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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fourth Semester B.Tech Degree (R,S) Examination May 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	Differentiate the concepts of macroscopic and microscopic viewpoints.	3
2	What you mean by an isolated system. Give an example	3
3	Explain free expansion with a suitable example.	3
4	State the limitations of the first law of thermodynamics.	3
5	A Carnot heat engine works between temperatures of 900°C and 30°C. Calculate the thermal efficiency and work done if heat supplied is 1000 kJ.	3
6	State and explain the third law of Thermodynamics	3
7	Explain triple point using P-T diagram with respect to water	3
8	Why do real gases deviate from ideal gas behaviour? When do the real gases approach to ideal behaviour?	3
9	Define Helmholtz function and state their significance	3
10	Explain Dalton's law.	3

PART B

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

Module -1

11	a)	Differentiate intensive and extensive properties with suitable examples	7
	b)	Consider a system whose temperature is 27°C. Express this temperature in (i) Kelvin, (ii) Rankine and (iii) Fahrenheit scale.	7
12	a)	Explain thermodynamic equilibrium of a system and conditions required for a thermodynamic equilibrium.	7
	b)	Describe quasi static process with the help of the pv diagram.	7

Module -2

13 a) Explain Joule's experiment with a neat sketch. 7

b) The properties of a closed system change following the relation between pressure and volume as pv=15 where p is in bar V is in m^3. Calculate the work done and heat transfer when the pressure increases from 3 bar to 15 bar. 7

14 a) Derive the expression for work transfer and heat transfer for an adiabatic process. 7

b) Air flows steadily at the rate of 0.6 kg/s through an air compressor, entering at 7m/s velocity, 100 kPa pressure, and 0.95 m^3/kg volume and leaving at 5m/s, 700 kPa, and 0.19 m^3/kg respectively. The internal energy of the air leaving is 90 kJ/kg greater than that of air entering. Cooling water in the compressor jackets absorbs heat from air at the rate of 58 kW. Compute the rate of shaft work input to ait in kW and find the ratio of the inlet pipe diameter to outlet pipe diameter. 7

Module -3

15 a) With the help of neat sketches, prove the equivalence of Kelvin-Planck and Clausius statements. 7

b) One kg of ice at -10°C is exposed to the atmosphere which is at 25°C. The ice melts and comes into thermal equilibrium with the atmosphere. Determine the entropy increase of the universe. Assume the C_p of ice is 2.093 kJ/kg K and the latent heat of fusion of ice is 333.3 kJ/kg. 7

16 a) A reversible heat engine operates between two reservoirs at temperature of 600°C and 40°C. The Engine drives a reversible refrigerator which operates between reservoirs at temperature of 40°C and – 20°C. The heat transfer to the heat engine is 2000 KJ and net- work output of combined engine refrigerator plant is 360 KJ. Evaluate the heat transfer to the refrigerator and the net heat transfer to the reservoir at 40°C. 7

b) What are the causes of irreversibility and explain it. 7

Module -4

17 a) Explain the T-v and p-v diagram of water while heating from 10 °C to 300 °C. Explain the concept of critical point and write down the pressure, temperature and specific volume corresponds to critical point of water. 7

b) A vessel of volume 0.045 m^3 contains a mixture of saturated water and saturated steam at a temperature of 250°C. Mass of liquid present is 9 kg. Find mass, 7 dryness fraction, specific volume, enthalpy, entropy and internal energy of the mixture.

18 a) Explain the Van der Waals Equation of State. What is the significance of this equation? How can we determine the Van der Waals constants? 7

b) Explain the concept of compressibility factor and principal of corresponding states. Discuss the important conclusions from generalized compressibility chart. 7

Module -5

19 a) A gas mixture contains 25% by volume of nitrogen, 55% by volume of hydrogen, and 20% by volume of carbon dioxide. Calculate molecular weight of mixture, characteristic gas constant (R) for the mixture and the value of reversible adiabatic index γ. (At 10°C C_p values of nitrogen, hydrogen and carbon dioxide are 1.039, 14.235 and 0.828 kJ/kg K respectively.) 7

b) Derive Maxwell's equations and explain the significance of Maxwell relations. 7

20 a) The gravimetric analysis of air is shown in table. Calculate (i) gas constant for air and apparent molecular weight (Molecular weight of Argon =40). 7

Constituent	Percentage
Oxygen	23.13
Nitrogen	75.54
Argon	1.28
Carbon dioxide	0.05

b) Explain the Joule-Thompson coefficient using inversion curve and prove that the Joule-Thompson coefficient is zero for an ideal gas. 7

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