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FACULTY OF ENGINEERING AND ARCHITECTURE
MECHANICAL ENGINEERING DEPARTMENT

ME 211 THERMODYNAMICS I

CHAPTER 5 EXAMPLES

1. Heat is transferred to a heat engine from a furnace at a rate of 80 MW. If the rate of waste heat rejection to a nearby river is 50 MW, determine the net power output and the thermal efficiency for this heat engine.

2. A household refrigerator with $\beta = 1.5$, removes heat from the refrigerated space at a rate of 60 kJ/min. Determine:

(a) the electric power consumed by the refrigerator and
(b) the rate of heat transfer to the kitchen air.

3. Determine the γ of heat pump that supplies energy to a house at a rate of 8000 kJ/h for each kW of electric power it draws. Also, determine the rate of energy absorption from the outdoor air.

4. A Carnot heat engine receives 650 kJ of heat from a source of unknown temperature and rejects 200 kJ of it to a sink at 17 ^{o}C. Determine:
(a) the temperature of the source and
(b) the thermal efficiency of the heat engine.

5. An experimentalist claims that, based on his measurements, a heat engine receives 300 Btu of heat from a source of 900 R, converts 160 Btu of it to work, and rejects the rest as waste heat to sink at 540 R. Are these measurements reasonable? Why?

6. An inventor claims to have developed a heat engine that receives 800 kJ or heat from a source at 400K and produces 250 kJ of net work while rejecting the waste heat to a sink at 300K. Is this reasonable?

7. A heat pump is used to heat a house and maintain it at 20°C. When the outdoor air temperature is -5°C, the house loses heat at a rate of 75000 kJ/hr. Find the minimum power required to operate the heat pump.

8. A heat pump with a γ of 3.2 consumes 5 kW of power. When the heat pump is turned on, the temperature inside the house is 7°C. If the mass of the house's contents is equivalent to a mass of 1500 kg of air (c_v = 0.72 kJ/kg.^{o}C, c_p = 1.0 kJ/kg.^{o}C), how long will it take to raise the temperature of the house to 22°C?

9. A Carnot refrigerator operates in a room in which the temperature is 25 ^{o}C. The refrigerator consumes 500 W of power when operating and has β of 4.5. Determine:

(a) the rate of heat removal from the refrigerated space and
(b) the temperature of the refrigerated space.

10. A Carnot heat engine receives heat from a reservoir at 900 ^{o}C at a rate of 800 kJ/min and rejects the waste heat to the ambient air at 27 ^{o}C. The entire work output of the heat engine is used to drive a refrigerator that removes heat from the refrigerated space at -5 ^{o}C and transfers it to the same ambient air at 27 ^{o}C. Determine:
(a) the maximum rate of heat removal from the refrigerated space and
(b) the total rate of heat rejection to the ambient air.