NAME:
AME 20231
Thermodynamics
Examination 2
Profs. A. M. Ardekani and J. M. Powers
5 April 2012

1. (20) A heat pump is used to heat a house in winter. The house's temperature is maintained at $23°C$. When the ambient temperature is $-10°C$, the rate of heat lost from the house to the surroundings is 25 kW. Calculate the minimum electrical power required to run the heat pump under these conditions.

2. (40) A refrigeration cycle using R-134a as the working fluid consists of a compressor, a condenser, an expansion valve, and an evaporator. See Fig. 1. R134a at $P_2 = 1.000\ MPa$ and $T_2 = 50°C$ enters the condenser. It leaves the condenser as a saturated liquid at the same pressure. The pressure in the evaporator is 133.7 kPa. The processes in the condenser and the evaporator are isobaric. The fluid enters the adiabatic compressor as a saturated vapor.

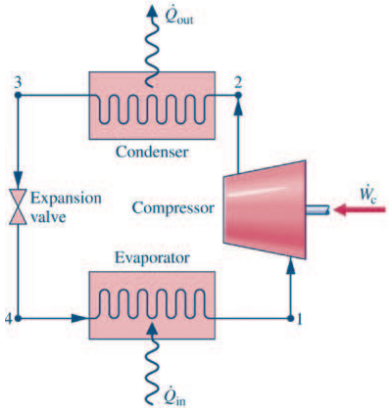

Figure 1: Schematic for refrigeration problem.

   (a) Determine for the condenser $\dot{Q}_{out}/\dot{m}$.
   (b) Determine T_4 and x_4.
   (c) Determine for the evaporator $\dot{Q}_{in}/\dot{m}$.
   (d) Determine the coefficient of performance of the cycle.

3. (40) A calorically imperfect ideal gas of mass m with gas constant R and specific heat at constant volume $c_v(T) = c_{vo} + aT$ exists in a piston-cylinder configuration at initial pressure and volume P_1 and V_1. The piston, with cross-sectional area A, is restrained by a linear spring, whose spring constant is k_s. At the initial state, the spring exerts no force on the piston. The gas is heated until its final volume is V_2. Find the final temperature T_2, the final pressure P_2, the work done ${}_1W_2$ and the heat transfer ${}_1Q_2$.