INDIAN MARITIME UNIVERSITY

(A Central University, Government of India)

End Semester Examinations December 2018

B. Tech (Marine Engineering)

Semester - I

Basic Thermodynamics – (UG11T3103)

Date: 02.01.2019 Maximum Marks: 100

Time: 3Hrs Pass Marks: 50

Note:- Use of Steam Tables and Charts are permitted

PART-A

(All Questions are compulsory) (10x3=30 Marks)

Q1.

a) Define Extensive and Intensive properties with examples. 3 Marks

b) What is diffuser? Write down the SFEE for Diffuser. 3 Marks

c) Determine the enthalpy of one kg of steam at 10 bar and dryness fraction 0.95. 3 Marks

d) Write down the Real gas equations. 3 Marks

e) What is flow work? Derive the equation of flow work. 3 Marks

f) What is volume flow rate? Establish the conservation of mass equation under steady condition for control volume. 3 Marks

g) What is Carnot cycle? Explain isothermal process. 3 Marks

h) What is isentropic process? Write down the change of entropy for adiabatic process. 3 Marks

i) What is reversible work and irreversibility? 3 Marks

j) Define Thermal Energy Reservoir with Example. 3 Marks

PART-B

(5x14=70)

(Answer any five questions from Question No 2 to Question No 8.)

Q2.

a) What is steady flow process? Write down the SFEE with assumptions. 6 Marks

b) One mole of an ideal gas is heated at constant pressure from 0^oC to 200^oC. (i) Calculate work done. (ii) If the gas were expanded isothermally & reversibly at 0°C from 1 atm to some other pressure P_t, what must be the final pressure if the maximum work is equal to the work involved in (i). 8 Marks

Q3.

a) Draw the P-T and T-v diagram of pure substance and explain the various regions of the diagram in details. 6 Marks

b) A vessel having a capacity of 0.05 m^3 contains a mixture of saturated water and saturated steam at a temperature of 245°C. The mass of the liquid present is 9 kg. Find the following : 8 Marks

(i) The specific volume (ii) The specific enthalpy,

(iii) The specific entropy and (iv) The specific internal energy.

Q4.

a) Prove that PV^γ =Constant for reversible adiabatic process. Also, for perfect gas, Prove that $C_p - C_v = R$ 6 Marks

b) A container of 3 m^3 capacity contains 10 kg of CO_2 at 27°C. Estimate the pressure exerted by CO_2 by using : 8 Marks

(i) Perfect gas equation

(ii) Van der Waals' equation, For CO_2 : a = 362850 $Nm^4/(kg\text{-}mol)^2$, b = 0.0423 $m^3/(kg\text{-}mol)$

Q5.

a) When a stationary mass of gas was compressed without friction at constant pressure its initial state of 0.4 m^3 and 0.105 MPa was found to change to final state of 0.20 m^3 and 0.105 MPa. There was a transfer of 42.5 kJ of heat from the gas during the process. How much did the internal energy of the gas change? 6 Marks

b) In a gas turbine unit, the gases flow through the turbine at 15 kg/s and the power developed by the turbine is 12000 kW. The enthalpies of gases at the inlet and outlet are 1260 kJ/kg and 400 kJ/kg respectively, and the velocity of gases at the inlet and outlet are 50 m/s and 110 m/s respectively. Calculate : (i) The rate at which heat is rejected to the turbine, and (ii) The area of the inlet pipe given that the specific volume of the gases at the inlet is 0.45 m^3/kg. 8 Marks

Q6.

a) What is Thermal Energy Reservoir (TER) and PMM2? 6 Marks

b) A house requires 2 × 105 kJ/h for heating in winter. Heat pump is used to absorb heat from cold air outside in winter and send heat to the house. Work required to operate the heat pump is 3 × 104 kJ/h. Determine : 8 Marks
(i) Heat abstracted from outside ;
(ii) Co-efficient of performance.

Q7.

a) What is entropy? Prove that entropy is a property of the system. 6 Marks

b) 0.04 m^3 of nitrogen contained in a cylinder behind a piston is initially at 1.05 bar and 15°C. The gas is compressed isothermally and reversibly until the pressure is 4.8 bar. Calculate: (i) The change of entropy, (ii) The heat flow, and (iii) The work done. Assume nitrogen to act as a perfect gas. Molecular weight of nitrogen = 28. 8 Marks

Q8.

a) Explain Second law efficiency and Exergy. 6 Marks

b) Air flows through an adiabatic compressor at 2kg/sec. The inlet conditions are 1bar and 310K and the exit conditions are 7 bar and 560K. Determine the net rate of exergy transfer and the irreversibility. The ambient temperature can be taken as 298K, the specific heat at constant pressure for air is 1.005 kJ/kgK and the gas constant for air is 0.287 kJ/kgK. 8 Marks

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