Course : Applied Thermal Engineering (UMT303)

Batch: B.E. Mechatronics (2nd yr.) **Faculty: Dr. Sayan Sadhu**

Tutorial No. 05 **Topic: Second Law of Thermodynamics**

Q1. A power cycle operating between two thermal reservoirs receives energy Q_H by heat transfer from a hot reservoir at T_H = 2000 K and rejects energy Q_C by heat transfer to a cold reservoir at T_C = 400 K. For each of the following cases determine whether the cycle operates reversibly, operates irreversibly, or is impossible. (a) Q_H = 1000 kJ, η= 60%, (b) Q_H = 1000 kJ,W_{cycle} = 850 kJ,(c) Q_H = 1000 kJ, Q_C = 200 kJ. **[Ans. irreversible, impossible, reversible]**

Q2. The food compartment of a refrigerator is maintained at 4°C by removing heat from it at a rate of 360 kJ/min. If the required power input to the refrigerator is 2 kW, determine (a) the coefficient of performance of the refrigerator and (b) the rate of heat rejection to the room that houses the refrigerator **[Ans. 3.0, 480 kJ/min]**

Q3. A heat pump is used to meet the heating requirements of a house and maintain it at 20°C. On a day when the outdoor air temperature drops to 2°C, the house is estimated to lose heat at a rate of 80,000 kJ/h. If the heat pump under these conditions has a COP of 2.5, determine (a) the power consumed by the heat pump and (b) the rate at which heat is absorbed from the cold outdoor air.. **[Ans. 32000kJ/hr 48000kJ/hr]**

Q4. A Carnot heat engine receives 500 kJ of heat per cycle from a high-temperature source at 652°C and rejects heat to a low-temperature sink at 30°C. Determine (a) the thermal efficiency of this Carnot engine and (b) the amount of heat rejected to the sink per cycle . **[Ans. 67.2%, 164kJ]**

Q5. A heat pump is to be used to heat a house during the winter. The house is to be maintained at 21°C at all times. The house is estimated to be losing heat at a rate of 135,000 kJ/h when the outside temperature drops to 5°C. Determine the minimum power required to drive this heat pump **[Ans. 3.32kW]**