

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~~ ^{write} the efficiency of an endoreversible heat engine and maximum power output ~~are~~ ^{is} given by

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

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. (9)

- (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)

Specific heat of water = 4.20