Thermal Engineering

Time: 3 Hrs.   Prelim Question Paper   [Marks : 70

Instructions:

1. All questions are compulsory.
2. Illustrate your answer with neat sketches wherever necessary.
3. Figure to the right indicates full marks.
4. Assume suitable data if necessary.
5. Preferably, write the answers in sequential order.
6. Use only H/2H grade pencils.

1. Attempt any **FIVE** of the following.   **[10]**
   (a) Explain difference between Thermodynamic Heat & Work transfer.
   (b) State Charle's law.
   (c) Define Dryness fraction and degree of superheat.
   (d) List out the losses in steam turbines.
   (e) Explain the purpose of compounding of steam turbines.
   (f) Define Mach number and critical pressure.
   (g) Define thermal Conductivity. State it's Unit.

2. Attempt any **THREE** of the following.   **[12]**
   (a) Apply steady state energy equation with a block diagram to nozzle & turbine.
   (b) Define adiabatic process and plot it on Pv & Ts diagrams.
   (c) Describe generation of steam at constant pressure with temperature enthalpy diagram
   (d) Draw a neat sketch of Loeffler boiler and explain its working.

3. Attempt any **THREE** of the following.   **[12]**
   (a) Classify steam turbines in detail.
   (b) Explain the working of impulse steam turbine with a sketch. Also show pressure 7 velocity variation for the same.
   (c) A gas at 7 bar, 400 K occupies a volume of 0.2 m^3. The gas expands according to the law $PV^{1.5}$ = C upto pressure of 1.5 bar. Determine work transfer.
   (d) Determine the state of steam if
       (i) Pressure is 10 bar and specific volume is 0.185 m^3/kg
       (ii) Pressure is 12 bar and temperature is 200°C.

4. Attempt any THREE of the following. **[12]**

(a) State the sources of air leakage and its effects in steam condenser.

(b) Wet steam at 10 bar pressure having total volume of 0.125 m^3 and enthalpy content is 1800 kJ. Calculate mass and dryness fraction of steam.

(c) A CO_2, gas expands adiabatically from a pressure and volume of 7 bar and 0.03 m^3 respectively to pressure 1.4 bar. Determine :
(i) Final volume   (ii) Work done   (iii) Change in internal energy
Assume C_p = 1.046 kJ/kg K and C_v = 0.752 kJ/kg K

(d) Draw a labelled sketch of plate heat exchanger. (6)

(e) Draw neat sketch of any one type of surface condenser with neat sketch.

5. Attempt any **TWO** of the following. **[12]**

(a) What is governing of steam turbine? Explain with neat sketch nozzle control governing.

(b) In a cold storage, the wall measures 3 m × 4 m constructed of bricks, 10 cm thick cork slab, insulation of 7.5 cm from outside and additional pine wood covering of 2.5 cm thick protecting cork. If the internal temperature is −5°C and outside temperature is 20 °C. Find out heat leakage per unit time. Thermal conductivity is 0.25 per brick, 0.036 for cork and 0.092 W/mK for pine wood.
What would be interface temperature?

(c) Calculate enthalpy of 1 kg of steam at a pressure of 7 bar and dryness fraction 0.8. Howe would be required to raise 2 kg of this steam from water at 30°C? C_{pw} = 4.187 kJ/kg°C.

6. Attempt any **TWO** of the following. **[12]**

(a) A steam of gases at 7.5 bar, 750°C and 140 m/s is passed through a turbine of a jet engine. The steam comes out of the turbine at 20 bar, 550°C and 280 m/s. The process is assumed to be adiabatic. The enthalpy of gas at the entry and exit of the turbine are 950 kJ/kg and 650 kJ/kg of gas respectively. Find the capacity of turbine.

(b) What is the function of cooling tower? Explain with neat sketch, the working of induced draught cooling tower.

(c) A metal pipe having diameter of 150 mm carries steam at 250°C. The pipe is covered externally by a 25 mm thick of an insulting material whose thermal conductivity is 0.152 W/mK. If outside temperature is 38°C. Find out amount of heat lost per metre length per minute.

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