Bachelor of Met Engineering 1st Year 2nd Semester Examination, 2018

HEAT ENGINEERING

Time: Three hours Full Marks: 100

Answer should be precise and 'to-the-point'. Use of Air, Steam and Refrigerant tables are permitted, if necessary. Data, if unfurnished, may be assumed consistent with the problem.

Answer any **FIVE** questions.

1.(a) Define: sub-cooled liquid, intensive property, triple point, work, compression ratio, saturated liquid. 12

(b) Show the following processes for water with proper labeling:

(i) Isobaric process from sub-cooled liquid zone to superheated vapor zone on Temperature-volume diagram.
(ii) Isothermal process from superheated vapor zone to saturated zone on enthalpy-entropy diagram. 6

© Discuss critical point. 2

2. (a) State the first law of Thermodynamics for a cycle. What is PMM-I? State the assumptions for steady and non-uniform flow process. 2+2 +4

(b) 1 Kg of water in a piston cylinder at 200° C and 1000 KPa is expanded in a isochoric process to 30 KPa. Find out the work done, heat transfer, and change in internal energy, enthalpy & entropy during the process. Also plot the above process on P-v plane. 12

3. (a) State the two statements of 2nd law of thermodynamics. State the two propositions (carnot theorems) regarding the efficiency of a carnot cycle. 4+4

(b) The exit pressure of a steam turbine is 20 KPa. The mass flow rate of steam is 1 Kg/s. Steam enters the turbine at 4 MPa, 300° C . What is the power output of the turbine. Plot the process on h-s & T-s diagrams with proper labeling. 12

4. (a) Write down the assumptions for the analysis of an air standard power cycle. 4

(b) A heat pump maintains a room at 25°C, being surrounded by an ambient whose temperature is -20°C, and has a COP of 8.5. How do you evaluate this claim? 6

© A piston cylinder contains 1 Kg of air at 120° C and 200 KPa. It undergoes an isobaric process to 300° C. Find out the work done, heat transfer, and change in internal energy, enthalpy & entropy during the process. Also plot the above process on T-v plane. 10

5. (a) Derive an expression for air standard thermal efficiency of Otto cycle in terms of compression ratio and the ratio of specific heats. 8

(b) In a refrigerator, R-134a enters the condenser as saturated vapor and leaves as saturated liquid. Evaporator temperature is -40° C and the condenser temperature is 60° C. Find out the heat and work transfer in all the components. Evaluate COP of the refrigerator. Plot the process on T-s and P-h diagram with proper labeling. 12

6. (a) Define: turbine efficiency, cut-off ratio, nozzle efficiency. 6

(b) An engine operates on Ottol cycle. At the beginning of compression, the temperature, pressure and volume are 30°C, 125 KPa and 0.35 $m^3$ respectively. The compression ratio is 10 and the the maximum temperature is 2200°C. Calculate the heat added, heat rejected, the net work done, mean effective pressure and the air standard thermal efficiency of the above cycle. Plot the cycle on P-v and T-s planes with proper labeling. 14

7. (a) Define Rankine cycle. What is reheating? What is its advantage? 6

(b) In a steam power plant, the operating pressure of boiler is 6 MPa and the operating pressure of condenser is 10 KPa. Steam enters the Turbine at 400° C. Steam leaves the condenser as saturated liquid. Find out the heat and work transfer in all the components. Determine the efficiency of the cycle. Plot the cycle on T-s diagram and label properly. 14

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