B. E. CIVIL ENGINEERING SECOND YEAR SECOND SEMESTER EXAM. 2018 (OLD)

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.
Incase of insufficiency of data, if any, suitable assumptions may be made.

1.a) Define Thermodynamic equilibrium of a system.
b) Differentiate between Macroscopic and Microscopic aspects of Thermodynamic analysis.
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) Show that Throttling is a constant Enthalpy process. 12+8=20

3.a) Derive the First Law of Thermodynamics for a Steady-State, Steady-Flow Process with proper assumptions.
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

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? 10+10=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) Helium has the lowest normal boiling point of any of the elements, namely 4.2K. At this temperature helium has an enthalpy of evaporation of 83.3kJ/kmol. A Carnot Refrigeration cycle is to be analyzed for the production of 1 kmol of liquid helium at 4.2K from saturated vapor at the same temperature. What is the work input to the refrigerator and the coefficient of performance of the refrigeration cycle, assuming that the ambient at a temperature of 300k acts as the high temperature thermal reservoir for the refrigerator. 8+12=20

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) An Air-Standard Diesel cycle has a compression ratio of 18, and the heat transferred to the working fluid per cycle is 1800kJ/kg. At the beginning of the compression process the pressure is 0.1MPa and the temperature is 15^0C. Determine :

i) The pressure and temperature at each nodal point in 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 with and without considering pump work.

b) Write short notes on any one of the following :

i) P-V-T surface for a pure substance which expands during freezing.

ii) The Rankine Cycle. 10+10=20