Code No: 153BZ

R18

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech II Year I Semester Examinations, December - 2019

THERMODYNAMICS

(Mechanical Engineering)

Time: 3 Hours **Max. Marks: 75**

Note: This Question paper contains two parts A and B.
Part A are 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 as sub questions.

PART A

(25 Marks)

1.a) Define Zeroth law of thermodynamics. [2]

b) What are Gibbs and Helmholtz functions? [2]

c) Define enthalpy. How is it related to internal energy? [2]

d) Explain mole fraction, volume fraction. [2]

e) Draw p-v diagram of Atkinson cycle. [2]

f) What do you understand by point function and path function? What are exact and inexact differentials? [3]

g) Define availability and irreversibility. [3]

h) What is Mollier chart? Why do isotherms on Mollier diagram become horizontal in superheated region at low pressures? [3]

i) Define specific humidity and relative humidity and represent them on the psychrometric chart. [3]

j) State different types of power cycles. Mention the merits and demerits of Stirling and Ericsson Cycles. [3]

PART B

(50 Marks)

2.a) What is a thermodynamic system? Explain different classes of systems with suitable examples.

b) A 15 cm diameter vertical cylinder, closed by a piston contains a combustible mixture at a temperature of 30^0C. The piston is free to move and its weight is such that the mixture pressure is 3 bar. Upper surface of the piston is exposed to the atmosphere. The mixture is ignited. As the reaction proceeds, the piston moves slowly upwards and heat transfer to the surroundings takes place. When the reaction is complete and the contents have been reduced to the initial temperature of 30^0C, it is found that the piston has moved upwards a distance of 8.5 cm and the magnitude of heat transfer is 4 kJ. Evaluate:
i) The work
ii) Decrease in internal energy of the system. [5+5]

OR

3.a) What is meant by displacement work? Explain the path dependence of displacement work with an example.

b) 90 kJ of heat are supplied to a system at a constant volume. The system rejects 95 kJ of heat at constant pressure and 18 kJ of work is done on it. The system is brought to original state by adiabatic process. Determine:
i) The adiabatic work
ii) The values of internal energy at all end states if initial value is 105 kJ. [5+5]

4.a) Prove that the COP of the reversible refrigerator operating between two given temperatures is the maximum.

b) Water is heated at a constant pressure of 0.7 M Pa. The boiling point is 164.97^{0}C. The initial temperature of water is 0^{0}C. The latent heat of evaporation is 2066.3 kJ/ kg. Find the increase of entropy of water if the final temperature is steam. [5+5]

OR

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

b) 0.1 m^3 of an ideal gas at 300 K and 1 bar is compressed adiabatically to 8 bars. It is then cooled at constant volume and further expanded isothermally so as to reach the condition from where it started. Calculate:
i) Pressure at the end of constant volume cooling.
ii) Change in internal energy during constant volume process.
iii) Net work done and heat transferred during the cycle. Assume c_p = 14.3 kJ/kg K and c_v = 10.2 kJ/kg K. [5+5]

6.a) Explain the p-v diagram of a pure substance with an example.

b) Show that for an ideal gas, $C_p - C_v = R$. [5+5]

OR

7.a) Explain the throttling and free expansion process.

b) A rigid close tank of volume 3m^3 contains 5 kg of wet steam at a pressure of 200 k Pa. The tank is heated until the steam becomes dry saturated. Determine final pressure and heat transfer to the tank. [5+5]

8.a) Write a short note on 'by-pass factor'.

b) A mixture of hydrogen (H_2) and oxygen (O_2) is to be made so that the ratio of H_2 to O_2 is 2:1 by volume. If the pressure and temperature are 1 bar and 25^{0}C respectively, calculate: (i) The mass of O_2 required; (ii) The volume of the container. [5+5]

OR

9.a) Write a short note on:
i) Sensible heating
ii) Cooling and dehumidification
iii) Heating and humidification.

b) What is the generalized compressibility chart? Explain in detail. [5+5]

10.a) Describe the various processes involved in Lenoir cycle. Represent the cycle on P – V and T – S diagram.

b) An Ericsson cycle operating with an ideal regenerator works between 1100K and 288K. The pressure at the beginning of isothermal compression is 1.013 bar. Determine (i) the compressor and turbine work per kg of air, and (ii) the cycle efficiency [5+5]

OR

11.a) Explain the working of vapour compression cycle with a neat sketch. Represent the processes on T-S diagram.

b) The compression ratio of an air-standard Dual cycle is 12 and the maximum pressure in the cycle is limited to 70 bar. The pressure and temperature of cycle at the beginning of compression process are 1bar and 300 K. Calculate: i) Thermal efficiency, ii) Mean effective pressure. Assume: cylinder bore = 250 mm, stroke length = 300 mm, c_p = 1.005, c_v = 0.718 and γ = 1.4. [5+5]

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