CES

ENERGY CONSERVATION (ESL-720)

Major Test

MM: 40

Time: 2 hour

Note: Attempt all questions.

1. (a) Derive an expression for entropy generation number for a mixing phenomenon and discuss the optimum conditions for minimum entropy generation number. (4)

(b) Water at 90 °C flowing at the mass flow rate of 2 kg/s mixes adiabatically with another stream of water at 30 °C flowing at the rate of 1kg/s. Estimate the entropy generation rate and the rate of exergy loss due to mixing process. Take T_0=300 K. (3)

(c) What are the availability functions for a closed system and steady flow system? (3)

2. (a) What is endoreversible system? Show that the efficiency of an endoreversible heat engine and maximum power output are given by

$$\eta = 1 - \sqrt{\left(\frac{T_L}{T_H}\right)} \quad \text{and} \quad P_{max} = \left(\frac{C_H C_L}{C_H + C_L}\right)\left(\sqrt{T_H} - \sqrt{T_L}\right)^2 \qquad P_0 =$$

where symbols have their own meanings. Compare the efficiency and power output with a reversible heat engine, assuming T_H=900 K, T_L=30 °C, C_H=2.0 and C_L=1.0 kW/K for a special case. (7)

(b) Two heat engines A and B have same thermal efficiency of 30% and source side temperature of 1000 K and both delivers 1000 kJ of work. Engine A is working with a sink temperature of 300 K while engine B is working with a sink temperature of 400 K. Which engine is more irreversible? (3)

3. (a) A heat pump provides 60 MJ/h to a house. If the compressor requires an electrical power input of 5 kW, calculate the COP. If the cost of electricity is $0.08 per kWh and the heat pump operates 100 h per month, how much money does the house owner can save by using the heat pump instead of electrical resistance heater? (6)

(b) A single phase motor with an efficiency of 80% is to be replaced with a new motor with an efficiency of 95%. How much is the energy saving potential between these two motors if the shaft power of 1 kW is to be delivered? If the load factor is 0.8 and operating hours of the motor are 2400 per year, calculate the annual energy saving. (4)

4. Attempt any two parts.

(a) Discuss energy conservation options in electrical energy systems like motor or transformer. (5)

(b) Discuss energy conservation aspects in the transport sector or the agriculture sector. (5)

(c) What are the energy saving options in the domestic sector or lighting systems? (5)

(d) Define active and reactive power. What is power factor correction? How it can be improved and help in achieving energy conservation? (5)