INDIAN MARITIME UNIVERSITY

(A Central University, Government of India)

END SEMESTER EXAMINATION DECEMBER 2017

Programme: B.Tech (Marine Engineering) Semester: I

Subject Name: Basic Thermodynamics Subject Code: UG11T3103

UG11T2103/ UG11T1103

Date: 09.12.2017 Maximum marks: 100

Pass marks: 50

PART – A 10 x 3 Marks = 30 Marks

(All questions are compulsory)

(Consider sp. gas constant R for air is 0.287kJ/kg-K)

1. (a) Define point function and path function with examples.

   (b) In a non-flow process, there is a heat transfer loss of 1055kJ and an internal energy increase of 210kJ. Determine the work transfer and state whether the process is an expansion or compression

   (c) Draw P-v diagram of pure substance.

   (d) Write down the characteristic Equation of state for a perfect gas. Brief about each parameter of the equation

   (e) Define specific heat of a substance. Write down the relationship between specific heat of constant volume (C_v) and specific heat of constant pressure (C_p).

   (f) Determine the enthalpy of one kg of steam at 10bar and 200°C.

   (g) Explain in brief: Kelvin Planck statement.

(h) Prove that COP of heap pump is greater than COP of refrigerator by one.

(i) Define exergy and Reversible work.

(j) A heat engine receives heat from a source at 1200K at a rate of 500kJ/s and rejects the waste heat to a medium at 300K. The power output of the heat engine is 180kW. Determine the reversible power and the irreversibility rate of the process.

PART – B 5 x 14 Marks = 70 Marks

(Answer any 5 of the following)

2. Derive the steady flow energy equation. Explain the significance of the each term involved in it. (14 marks)

3. (a) Steam at 1.4MN/m^2 and of dryness fraction 0.7 is throttled to 0.11 MN/m^2. Determine the dryness fraction of the steam after throttling. (7 marks)

(b) Steam at 4 MN/m^2 and dryness fraction 0.95 receives heat at constant pressure until its temperature becomes 350°C. Determine the heat received by the steam per kilogram. (7 marks)

4. (a) For polytropic process $P_1V_1^n = P_2V_2^n$, prove that

$$\frac{T_1}{T_2} = \left(\frac{P_1}{P_2}\right)^{\frac{n-1}{n}} = \left(\frac{V_2}{V_1}\right)^{n-1}$$

(7 marks)

(b) 0.675 kg of gas at 1.4MN/m^2 and 280°C is expanded 4 times the original volume according to the law $PV^{1.3}$ =C. Determine,
(1) Original and final volume of the gas
(2) Final pressure of the gas
(3) Final temperature of the gas. (7 marks)

5. (a) A mass of 2.4kg of air at 150kPa and 12°C is contained in a gas-tight, frictionless piston-cylinder device. The air is now compressed to a final pressure of 600kPa. During the process, the heat is transferred

from the air such that the temperature inside the cylinder remains constant. Calculate the work input during this process. (7 marks)

(b) Consider an ordinary shower where hot water is at 60°C is mixed with cold water at 10°C. If it is desired that a steady stream of warm water at 45°C be supplied, determine the ratio of the mass flow rates of the hot to cold water. Assume the heat loss from the mixing chamber to be neglected and the mixing to take place at a pressure of 150kPa. (7 marks)

6. Draw P-v diagram and T-s diagram for Carnot cycle. Explain all the processes involved in the cycle. Derive the thermal efficiency of the Carnot cycle. (14 marks)

7. A quantity of gas has an initial pressure, volu
8. me and temperature of 140KN/m^2, 0.14 m^3 and 25°C, respectively. It is compressed to a pressure of 1.4 MN/m^2 according to the law $PV^{1.25}$ = constant. Determine,
   1. The change of entropy
   2. An approximate change of entropy obtained by dividing the heat transferred by the gas by the mean absolute temperature during the compression.
   3. Take C_p= 1.041 KJ/kg K C_v = 0.743 KJ/kg K (14 marks)

9. (a) Explain Second-Law Efficiency (4 marks)

   (b) Draw and explain Mollier chart (4 marks)

   (c) 1.5 kg of steam originally at a pressure of 1 MN/m^2 and temperature 225°C is expanded until the pressure becomes 0.28 MN/m^2. The dryness fraction of steam is then 0.9.Determine the change of internal energy which occurs. (6 marks)

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