INDIAN MARITIME UNIVERSITY

(A Central University, Government of India)

End Semester Examinations- June-July 2019

Semester – I

B.Tech (Marine Engineering)

Basic Thermodynamics–(UG11T2103)

Date: 13-07-2019 Maximum Marks: 100

Time: 3 Hrs Pass Marks: 50

PART – A **(3 x10 = 30 Marks)**

Compulsory Questions

1 (a) Explain the statement "conservation of Energy".

(b) How do you classify thermodynamic system?

(c) What is meant by intensive and extensive property? Give an example

(d) What is meant by thermodynamic equilibrium?

(e) What are meant by reversible and irreversible processes?

(f) What are the limitations of first law of thermodynamics?

(g) Define the term enthalpy?

(h) What are the important characteristics of entropy?

(i) State the Kelvin–Planck statement of second law of thermodynamics.

(j) What is the difference between a heat pump and a refrigerator.

PART-B **(5X14=70)**

(Answer any five from 2 to 8)

2. Briefly explain the following:

(i) Adiabatic and Isothermal process (4)

(ii) System, state (6)

(iii) Quasi- Equilibrium process. (4)

3(a) The temperature inside a Carnot refrigerator is maintained at 5°C by rejecting heat to the surroundings at an ambient temperature of 27°C. The inside temperature is now decreased to −13°C, the ambient temperature remaining Constant at 27°C. Determine the percent increase in input for the same quantity of heat removed. (7)

(b) Water is continuously spilling over a water tank at a height of 100 m from ground level. a) Calculate the potential energy of the water at the top of the tank with respect to its base. b) Calculate the kinetic energy of the water just before it strikes the floor. c) After the water enters the flow below, what change has occurred to its state? Calculate for 1 kg of water in all three cases, assuming that there is no energy exchange with the surroundings. (7)

(4) State and derive steady flow energy equation and apply it to a boiler, condenser, nozzle and turbine. (14)

5(a) A steam power plant uses steam at boiler pressure of 150 bar and temperature of 550°C with reheat at 40 bar and 550 °C at condenser pressure of 0.1 bar. Find the quality of steam at turbine exhaust, cycle efficiency and the steam rate. **Given Data:** p_1 = 150 bar, T_1 = 550°C,p_2 = 40 bar, T_3 = 550 °C, p_3 = 0.1 bar, **find:**

(i) The quality of steam at turbine exhaust,(ii)Cycle efficiency and (iii) The steam rate (7)

(b) Air leaves a heat exchanger at a temperature of 750 °C and enters a turbine at a speed of 25 m/s. Speed of air at the turbine outlet is 50 m/s. Temperature at the outlet, assuming isentropic expansion, is 500°C. Mass flow rate of air is 1.5 kg/s. Neglect heat transfer. Assume total-to-static efficiency of the turbine to be 85%. Take C_p=1005 J/kg-K for air. Determine:

i) the ratio of outlet pressure to inlet pressure

ii) the power output from the turbine …….. (kW) (7)

iii)

6 (a) Air at 1 bar and 298.15K (25℃) is compressed to 5 bar and 298.15K by two different mechanically reversible processes: (i) Cooling at constant pressure followed by heating at constant volume. (ii) Heating at constant volume followed by cooling at constant pressure. Calculate the heat and work requirements and ΔU and ΔH of the air for each path. The following heat capacities for air may be assumed independent of temperature: CV= 20.78 and CP=29.10 J mol-1 K-1 Assume also for air that PV/T is a constant, regardless of the changes it undergoes. At 298.15K and 1 bar the molar volume of air is 0.02479 m3 mol-1 (7)

(b) A 34 kg steel casting at a temperature of 427°C is quenched in 136 kg of oil initially at 21°C. Assuming no heat losses and the steel casting and oil to have constant specific heats of 0.5024 and 2.5121 kJ/kg − °K respectively, determine the change in entropy for a system consisting of the oil and casting. (7)

7. A 0.1 m diameter, 0.1 m high solid copper cylinder is initially at 180°C. It is then placed in a room and is allowed to cool to a final temperature of 30°C. Assuming copper to have a density of 8954 kJ/kg − °K, calculate the heat transfer and the irreversibility of the process if the temperature of the surroundings (T_0) is 25°C. (14)

8. A mixture of 1.78 kg of water and 262 g of ice at 0°C is, in a reversible process, brought to a final equilibrium state where the water / ice ratio, by mass 1:1 at 0°C. (i) Calculate the entropy change of the system during this process. (ii) The system is then returned to the first equilibrium state, but in an irreversible way (by using a Bunsen burner, for instance). Calculate the entropy change of the system during this process. (iii) Show that your answer is consistent with the second law of thermodynamics.

6+4+4=14

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