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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S4 (S, FE) / S2 (PT) (S) Examination January 2024 (2019 Scheme)

Course Code: MET202

Course Name: ENGINEERING THERMODYNAMICS

Max. Marks: 100 Duration: 3 Hours

(Use of steam tables & Mollier chart are permitted)

PART A

(Answer all questions; each question carries 3 marks) Marks

1		What is the concept of continuum? How would you use this idea to define density? Describe with neat diagrams.	3
2		Provide the terminological expressions for the universal and characteristic gas constants. Also explain the difference between them.	3
3		What is displacement work? Under what circumstances does the work done equal to $\int_1^2 pdV$?	3
4		Define enthalpy. Why is temperature the only factor to determine enthalpy of an ideal gas?	3
5		What is available energy and unavailable energy?	3
6		Define entropy, and prove that entropy is a property of a system.	3
7		What is meant by vapour dome? Provide an illustration on T-s and h-s diagrams.	3
8		What is the degree of super heat and the degree of sub cooling? Use diagrams to illustrate them.	3
9		Define Joule-Thomson coefficient. Show that Joule-Thomson coefficient is zero for an ideal gas.	3
10		Show that the internal energy of an ideal gas is a function of temperature.	3

PART B

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

Module -1

11	a)	What is ideal gas temperature scale?	6
	b)	Explain the terms classical thermodynamics and statistical thermodynamics.	8
12	a)	Explain the terms state, change of state, path, process, cycle and quasistatic process. Represent them in a p-v diagram.	10

b) The e.m.f. measured by a thermocouple on a gas thermometer scale, is represented by the equation; 4

$e.m.f. = 0.2x - 5 \times 10^{-4} x^2$ mV, where 'x' is the temperature of the test junction in °C. Steam point and ice point are used as reference points to calibrate the millivolt meter. In a location where the gas thermometer reads 50°C, what will be the reading of gas thermometer?

Module -2

13 a) Gas from a bottle of compressed helium is used to inflate an inelastic flexible balloon, originally folded completely flat to a volume of 0.5 m^3. If the barometer reads 760 mm Hg, what is the amount of work done upon the atmosphere by the balloon? Sketch the system before and after the process. 5

b) Derive the Steady Flow Energy Equation.? Prove that a fluid enthalpy before and after throttling are the same. 9

14 a) Define the specific heats at constant volume and constant pressure. Show $(Q)_v = (\Delta u)_v$ and $(Q)_p = (\Delta h)_p$. 7

b) Air flows steadily at the rate of 0.5 kg/s through an air compressor, entering with a velocity 7m/s, pressure 100 kPa, and specific volume 0.95 m^3/kg. The corresponding values at the exit are 5 m/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 the air entering. Cooling water in the compressor jackets absorbs heat from the air at the rate of 58 kW. (a) Compute the rate of shaft work input to the air in kW. (b) Find the ratio of the inlet pipe diameter to outlet pipe diameter. 7

Module -3

15 a) What is Clausius' statement of the second law of Thermodynamics? With neat sketches, show that the COP of a heat pump is greater than the COP of a refrigerator by unity. 7

b) State and prove Clausius' Theorem. 7

16 a) Establish the inequality of Clausius. 5

b) A system has a capacity at constant volume 9

$$C_v = AT^2$$

where $A = 0.042 J/K^3$. The system is originally at 200 K, and a thermal reservoir at 100 K is available. What is the maximum amount of work that can be recovered as the system is cooled down to the temperature of the reservoir?

Module -4

17	a)	What is Mollier Chart? Why do the isobars on Mollier diagram diverge from one another?	4
	b)	Steam initially at 1.5 MPa and 300°C expands reversibly and adiabatically in a steam turbine to 40°C. Determine the ideal work output of the turbine per kg of steam.	10
18	a)	What are saturation states? Express the saturation states on h-s ,T-h and T-s diagrams .	5
	b)	A vessel of volume 0.04 m^3 contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of the liquid present is 9 kg. Find the pressure, mass, specific volume, enthalpy, entropy, and internal energy of the mixture.	9

Module -5

19	a)	Explain Joule-Kelvin effect with respect to significance of inversion curve. Show that for an ideal gas, Joule-Kelvin coefficient is zero	5
	b)	Define chemical potential of a component in terms of U,H,F,G. and derive its relations	9
20	a)	State and explain Dalton's law of partial pressures and Amagat's laws of additive volumes.	6
	b)	Derive Maxwell's equations	8

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