
	Total	10

Signal Analysis (10 marks).		
Criteria	Description	Marks
Demonstration & Working Principle	Correctly identifies the allotted thermodynamic system, process, or instrument, explains its working principle, operation, important components (wherever applicable), and engineering applications.	5
Conceptual Understanding & Viva Voce	Demonstrates sound understanding of the associated thermodynamic principles, answers viva voce questions confidently, and explains the concepts clearly and accurately.	5
	Total	10

Module 2: First Law of Thermodynamics

Signal Analysis (10 marks).		
Criteria	Description	Marks
Experimental Procedure & Observation	Performs the allotted experiment by following the prescribed procedure, operates the apparatus correctly, observes safety precautions, and records experimental observations accurately and systematically.	5
Calculations, Result Interpretation & Conceptual Understanding	Performs the required calculations correctly, verifies the energy balance based on the First Law of Thermodynamics, interprets the obtained results, and draws appropriate conclusions.	5
	Total	10

Signal Analysis (10 marks).		
Criteria	Description	Marks
Demonstration & Working Principle	Correctly identifies the allotted thermodynamic system, control volume, steady flow apparatus, or energy transfer process, explains its working principle, energy interactions, important components (wherever applicable), and engineering applications.	5
Conceptual Understanding &	Demonstrates sound understanding of the First Law of Thermodynamics and the Steady Flow Energy Equation	5

Viva Voce	(wherever applicable), answers viva voce questions confidently, and explains the concepts clearly and accurately.	
	Total	10

Module 3:

Signal Analysis (10 marks).		
Criteria	Description	Marks
Experimental Procedure & Observations	Performs the allotted experiment by following the prescribed procedure, operates the apparatus correctly, observes safety precautions, and records experimental observations accurately and systematically.	5
Calculations, Result Interpretation & Conceptual Understanding	Performs the required calculations correctly, evaluates thermal efficiency or coefficient of performance (wherever applicable), interprets the obtained results, explains the associated Second Law principles, and draws appropriate conclusions.	5
	Total	10

Signal Analysis (10 marks).		
Criteria	Description	Marks
Demonstration & Working Principle	Correctly explains the allotted heat engine, refrigerator, heat pump, Carnot cycle model, or reversible/irreversible thermodynamic process, identifies important components (wherever applicable), describes its operation, and discusses engineering applications.	5
Conceptual Understanding & Viva Voce	Demonstrates sound understanding of the Second Law of Thermodynamics, thermal efficiency, coefficient of performance (COP), entropy considerations, and reversible/irreversible processes, answers viva voce questions confidently, and explains the concepts clearly and accurately.	5
	Total	10

Module 4:

Signal Analysis (10 marks).		
Criteria	Description	Marks
Experimental Procedure & Observation	Performs the allotted experiment by following the prescribed procedure, operates the apparatus correctly, observes safety precautions, and records experimental observations accurately and systematically.	5
Calculations, Result Interpretation & Conceptual Understanding	Performs the required calculations correctly, determines entropy change or entropy balance, interprets the obtained results, explains entropy transfer and entropy generation, and draws appropriate conclusions.	5

	Total	10

Signal Analysis (10 marks)		
Criteria	Description	Marks
Demonstration & Working Principle	Correctly explains the allotted thermodynamic system, entropy transfer mechanism, reversible or irreversible process, entropy generation setup, or steady flow entropy analysis model, identifies important components (wherever applicable), and discusses engineering applications.	5
Conceptual Understanding & Viva Voce	Demonstrates sound understanding of entropy, Clausius theorem, Clausius inequality, entropy balance, and the Second Law of Thermodynamics, answers viva voce questions confidently, and explains the concepts clearly and accurately.	5
	Total	10

Module 5:

Signal Analysis (10 marks).		
Criteria	Description	Marks
Experimental Procedure & Observation	Performs the allotted experiment by following the prescribed procedure, operates the apparatus correctly, observes safety precautions, and records experimental observations accurately and systematically.	5
Calculations, Result Interpretation & Conceptual Understanding	Performs the required calculations correctly, applies the appropriate gas laws or equations of state, interprets the obtained results, explains the thermodynamic behaviour of gases or gas mixtures, and draws appropriate conclusions.	5
	Total	10

Signal Analysis (10 marks).		
Criteria	Description	Marks
Demonstration & Working Principle	Correctly explains the allotted gas property, equation of state, gas compression process, gas mixture analysis, compressibility chart, thermodynamic property determination, or Gibbs function model, identifies important parameters (wherever applicable), and discusses engineering applications.	5
Conceptual Understanding & Viva Voce	Demonstrates sound understanding of Avogadro's Law, equations of state, Dalton's Law of Partial Pressures, gas mixtures, compressibility behaviour, and thermodynamic properties, answers viva voce questions confidently, and explains the concepts clearly and accurately.	5
	Total	10