B.E. ELECTRICAL ENGINEERING FIRST YEAR SECOND SEMESTER – 2017

THERMODYNAMICS AND HEAT POWER ENGINEERING.

Full Marks: 100 Time: 3 hours

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

1. a) Define: energy, nozzle efficiency, triple point, heat, dryness fraction, degree of superheat. 12

   b) Show the following processes for water with proper labelling: 5
   (i) Isobaric process from solid phase zone to superheated vapour zone on P-v-T equilibrium surface, passing between triple line and critical point.
   (ii) Isothermal process from superheated vapour zone to liquid-vapour two phase zone on enthalpy-entropy plane.

   c) Explain critical point. 3

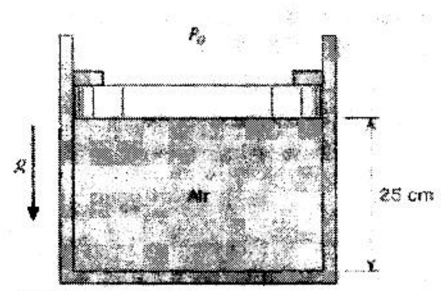

FIGURE P3.111

2. a) State the first law of Thermodynamics for a cycle. What is PMM-I? 5

   b) A piston/cylinder arrangement, shown in Fig. P3.111, contains air at 250 kPa and 300°C. The 50-kg piston has a diameter of 0.1 m and initially pushes against the stops. The atmosphere is at 100 Kpa and 20°C. The cylinder now cools as heat is transferred to the ambient surroundings. At what temperature does the piston begin to move down? How far the piston drops when the temperature reaches the ambient? 15

3. a) Show that stored energy is a property of system. 6

   b) A piston/cylinder arrangement contains water that has the piston exposed to atmospheric pressure. The piston mass is such that the pressure inside is 150 kPa. The temperature of inside water is 10°C. This water is heated until it becomes saturated vapour. Find the final temperature and specific heat and work transfer for the process. Plot the process on T-v plane and label properly. 14

4. a) Write down the two statements of the second law of thermodynamics. Show that entropy is a property of a system. 4+4=8

   b) Steam enters a nozzle at 0.6 MPa, 200° C with a velocity of 50 m/s. It leaves at a pressure of 150 KPa and a velocity of 600 m/s. Isentropic efficiency of the nozzle is 0.95. Determine the condition of steam at nozzle outlet. Plot the process on h-s plane with proper labelling. 14

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5. a) What is superheating and sub-cooling? Why are they necessary in steam power plants? 6

   b) In a steam power plant, steam enters the turbine at 350°C. Boiler pressure is 3.5 MPa and condenser pressure is 15 KPa. Steam comes out of 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 plane and label properly. 14

6. a) The maximum temperature in an air standard Otto cycle is 1400°C. At the beginning of compression, the temperature, pressure and volume are 25°C, 125 KPa and 0.3 m^3 respectively. Compression ratio is 10. 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 labelling. 10

   b) A refrigerator has R-134a as the working fluid. The refrigerant enters the condenser as saturated vapour and leaves as saturated liquid. The evaporator temperature is -30° C and the condenser temperature is 50° 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 planes with proper labelling. 10

7. a) Deduce the expression for temperature distribution as a function of radius for a solid cylinder with heat generation with surface temperature being specified. 8

   b) State the Fourier's law of heat conduction. 2

   c) A plane composite wall is made of materials A and B with thicknesses 50 mm & 20 mm and thermal conductivities 75 w/m-K & 150 w/m-K respectively. It has side A exposed to a hot stream of air at 90°C with convective heat transfer co-efficient being 1100 w/m^2-K, while side B is exposed to a cold stream of air at 10°C with convective heat transfer co-efficient being 1000 w/m^2-K. Find the rate of heat transfer per unit area of this composite wall. 10

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