Ex/MET/ME/T/124/ 2017

Bachelor of Met Engineering 1st Year 2nd Semester Examination, 2017

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: compressed liquid, extensive property, triple point, heat, compression ratio, saturated vapor. 12

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

(i) Isothermal process from sub-cooled liquid zone to superheated vapor zone on Pressure-volume diagram.
(ii) Isobaric 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 and hence, show that energy is a property of a system. 8

(b) A piston cylinder contains 2 Kg of air at 150° C and 850 KPa. It is expanded in a reversible isothermal process to 200 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. Show that entropy is a property of a system. 8

(b) The exit pressure of a steam turbine is 10 KPa. The mass flow rate of steam is 2.5 Kg/s. Steam enters the turbine at 3.5 MPa, 400° C . What is the power output of the turbine. Plot the process on h-s diagram with proper labeling. 12

4. (a) Why Carnot cycle is not used in power plants? What is superheating? 6

(b) In a steam power plant, the operating pressure of boiler is 4.5 MPa and the operating pressure of condenser is 15 KPa. Steam enters the Turbine at 450° 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

5. (a) Define: compressor efficiency, cut-off ratio, heat engine. 6

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5.(b) An engine operates on Diesel cycle. At the beginning of compression, the temperature, pressure and volume are 20°C, 100 KPa and 0.4 $m^3$ respectively. The compression ratio is 20 and the the maximum temperature is 2000°C. Calculate the heat added, heat rejected, the net work done, the cut-off ratio, 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

6. (a) Derive an expression for air standard thermal efficiency of Brayton cycle in terms of pressure 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 -25° C and the condenser temperature is 45° C. Find out the heat and work transfer in all the components. Evaluate COP of the refrigerator. Plot the process on T-s diagram with proper labeling. 12

7. (a) Discuss on the causes of irreversibility. 4

(b) A refrigerator maintains the a refrigerated space at -20°C, while operating in a room where the temperature is 35°C, and has a COP of 8.5. How do you evaluate this claim? 6

© 3 Kg of water in a piston cylinder at 150° C and 100 KPa is expanded in a reversible adiabatic process to 20 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. 10

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