Ref. No. : Ex/Met/ME/T/124/2019(old)

B.E. METALLURGICAL AND MATERIAL ENGINEERING FIRST YEAR SECOND SEMESTER EXAM 2019(old)

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: control volume, intensive property, triple point, heat, coefficient of performance for heat pump, compressed liquid. 12

(b) Show the following processes for water with proper labeling:
(i) Isothermal process from compressed liquid zone to superheated vapor zone on P-v diagram.
(ii) Isobaric process from saturated zone to superheated vapor zone on enthalpy-entropy diagram. 6

(c) Define critical point. 2

2. (a) Define energy. State the first law of Thermodynamics for a cycle and hence, show that energy is a property. 8

(b) 1 Kg of air in a piston cylinder at 200° C and 800 KPa is expanded in a isothermal process to 100 KPa. State the assumptions. 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. 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) Discuss the effect of pressure on Rankine cycle. 4

(b) A steam power plant operates between 2 MPa and 10 KPa, the Turbine inlet temperature being 300° C. State clearly the assumptions. 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. 16

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5. (a) Define: mean effective pressure, turbine efficiency, pressure ratio, specific heat. 8

(b) At the beginning of compression in an air standard otto cycle, the temperature, pressure and volume are 25°C, 95 KPa and 0.2 m3 respectively. If the compression ratio is 8 and the amount of heat added in the cycle is 800 KJ/Kg, calculate the maximum temperature, heat rejected, the net work done, mean effective pressure and the air standard thermal efficiency of the above cycle. Plot the cycle on T-s planes with proper labeling. 12

6. (a) Define cut-off ratio and compressor efficiency. Derive an expression for air standard thermal efficiency of Brayton cycle in terms of pressure ratio and the ratio of specific heats. 4+6

(b) A refrigerator with R-134a as the working fluid works between -20° C and 40° C temperature limits. The refrigerant enters the condenser as saturated vapor and leaves as saturated liquid. State the necessary assumptions. 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. 10

7. (a) State the assumptions for steady and non-uniform flow process. 4

(b) An inventor claims to have developed a refrigerator that maintains the refrigerated space at -10°C, while operating in a room where the temperature is 25°C, and which has a COP of 9. How do you evaluate his claim? How would you evaluate his claim of a COP of 7.0? 4

(c) 1 Kg of water in a piston cylinder at 300° C and 1000 KPa is expanded in a reversible adiabatic process to 40 KPa. Find out the work done, heat transfer, and change in internal energy, enthalpy & entropy during the process. Also plot the above process on h-s plane. 12