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? Explain Gibbs-Dalton's law	7
	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

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