B. E. CIVIL ENGINEERING SECOND YEAR FIRST SEMESTER SUPPLEMENTARY EXAM. 2018

THERMODYNAMICS & HEAT POWER Time -- Three hours Full Marks – 100

Answer any 5(Five) questions. All questions carry equal marks.
Use of Steam Tables and Thermodynamic Tables are allowed.
Parts of the same question are to be answered sequentially.
Unfurnished data, if any, can be assumed suitably.

1.a) Define Thermodynamic equilibrium of a system.
b) Explain the similarities and differences between "Heat" and "Work".
c) A vessel having a volume of $0.4m^3$ contains 2.0kg of a liquid water and water vapor mixture in equilibrium at a pressure of 600 kPa. Calculate:
i) The volume and mass of liquid.
ii) The volume and mass of vapor. 5+5+10=20

2. a) A Cylinder fitted with a piston has a volume of $0.1m^3$ and contains 0.5kg of steam at 0.4MPa. Heat is transferred to the steam until the temperature is 300^0C, while the pressure remains constant. Determine the heat transfer and the work for this process.
b) Draw the constant pressure process and constant temperature process on the P-v and T-s planes for a pure substance. Also define Critical Point of a pure substance. 12+8=20

3.a) Derive the First Law of Thermodynamics for a Steady-State, Steady-Flow Process with proper assumptions.
b) Explain Throttling process. Show that under Steady-State, Steady-Flow conditions and also with suitable assumptions the Throttling process is a constant Enthalpy process. 10+10=20

4.a) State the two statements of the Second Law of Thermodynamics and prove that they are equivalent.
b) A Reversed Carnot cycle refrigerator operates in a room in which the temperature is 20^0C. It is required to transfer heat from the cold space at the rate of 5kW in order to maintain its temperature at -30^0C. What power motor is required to operate this refrigerator? 12+8=20

5.a) Explain the difference between a Heat Pump and a Refrigerator. Which one has a higher COP when operating between the same two Thermal Reservoirs?
b) Steam at 0.6MPa, 200^0C enters an insulated nozzle with velocity of 50m/s. It leaves at a pressure of 0.15MPa and a velocity of 600m/s. Determine the final temperature if the steam is superheated in the final state, or the quality if it is saturated in the final state. 10+10=20

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6.a) Show that "Entropy" is a property of a system.

b) Prove the Thermodynamic relations :

$$TdS = dU + PdV$$

$$TdS = dH - VdP$$

Using the above relations, find out the entropy change of an ideal gas with changes in temperature, pressure or volume. 8+12=20

7. a) Enumerate the assumptions of an "Air-Standard Cycle". Derive the expression of thermal efficiency of the Air-Standard Otto Cycle.

b) The compression ratio in an air-standard Otto cycle is 8. At the beginning of the compression stroke the pressure is 0.1 MPa and the temperature is 15^0C. The heat transfer to the air per cycle is 1800 kJ/kg air. Determine:

i) The pressure and temperature at the end of each process of the cycle.

ii) The thermal efficiency

iii) The mean effective pressure. 10+10=20

8. a) In a Rankine cycle steam leaves the boiler and enters the turbine at 4 MPa, 400^0C. The condenser pressure is 10kPa. Determine the cycle efficiency neglecting the pump work.

b) Explain the effects of changes in pressure and temperature on the performance of the Rankine cycle with suitable diagrams. 10+10=20

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