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Reg. No._____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, JULY 2017

ME205: THERMODYNAMICS (AN, MA, MP, ME)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any THREE questions.

1. a) Define thermometric property. Why is a gas chosen as standard thermometric substance (3)

   b) Explain temperature scale. How can the ideal gas temperature for the steam point be measured? (4)

   c) Show that work is a path function and not a property (3)

2. a) State first law for closed system undergoing a change of state and show that energy a property of system (3)

   b) Define enthalpy. Why the enthalpy of an ideal gas does depend only on temperature? (3)

   c) A gas of 4 kg is contained within the piston cylinder machine. The gas undergoes a process for which $pV^{1.5}$ = Constant. The initial pressure is 3 bar and the initial volume is $0.1m^3$, and the final volume is $0.2m^3$. The specific internal energy of the gas decreases by 4.6kJ/kg. There is no significant change in KE and PE. Determine net heat transfer for the process. (4)

3. a) Define specific heat and derive it for constant pressure and constant volume? (4)

   b) A turbo compressor delivers 2.33 m^3/s at 0.276 MPa, 43°C which is heated at this pressure to 430°C and finally expanded in a turbine which delivers 1860 kW. During the expansion, there is a heat transfer of 0.09 MJ/s to the surroundings. Calculate the turbine exhaust temperature if changes in kinetic and potential energy are negligible? (6)

4. a) Write steady flow energy equation for a single stream entering and single stream leaving a control volume and explain the various terms in it. (4)

   b) A pump steadily delivers water at a volumetric flow rate of $0.05m^3/s$ through a pipe of diameter 18 cm located 100 m above the inlet pipe which has a diameter of 15 cm. The pressure is nearly equal to 1 bar at both the inlet and the exit, and the temperature is nearly constant at 20°C throughout. Determine the power required by the pump. Take g= 9.81 m/s^2 (6)

PART B

Answer any THREE questions.

5. a) Establish the equivalence of Kelvin-Plank and Clausius statements. (4)

   b) A heat pump working on the Carnot cycle takes in heat from a reservoir at 5°C and delivers heat to a reservoir at 60°C. The heat pump is driven by a reversible heat engine which takes in heat from a reservoir at 840°C and rejects heat to a reservoir at 60°C. The reversible heat engine also drives a machine that absorbs 30kW. If the heat

pump extracts 17kJ/s from 5°C reservoir. Determine (a) rate of heat supply from the 840°C source and (b) the rate of heat rejection to the 60°C sink. (6)

6. a) Establish the Inequality of Clausius? (4)

b) Two kg of air at 500 kPa, 80°C expands adiabatically in a closed System until its volume is doubled and its temperature becomes equal to that of the surroundings which is at 100 kPa, 5°C. For this process, determine (a) the maximum work, (b) the change in availability and (c) the irreversibility. For air, take c_v = 0.718 kJ/Kg K, u = c_vT where c_v is constant, and pV = mRT where p is pressure in kPa, V volume in m^3, m mass in kg, R a constant equal to 0.287 kJ/kg K, and T temperature in K. (6)

7. a) Explain mollier chart, P-V, P-T, P-V-T diagrams for pure substances. (7)

b) A domestic food freezer maintains a temperature of -150C. The ambient air temperature is 300C. If heat leaks into the freezer at the continuous rate of 1.75KJ/S what is the least power necessary to pump this heat out continuously? (3)

8. a) What is energy, dead state and triple point? (4)

b) A rigid vessel contains 1 kg of a mixture of saturated water and saturated steam at a pressure of 0.15 MPa. When the mixture is heated, the state passes through the critical point. Determine (i) The volume of the vessel (ii) The mass of liquid and of vapour in the vessel initially(iii) The temperature of the mixture when the pressure has risen to 3 MPa (iv) The heat transfer required to produce the final state. (6)

PART C

Answer any FOUR questions.

9. Derive Maxwell relations from basic thermodynamic relations? (10)
10. a) Write down the van der Waals equation of state. How does it differ from the ideal gas equation of state? (4)

b) Express the changes in internal energy and enthalpy of an ideal gas in a reversible adiabatic process in terms of pressure ratio. (6)

11. Explain different properties of real gas mixtures and the laws associated. (10)
12. a) Define adiabatic flame temperature. How is it estimated? (5)

b) What is enthalpy of combustion? What do you understand by higher heating value and lower heating value of fuel? (5)

13. a) Derive TDS Equations (4)

b) A supply of natural gas is required on a site 800 m above storage level. The gas at - 150°C, 1.1 bar from storage is pumped steadily to a point on the site where its pressure is 1.2 bar, its temperature 15°C, and its flow rate 1000 m^3 /hr. If the work transfer to the gas at the pump is 15 kW, find the heat transfer to the gas between the two points. Neglect the change in K.E. and assume that the gas has the properties of methane (CH_4 M=16) which may be treated as an ideal gas having γ = 1.33 (g = 9.75 m/s^2) (6)

14. a) Derive Clausius clapeyron equation. (6)

b) A certain gas has P c = 0.913 and V c = 0.653 kJ/kg K. Find the molecular weight and the gas constant R of the gas. (6)

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