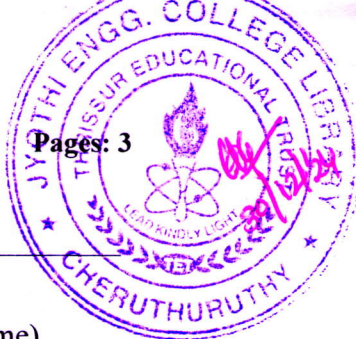


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0200MRT202052401



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Reg No.: _____

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S4 (S, FE) Examination December 2024 (2019 Scheme)

Course Code: MRT202

Course Name: THERMODYNAMICS

(Permitted to use Steam Tables and Mollier charts)

Max. Marks: 100

Duration: 3 Hours

PART A

(Answer all questions; each question carries 3 marks)

Marks

- | | | |
|----|---|---|
| 1 | Explain concept of temperature measurement or Equality of Temperatures (or zeroth law of thermodynamics)? | 3 |
| 2 | Explain two approaches used in the study of thermodynamics? | 3 |
| 3 | What is PMM1? Why it is not possible? | 3 |
| 4 | Derive the equation for pdv work in a polytropic expansion process | 3 |
| 5 | What are the causes of irreversibility of a process? | 3 |
| 6 | What is entropy? Prove that entropy is a property of a system | 3 |
| 7 | Explain Degree of Dryness fraction and its importance | 3 |
| 8 | Explain different Equation of states associated to predict real gas behaviour | 3 |
| 9 | What is Amagat's Laws of additive volumes? | 3 |
| 10 | Define Gibbs and Helmholtz function. Give its significance on chemical reaction. | 3 |

PART B

(Answer one full question from each module, each question carries 14 marks)

Module -1

- | | | |
|----|---|---|
| 11 | a) Explain different types of work transfers? | 7 |
| | b) What is the working principle of a constant volume gas thermometer? Explain with neat sketches | 7 |
| 12 | a) Consider a system whose temperature is 18°C. Express this temperature in R, K, and °F. Use this to convert C=18 to R, K and F | 6 |
| | b) The temperature t on a thermometric scale is defined in terms of a property K by the relation $t = a \ln K + b$ where a and b are constants. The values of K are found to be 1.83 and 6.78 at the ice point and the steam point, the temperatures of which | 8 |

are assigned the numbers 0 and 100 respectively. Determine the temperature corresponding to a reading of K equal to 2.42 on the thermometer.

Module -2

- | | | | |
|----|----|--|---|
| 13 | a) | Derive steady flow energy equation. Application of SFEE | 7 |
| | b) | Explain Joule's experiment with neat sketches and state first law | 7 |
| 14 | a) | In an insulated nozzle, Steam at a 6.87 bar, 205°C, enters with a velocity of 40 m/s. It leaves at a pressure of 1.37 bar and a velocity of 400 m/s. Determine the final enthalpy of steam | 6 |
| | b) | Explain Limitations of First Law, Show that work is a path function and not a property | 8 |

Module -3

- | | | | |
|----|----|---|---|
| 15 | a) | Prove the inequality of Clausius for defining the reversibility condition for a cycle. Write also the criterion for reversible cycle, irreversible cycle, and impossible cycle | 7 |
| | b) | Give the following statements of second law of thermodynamics. (i) Clausius statement (ii) Kelvin-Planck statement. Explain Equivalence of these two statements | 7 |
| 16 | a) | A heat pump working on the Carnot cycle takes in heat from a reservoir at 10°C and delivers heat to a reservoir at 80°C. The heat pump is driven by a reversible heat engine which takes in heat from a reservoir at 1000°C and rejects heat to a reservoir at 80°C. The reversible heat engine also drives a machine that absorbs 50 kW. If the heat pump extracts 10 kJ/s from the 10°C reservoir, determine (a) The rate of heat supply from the 1000°C source, and (b) The rate of heat rejection to the 80°C sink. | 8 |
| | b) | Compare the COP of heat pump to that of a refrigerator. What is the reason for their difference?
Why second law is called law of degradation? | 6 |

Module -4

- | | | | |
|----|----|---|---|
| 17 | a) | i) What are Virial equations of state? ii) Define compressibility factor. | 6 |
| | b) | 1. Explain mollier chart, P-V, P-T, P-V-T diagrams for pure substances.
2. Draw the p-v-T surface of a substance that contracts on freezing.
3. Explain the importance of the critical point during the phase change process of a pure substance using a P-v diagram. | 8 |

- 18 a) Steam initially at 0.3 MPa, 250°C is cooled at constant volume. Determine the following: (a) At what temperature will the steam become saturated vapor? (b) What is the quality at 80°C? (c) What is the heat transferred per kg of steam in cooling from 250°C to 80°C? 8
- b) Write down the van der Waals equation of state. How does it differ from the ideal gas equation of state? 6

Module -5

- 19 a) Derive the Maxwell relations. Explain their significance? 7
Explain Gibbs-Dalton's law
- b) Define Joule-Thomson coefficient. What is its significance? 7
- 20 a) Derive the TdS equations for a pure substance undergoing an infinitesimal reversible process. 5
- b) A mixture of ideal gases consists of 3kg of nitrogen and 5kg of carbon dioxide at a pressure of 300 kPa and a temperature of 20°C. Find, (a) The mole fraction of each component. (b) The equivalent molecular weight of the mixture. (c) The equivalent gas constant of the mixture. (d) The partial pressure and the partial volumes 9
