B.E. CONSTRUCTION ENGINEERING 1ST YEAR 2ND SEMESTER(Old)-2019

THERMODYNAMICS AND HEAT POWER

Time: Three Hours **Full Marks:100**

Answer any five question

Answer to all parts of a question must be together

Assume any data, if not furnished, consistent with the problem.

1.(a) Define (i) Quasi-static process (ii) dryness fraction (iii) point function (iv) TER. 8

(b)What is the difference between intensive and extensive properties? Give examples. 4

(c) State the purpose of reheating a simple Rankine cycle. 2

(d) Establish the relation: $COP_{HP} = COP_R + 1$. 2

(e) It is desired to have a comfortable 20°C inside a room on a hot summer day having an outside temperature of 40°C. What will be the power consumption, if a 2 TON air-conditioner is running in the room? [1 TON = 3.5 kW] 4

2.(a) Show that the violation of Kelvin-Planck statement leads to the violation of Clausius statement. 10

(b) Derive the energy balance equation for a steady flow system with a single stream. What is the difference between a closed and open system? 10

3.(a) Write the expression for cycle efficiency, in terms of compression ratio, for an Otto cycle and show the processes on p-V planes. 8

(b) Write six difference between a 2-stroke and a 4-stroke engine. 12

4.(a) A blower handles 1 kg/s of air at 20°C and consumes a power of 15 kW. The inlet and outlet velocities of air 100 m/s and 150 m/s respectively. Find the exit air temperature, assuming adiabatic conditions. 8

(b) Define heat and work. What do you understand by "increase of entropy principle"? 6

(c) State the Kelvin-Planck statement of 2nd law? What is the difference between a refrigerator and a heat pump? 6

5.(a) Water is heated at a constant pressure of 0.7 MPa. The boiling point is 164.97°C. The initial temperature of water is 0°C. The latent heat of evaporation is 2066.3 kJ/kg. Find the increase of entropy of water, if the final state is steam. 6

(b) Two bodies each of equal mass m and heat capacity c, are of temperatures T_1 and T_2 ($T_1 > T_2$) respectively. The first body is used as a source of reversible engine and the second body as the sink. Show that the maximum work obtainable from such an arrangement is:

$$W_{max} = mc\left[\left(\sqrt{T_1} - \sqrt{T_2}\right)\right]^2$$ 8

(c) A 30-kg iron block and a 40-kg copper block, both initially at 80°C, are dropped into a large lake at 15°C.Thermal equilibrium is established after a while as a result of heat transfer between the blocks and the lake water. Determine the total entropy change for this process. 6

6.(a) Using an engine of 30 % thermal efficiency to drive a refrigerator having a COP of 5, what is the heat input into the engine for 1 MJ removed from the cold body by the refrigerator? If this system is used as a heat pump, how many MJ of heat would be available for heating, for each MJ of heat input to the engine? 8

(b) State the Clausius statement. What is a PMM-II? Also mention the Carnot principles. 6

(c) A refrigerator plant for a food store operates as a reversed Carnot heat engine cycle. The store is to be maintained at a temperature of -5°C and the heat transfer from the store to the cycle is at a rate of 5 kW. If heat is transferred from the cycle to the atmosphere at a temperature of 25°C; calculate the power required to drive the plant. 6

7.(a) Air flows steadily at the rate of 0.4 kg/s through an air compressor, entering at 6 m/s with a pressure of 1 bar and a specific volume of 0.85 m^3/kg, and leaving at 4.5 m/s with a pressure of 6.9 bar and a specific volume of 0.16 m^3/kg. The internal energy of the air leaving is 88 kJ/kg greater than that of the air entering. Cooling water in a jacket surrounding the cylinder absorbs heat from the air at the rate of 59 W. Calculate the power required to drive the compressor. 10

(b) From the definition of First law of thermodynamics derive the expression for heat interaction during an adiabatic process, with ideal gas as the working medium. 6

(c) Highlight two difference between a CI and SI engine. 4