CANKAYA UNIVERSITY
FACULTY OF ENGINEERING AND ARCHITECTURE
MECHANICAL ENGINEERING DEPARTMENT
ME 212 THERMODYNAMICS II

CHAPTER 10
EXAMPLES

1) An ideal vapor-compression refrigerant cycle operates at steady state with Refrigerant 134a as the working fluid. Saturated vapor enters the compressor at -10^{0}C, and saturated liquid leaves the condenser at 28^{0}C. The mass flow rate of refrigerant is 5 kg/min. Determine

(a) The compressor power, in kW
(b) The refrigerating capacity, in tons.
(c) The coefficient of performance.

2) A vapor-compression refrigeration system circulates Refrigerant 134a at rate of 6 kg/min. The refrigerant enters the compressor at -10^{0}C, 1.4 bar, and exits at 7 bar. The isentropic compressor efficiency is 67%. There are no appreciable pressure drops as the refrigerant flows through the condenser and evaporator. The refrigerant leaves the condenser at 7 bar, -24^{0}C. Ignoring heat transfer between the compressor and its surroundings, determine

(a) The coefficient of performance.
(b) The refrigerating capacity, in tons.
(c) The irreversibility rates of the compressor and expansion valve, each in kW
(d) The changes in specific flow availability of the refrigerant passing through the evaporator and condenser, respectively, each in kJ/kg.

Let T_0 = 21^{0}C, p_0 = 1 bar

3) An ideal vapor-compression heat pump cycle with Refrigerant 134a as the working fluid provides 15 kW to maintain a building at 20^{0}C when the outside temperature is 5^{0}C. Saturated vapor at 2.4 bar leaves the evaporator, and saturated liquid at 8 bar leaves the condenser. Calculate

(a) The power input to the compressor, in kW
(b) The coefficient of performance.
(c) The coefficient of performance of a reversible heat pump cycle operating between thermal reservoirs at 20 and 5^{0}C

4) A vapor-compression heat pump with a heating capacity of 500 kJ/min is driven by a power cycle with a thermal efficiency of 25%. For the heat pump, Refrigerant 134a is compressed from saturated vapor at -10^{0}C to the condenser pressure of 10 bar. The isentropic compressor efficiency is 80%. Liquid enters the expansion valve at 9.6 bar, 34^{0}C. For the power cycle, 80% of the heat rejected is transferred to the heated space.

(a) Determine the power input to the heat pump compressor, in kW.

(b) Evaluate the ratio of the total rate that heat is delivered to the heated space to the rate of heat input to the power cycle. Discuss.

5) Air enters the compressor of an ideal Brayton refrigeration cycle at 140 kPa, 270 K, with a volumetric flow rate of 1 m^3/s, and is compressed to 420 kPa. The temperature at the turbine inlet is 320 K. Determine

(a) The net power input, in kW
(b) The refrigerating capacity, in kW.
(c) The coefficient of performance.
(d) The coefficient of performance of a reversible refrigeration cycle operating between reservoirs at T_C = 270 K and T_H = 320 K.