

Code No: 113AB

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B.Tech II Year I Semester Examinations, November/December-2016

THERMODYNAMICS

(Common to AE, AME, ME, MSNT)

Time: 3 Hours

Max. Marks: 75

Note: This question paper contains two parts A and B.

Part A is compulsory which carries 25 marks. Answer all questions in Part A.
Part B consists of 5 Units. Answer any one full question from each unit.
Each question carries 10 marks and may have a, b, c as sub questions.

PART - A

(25 Marks)

1. a) Define control volume and control surface. [2]
- b) The pressure in a constant gas thermometer is measured as 32 mm of Hg above atmospheric pressure at triple point. Determine the temperature in $^{\circ}\text{C}$, when the pressure is 76 mm of Hg above atmospheric pressure. The barometer reads 752 mm of Hg. [3]
- c) Define and explain the flow work. [2]
- d) Calculate the percent error in C_v that would result if $C_p = C_v$ is assumed for liquid water at 1 atm and 27°C . [3]
- e) Define the pure substance. [2]
- f) Calculate specific enthalpy, specific volume and density of 1 kg of steam at a pressure of 1.9 MPa, having a dryness fraction 0.85. [3]
- g) What are mass fraction and mole fraction? [2]
- h) A volumetric analysis of a gaseous mixture gives the following results:
 $\text{CO}_2 = 12.0\%$ $\text{O}_2 = 4.0\%$
 $\text{N}_2 = 82.0\%$ $\text{CO} = 2.0\%$
 Determine the analysis of gas mixture on the mass basis, the molecular weight and gas constant on the mass basis for the mixture. Assume ideal gas behavior. [3]
- i) Compare Otto, Diesel and Dual cycles for given compression ratio. [2]
- j) A refrigerator has a working temperature in the evaporation and condenser coils of -30°C and 30°C , respectively. What is the maximum possible COP of the refrigerator? [3]

PART - B

(50 Marks)

2. a) Define thermodynamic property, state, path process and cycle.
- b) The temperature scale of a certain thermometer is given by the $t = A \ln P + B$, where A and B are constants and P is the thermometric property of the fluid of the thermometer. At ice point and steam point, if the thermometer property is found to be 1.5 and 7.5, respectively, what will be temperature corresponding to the thermometric property of 3.5 on Celsius scale? [5+5]

OR

3. a) Differentiate between closed system and open system.
- b) A spherical balloon contains 5 kg of air at 200 kPa and 500 K. The balloon material is such that the pressure inside is always proportional to the square of the diameter. Determine the work done when the volume of the balloon doubles as a result of heat transfer. [5+5]

4.a) Prove that $dS = \frac{\delta Q}{T}$ for a reversible process and show that the entropy is a property of a system.

b) Steam initially at 1.5 MPa and 300°C expands reversibly and adiabatically in a steam turbine to 40°C. Determine the

- Condition of steam after expansion,
- Work done by the turbine per kg of steam.

[5+5]

OR

5.a) Sketch the thermodynamic mnemonic diagram and explain its use to obtain Gibbsian equations and Maxwell relations.

b) One kg of ice at -20°C is exposed to the atmosphere which is at 20°C. The ice melts and comes into thermal equilibrium with the atmosphere. Calculate the entropy increase of the universe. Take C_p of ice as 2.093 kJ/kg.K and latent heat of the fusion of ice as 334.5 KJ/kg.

[5+5]

6.a) Explain why food cooks faster in a pressure cooker than in conventional cooking?

b) Find the internal energy of 1 kg steam at a pressure of 10 bar, when the condition of steam is

- Wet with a dryness fraction of 0.85,
- Dry and saturated, and
- Superheated, the degree of superheat being 50°C.

The specific heat of superheat steam at constant pressure is 2.01 kJ/kg. K. [5+5]

OR

7.a) Explain the procedure of obtaining dryness fraction of steam by a throttling calorimeter.

b) A room of 1000 m³ volume, contains air at 1 bar and 300 K. In the room, there is a balloon which contains air at 300 K. Suddenly, the balloon bursts. Before any air can escape through the doors or windows, the pressure in the room becomes 1.3 bar, while its temperature is still 300 K. If the volume of balloon was 50 m³, find:

- Mass of air originally in the room (outside the balloon),
- Initial pressure in bar of air in the balloon, and
- Final mass of air in the room.

[5+5]

8.a) Express Dalton's law of partial pressures. Does this law hold exactly for ideal gas mixtures?

b) A vessel of volume 0.4 m³ contains 0.45 g of carbon monoxide and 1 kg air, at 15°C. Calculate the partial pressure of each constituent and the total pressure in the vessel. The air contains 23.3% oxygen and 76.7% nitrogen by mass. Take the molar masses of carbon monoxide, oxygen and nitrogen as 28, 32 and 28 kg/k mol, respectively.

[5+5]

OR

9.a) Prove that the specific humidity is given by

$$w = 0.322 \frac{p_v}{P - p_v} \quad \text{Where } p_v = \text{partial pressure of water vapour}$$

$P =$ total pressure of air.

b) Air enters a window air conditioner at 1 atm, 30°C and 80% RH at rate of 10 m³/min and it leaves at saturated at 14°C. A part of moisture, which condenses during the process is also removed at 14°C. Determine the rate of heat and moisture removal from air.

[5+5]