Mechanical Engineering Department
University of California at Berkeley

Midterm II

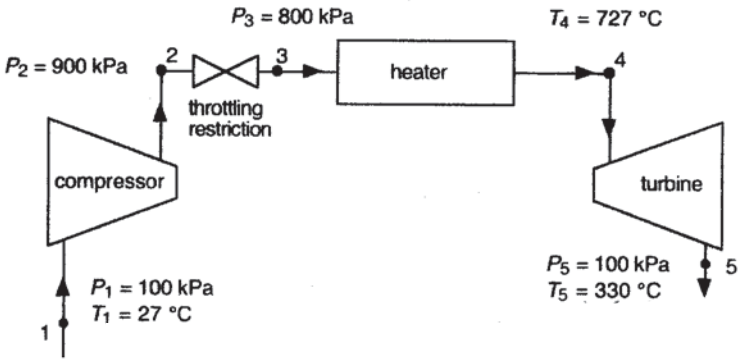
Name: _____

Instructions: Do both problems. The first problem is worth 60 points and the second is worth 40 points. Show all work and make sure that your final answers are clearly distinguishable *with proper units*.

1. ___

2. ___

TOTAL: ___



1. (60 points)

The gas turbine system shown schematically above functions like a steady-flow standard Brayton cycle except that a damaged flow conduit between the compressor and heater results in a throttling restriction (with no heat or work interaction) that causes the pressure to drop from 2 to 3 by 100 kPa. Information about the states during actual system operation is shown in the diagram above. The air-flow rate is 8.5 kg/s. The compressor efficiency is 0.82. In analyzing this system, assume the compressor and turbine are adiabatic, and treat the working fluid, air, as a ideal gas with constant specific heats: $c_p = 1.005$ kJ/kgK, $c_v = 0.718$ kJ/kgK.

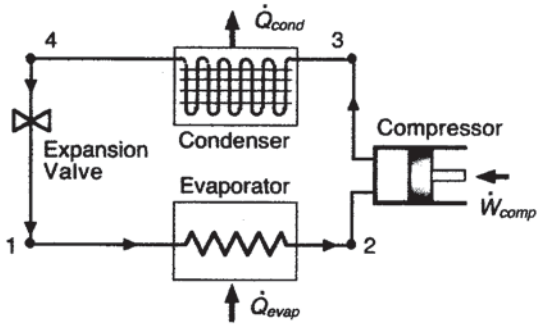
(a) Plot the state points and processes on a T-s diagram, showing appropriate constant pressure lines.

(b) Determine the power input to the compressor and the actual exit temperature from the compressor, T_2.

(c) Determine T_3.

(d) Determine the rate of heat input to the heater.

(e) Determine the net power output of the system and the cycle efficiency.



2. (40 points)
The vapor compression refrigeration system shown schematically above uses R-134a as its working fluid. The mass flow rate of R-134a in the system is 0.031 kg/s. The pressure at states 3 and 4 is 1600 kPa. State 4 is saturated liquid. The pressure at states 1 and 2 is 360 kPa. State 2 is saturated vapor. The following R-134a data is available for your analysis:

The specific entropy of saturated vapor at 360 kPa is 0.92836 kJ/kgK.
For superheated vapor at P = 1600 kPa and s = 0.92836 kJ/kgK, the specific enthalpy is 284.76 kJ/kg.

In this cycle, because the piping is not insulated, the process from 4 to 1 is *not* adiabatic. From 4 to 1, heat is input at a rate of 0.8 kW. In your analysis, assume the compressor is reversible and adiabatic.

(a) Show the cycle on a P-h diagram.
(b) At both 360 kPa and 1600 kPa determine the saturated liquid and vapor specific enthalpies (h_f and h_g)
(c) Determine the rate of heat absorption in the evaporator.
(d) Determine the cycle COP.