Centre for Energy Studies
(Major Test)
ESL (Energy Conversion & Management)

Time 1 hrs
M.M. 30

Note: Answer Section A and Section B on separate sheets

Part - A: Thermal

1 (a) Drive an expression for the Entropy Generation for the mixing of two fluids with different mass flows and temperatures. Discuss the special cases. (6)

(b) Show the equivalence between the Heat Transfer irreversibility and the pressure drop irreversibility. (2)

2 (a) A heat pump is to be used to heat a house in winter and then reversed to cool the house in summer. The interior temperature is to be maintained at 22°C. Heat transfer through the wall and roof is estimated to be 2500 kJ per hour per degree temperature difference between the inside and outside. Find the (i) minimum power required to derive the heat pump if the outside temperature in winter is -3°C.

(ii) If the same power input is used for cooling also as in part (a), what is the maximum outside temperature for which the inside temperature can be maintained at 22°C. (6)

(b) A 500 kg iron block is initially at 200°C and is allowed to cool to 27°C transferring heat to the surroundings air at 27°C. Determine the reversible work and irreversibility for this process. If this iron block is to be used to maintain a room at 27°C when the out door air is 5°C. Determine the maximum heat that can be transferred to the house as the iron block cools to 27°C. (4)

3 (a) Define the Second Law efficiency and show that

$$\eta_{II}=\eta_I\frac{(1-To/Tu)}{(1-To/Tf)}$$

Where symbols have their usual meanings. By burning a fuel the rate of heat release is 500 kW at 2000 K. What would be first and second law efficiencies if
(a) Energy is absorbed in a furnace at the rate of 480 kW at 1000 K.
(b) Energy is absored at the rate of 450 kW for steam generation at 500 K
(c) Energy is absorbed in a chemical process at the rate of 300 kW at 350 K. Assuming the surroundings temperature T_o = 300 K (6)

(b) Explain How

(i) Heat pump is cost effective for space heating in large Buildings
(ii) Cost is also related to the Second Law Efficiency
(iii) Irreversibility and lost Available Work are proportional to Entropy Generation
(iv) Entropy generation is due to Irreversible heat and work Transfer
(v) Work is Heat available at infinite temperature
(vi) One TR is 3.5167 kW (6)