ME 105 **Final** **Fall '06**

12/18/06

Problem 1

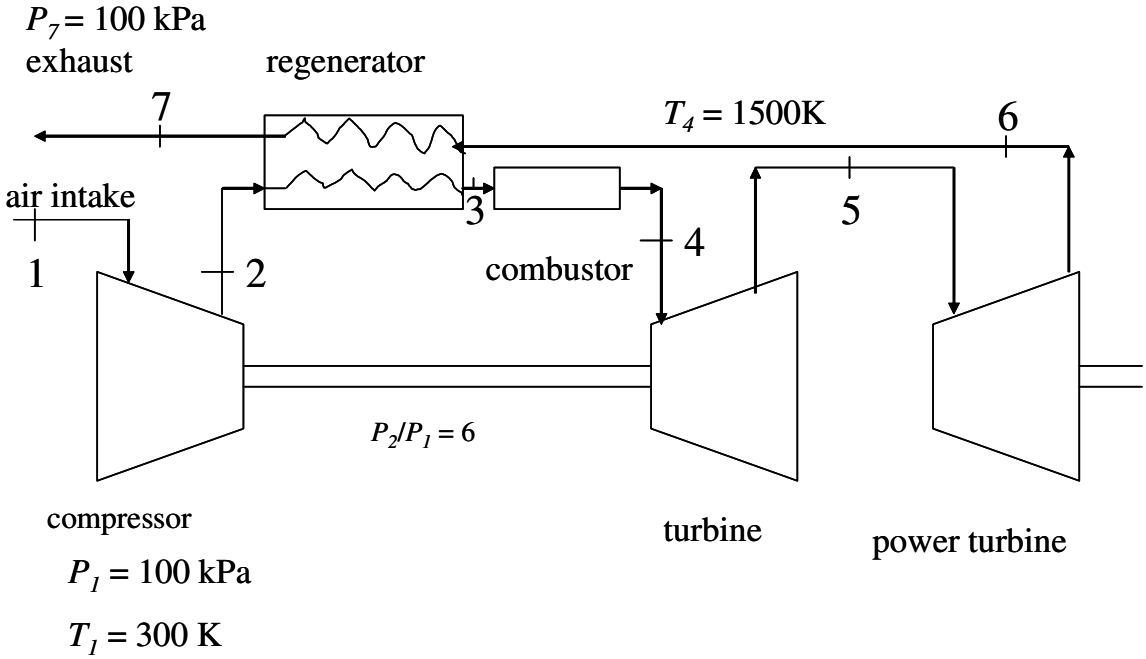
Atmospheric air at 101 kPa, 30°C, and 60% relative humidity flows over a set of cooling coils at an inlet flow rate of 100 m^3/min. Subsequent heating of the air results in a final state of 25°C and 60% relative humidity. Determine:

(a) The heat removed in the cooling section.
(b) The heat added in the heating section.
(c) The amount of vapor condensed.

Problem 2

A gas turbine automobile cycle is shown below. In the first turbine, the gas expands to just a low enough pressure P_5 for that turbine to drive the compressor. The gas is then expanded through a second turbine connected to the drive wheels. The data for this engine are as shown in the figure. Consider the working fluid to be air throughout the entire cycle, and assume that all processes are ideal. Determine the following:

(a) The pressure P_5.
(b) The net work per kg and mass flow rate if the net power, $\dot{W}_{net}$=100 kW.
(c) The temperature T_3 and cycle thermal efficiency.
(d) The *T*-*s* diagram for the cycle.



Problem 3

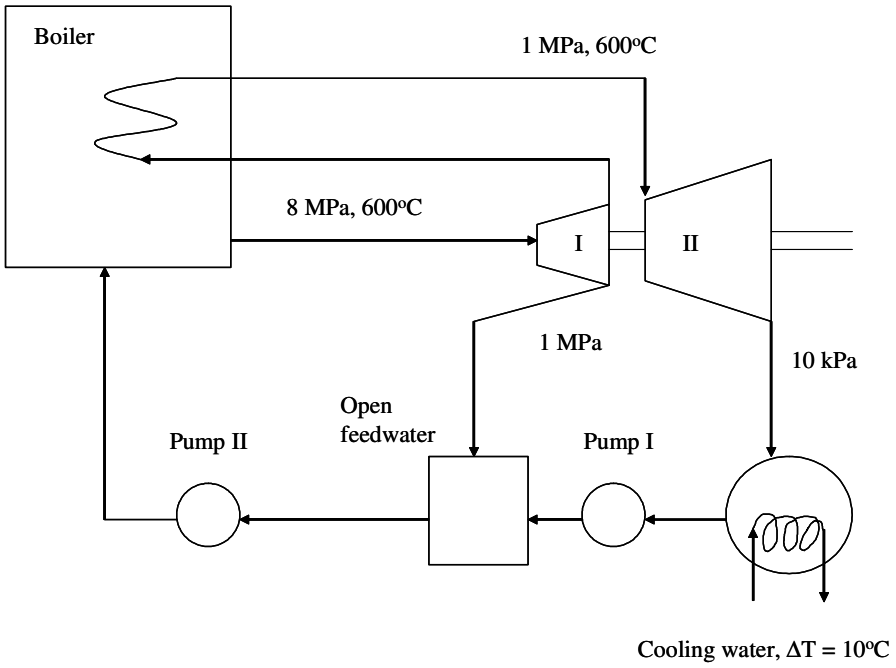
Refrigerant 134a enters the compressor of a refrigeration system at 140kPa and -10°C at a rate of 1 m^3/min and leaves at 1 MPa. The isentropic efficiency of the compressor is 80%. The refrigerant enters the throttling valve as saturated liquid at 1 MPa and leaves the evaporator as saturated vapor:

(a) Show the cycle on a *T-s* diagram and determine the power input to the compressor.
(b) Find the rate of heat removal from the refrigerated space.
(c) Find the coefficient of performance of the cycle.

Problem 4

An ideal steam power plant is designed to operate on the combined reheat and regenerative cycle and to produce a net power output of 10 MW. Steam enters the high-pressure turbine at 8 MPa, 600oC and is expanded to 1 MPa. At that pressure, some of the steam is fed to an open feedwater heater, and the remainder is reheated to 550°C. The reheated steam is then expanded in the low-pressure turbine to 10 kPa.

(a) Determine the steam flow-rate to the high-pressure turbine
(b) Determine the size of the motor required to drive each of the pumps
(c) If the increase of the condenser cooling water temperature is 10oC, what is the flow of the cooling water
(d) If the steam velocity in the turbine-condenser connecting pipe is restricted to a maximum of 100 m/s, what is the diameter of the connecting pipe.



Problem 5

A tall cylinder contains 0.5 kg of ethane and methane gas mixture. The mass of the piston and the weights is such that a cylinder pressure of 5 MPa is needed to float the piston. The gases are initially at thermal equilibrium with the surroundings at 32^{o}C, and the mole fraction of ethane of 0.20. A line containing pure ethane at 50^{o}C and 10 MPa fills the cylinder until the mole fraction of ethane is 50%, and the cylinder is allowed to reach thermal equilibrium with the surroundings. Using real gas relations, calculate the amount of heat transfer through the cylinder. Assume constant specific heats at 300K and Amagat's law for ideal gas.