INDIAN MARITIME UNIVERSITY

(A Central University, Government of India)

End Semester Examinations- June-July 2019

Semester – I

B.Tech (Marine Engineering)

Basic Thermodynamics (UG11T3103)

Date: 13-07-2019 Maximum Marks: 100

Time: 3 Hrs Pass Marks: 50

PART-A (Marks: 10×3 = 30)

(All Questions are compulsory)

1. a) Define Point function and Path function with example of each

   b) State first law of thermodynamics for cyclic process and closed system

   c) Define Saturation Temperature and Saturation Temperature

   d) Write characteristic equation of state; write meaning of terms with units

   e) Establish energy balance for adiabatic mixing process

   f) Write conservation of mass principle for incompressible flow

   g) Prove that, $COP_{Heat\ Pump} = COP_{Refrigerator} + 1$

   h) State Carnot theorems

   i) What is Exergy and Dead State?

   j) Write principle of Exergy destruction

PART-B (Marks: 5×14 = 70)

(Answer any 5 of the following 7 Questions)

2. a) Apply First law of thermodynamics to following non-flow processes
   i) Constant volume process ii) Constant pressure process (6)

b) Air enters a compressor at 10^5 Pascal and 25°C having volume of 1.8 m^3/kg and is compressed to 5×10^5 Pascal isothermally. Determine: i) Work done ii) Change of Internal energy and iii) Heat transferred (8)

3. a) Explain phase change process of a pure substance with T-v diagram (6)

b) Find the specific volume, enthalpy and internal energy of wet steam at 18 bar and dryness fraction 0.85 (8)

4. a) State Joule's law and prove that $\Delta U = mc_v(T_2 - T_1)$, where T_2 and T_1 are the final and initial temperatures during a non-flow process. (6)

b) 0.25 kg of air at a pressure of 140 kN/m^2 occupies 0.15 m^3 and from this condition it is compressed to 1.4 MN/m^2 according to law $pV^{1.25}=C$. Determine: i) change in internal energy of the air ii) the work done on the air and iii) the heat received or rejected by the air, Take c_p=1.005 kJ/kgK, c_v=0.718 kJ/kgK. (8)

5. a) What is specific heat at constant volume and constant pressure? Why solids and liquids have only one specific heat? (6)

b) At the inlet to a certain nozzle the enthalpy of fluid passing is 2800 kJ/kg and the velocity is 50 m/s. At the discharge end the enthalpy is 2600 kJ/kg. The nozzle is horizontal and there is negligible heat loss from it. Find: i) the velocity at the exit of the nozzle and ii) mass flow rate through nozzle if the inlet area is 900 cm^2 and specific volume at the inlet is 0.187 m^3/kg. (8)

6. a) Why Carnot cycle is not practicable for heat engines? (6)

b) A fish freezing plant requires 40 tons of refrigeration. The freezing temperature is -35°C while the ambient temperature is 30°C. If the performance of the plant is 20% of the theoretical reversed Carnot cycle working within the same temperature limits, calculate the power required to run the plant. (Take 1 Ton= 210 kJ/min) (8)

7. a) Derive the general expression for change in entropy of a gas in terms of temperature and volume. (6)

b) A rigid cylinder containing 0.004 m^3 of nitrogen at 1 bar and 300 K is heated reversibly until temperature becomes 400 K. Determine i) the heat supplied and ii) the entropy change. Assume Nitrogen to be a perfect gas (molecular mass = 28 and γ =1.4). (8)

8. a) Explain Irreversibility and Second law efficiency in brief. (6)

b) A heat engine receives heat from a source at 1200 K at a rate of 500 kJ/s and rejects the waste heat to a medium at 300 K. The power output of the heat engine is 180 kW. Determine the reversible power and the irreversibility rate for this process. (8)

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