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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S4 (S,FE) (FT/WP/S2PT) Examinations May 2026 (2019 Scheme)

Course Code: MET202

Course Name: ENGINEERING THERMODYNAMICS

Max. Marks: 100 Duration: 3 Hours

Use of steam tables, Mollier diagram and compressibility charts are permitted

PART A

(Answer all questions; each question carries 3 marks)

		Marks
1	Differentiate closed and open systems with examples.	3
2	Describe the conditions for a system to be in thermodynamic equilibrium.	3
3	What are the limitations of first law of thermodynamics?	3
4	Differentiate between flow work and non-flow work with suitable examples	3
5	State Carnot's theorem and write its significance.	3
6	State the principle of increase of entropy. Deduce the entropy generation for processes from it.	3
7	Differentiate between characteristic gas constant and universal gas constant of an ideal gas.	3
8	What is virial expansion? Write its significance in real gas modelling.	3
9	State Amagat's Law of Additive Volumes and mention its significance.	3
10	Distinguish mass fraction from mole fraction of an ideal gas mixture.	3

PART B

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

Module -1

11	a)	Explain macroscopic and microscopic viewpoints of thermodynamics. Mention at least three differences between them.	7
	b)	Define thermometric property. Describe the thermometric properties and relations used in any three thermometers.	7
12	a)	Discuss the concept of continuum applied in thermodynamic systems with density as example.	7
	b)	A platinum wire is used as a resistance thermometer. The wire resistance is found to be 10 ohms at ice point, 16 ohms at steam point and 30 ohms at sulphur boiling point of 444.6°C. Find the resistance of the wire at 500°C, if the resistance varies with temperature as $R = R_o(1 + \alpha t + \beta t^2)$ where t is in °C	7

Module -2

13 a) State and discuss the first law of thermodynamics for a closed system undergoing a process. Describe the different forms of energy of a thermodynamic system. 7

b) A gas of mass 1.5 kg undergoes a quasi – static expansion which follows the relation $p = a + bV$, where a and b are constants. The initial and the final pressures are 1000 kPa and 200 kPa respectively and the corresponding volumes are 0.2 m^3 and 1.2 m^3. The specific internal energy of the gas is given by the relation $u = 1.5pv - 85\ kJ/kg$, where p is in kPa and v is in m^3/kg. Calculate the net heat transfer of the system and its direction. 7

14 a) Define the specific heats at constant volume and constant pressure. Prove that, for a constant-volume process, heat transfer equals the change in internal energy, $(Q)_v = (\Delta u)_v$ and for a constant-pressure process, heat transfer equals the change in enthalpy $(Q)_p = (\Delta h)_p$ 7

b) A turbine operates under steady flow conditions, receiving steam at the following state: Pressure 1.2 MPa, temperature 188°C, enthalpy 2785 kJ/kg, velocity 33.3 m/s and elevation 3 m. The steam leaves the turbine at the following state: Pressure 20 kPa, enthalpy 2512 kJ/kg, velocity 100 m/s, at ground level. Heat is lost to the surroundings at the rate of 0.29 kJ/s. If the rate of steam flow through the turbine is 0.42 kg/s, what is the power output of the turbine in kW? 7

Module -3

15 a) State the Kelvin-Planck and Clausius statements of the second law of thermodynamics. Prove that violation of one statement leads to the violation of the other. (One proof) 7

b) An insulated rigid cylinder of volume 4 m^3 contains 20 kg of nitrogen. Paddle work is done on the gas by stirring it till the pressure in the vessel gets increased from 4 bar to 8 bar. Determine: (i) Change in internal energy, (ii) Work done (iii) Heat transferred (iv) Change in entropy. 7

Take for nitrogen: $C_p = 1.04$ kJ/kg K, and $C_v = 0.7432$ kJ/kg K

16 a) A heat pump is used to heat a house in the winter. The interior temperature of the house is to be maintained at 20°C. Heat transferred through the walls and the roof is estimated to be 2400 kJ/h per degree temperature difference between the inside and the outside. If the outside temperature in the winter is 0°C, what 7

is the minimum power required to drive the heat pump?

b) State and Prove Clausius inequality. 7

Module -4

17 a) One kilogram of an ideal gas expands in a polytropic process according to the law $PV^{1.3} = constant$. The initial pressure and volume are 620 kPa and 0.15 m^3 respectively. The final volume is 1 m^3. Assume R = 0.130 kJ/kg K and C_v = 0.511 kJ/kg K. Find (a) the final temperature (b) the work done and (c) the change in internal energy. 8

b) Discuss van der Waals equation of state. How does it differ from ideal gas equation of state? 6

18 a) A 0.3m^3 rigid vessel initially contains mixture at 150°C. The mixture is now heated until it reaches the critical state. Determine the (i) dryness fraction at the initial state (ii) the mass of the liquid water and (iii) the volume occupied by the liquid water at the initial state. 8

b) Draw the P-T diagram of a pure substance that expands on freezing showing all the regions. Explain the phase change process for heating with constant pressure lines. 6

Module -5

19 a) Derive the Maxwell's relations starting from the fundamental thermodynamic equations. 8

b) Derive the first and the second Tds equations. 6

20 a) Explain Joule-Kelvin effect. Discuss inversion curve and its significance. 6

b) A vessel of 6 m^3 capacity contains two gases A and B in proportion of 45% and 55% by mass respectively at 30°C. If the value of R for the gases is 0.288 kJ/kg K and 0.295 kJ/kg K respectively and if the total weight of the mixture is 2 kg, calculate: (i) the partial pressure; (ii) the total pressure; (iii) the mean value of R for the mixture. 8

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