Thermodynamics, MECH2010 Fall 2018, Test 3a 2018/12/11

Prof Fu-Lin Tsung

Name Chinese________________ Name, Pinyin _________________ Student number ______________

Name, English________________

1	2	3	4	5	6	Total
2	13	15	25	25	20	100

Problem 1 (2 pts)

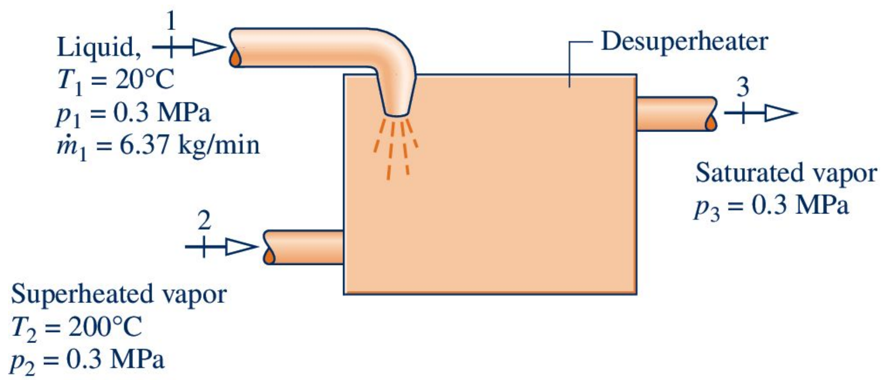
_____________ Cycle is a theoretical thermodynamics cycle that provides the maximum limit on the efficiency that any classical thermodynamic engine can achieve during the conversion of heat into work, or conversely, the maximum performance of a refrigeration system in creating a temperature difference by the application of work to the system.

Hi Bella, this problem can be on the front page, left hand side, underneath of all the writing since is just fill in the blank (the half sheet).

Problem 2 (13 pts)

For the desuperheater shown, liquid water at state 1 is injected into a stream of superheated vapor entering at state 2. As a result, saturated vapor exits at state 3. Data for steady state operation are shown on the figure. Ignoring stray heat transfer and kinetic and potential energy effects, determine the mass flow rate of the incoming superheated vapor, in kg/min.

4.8



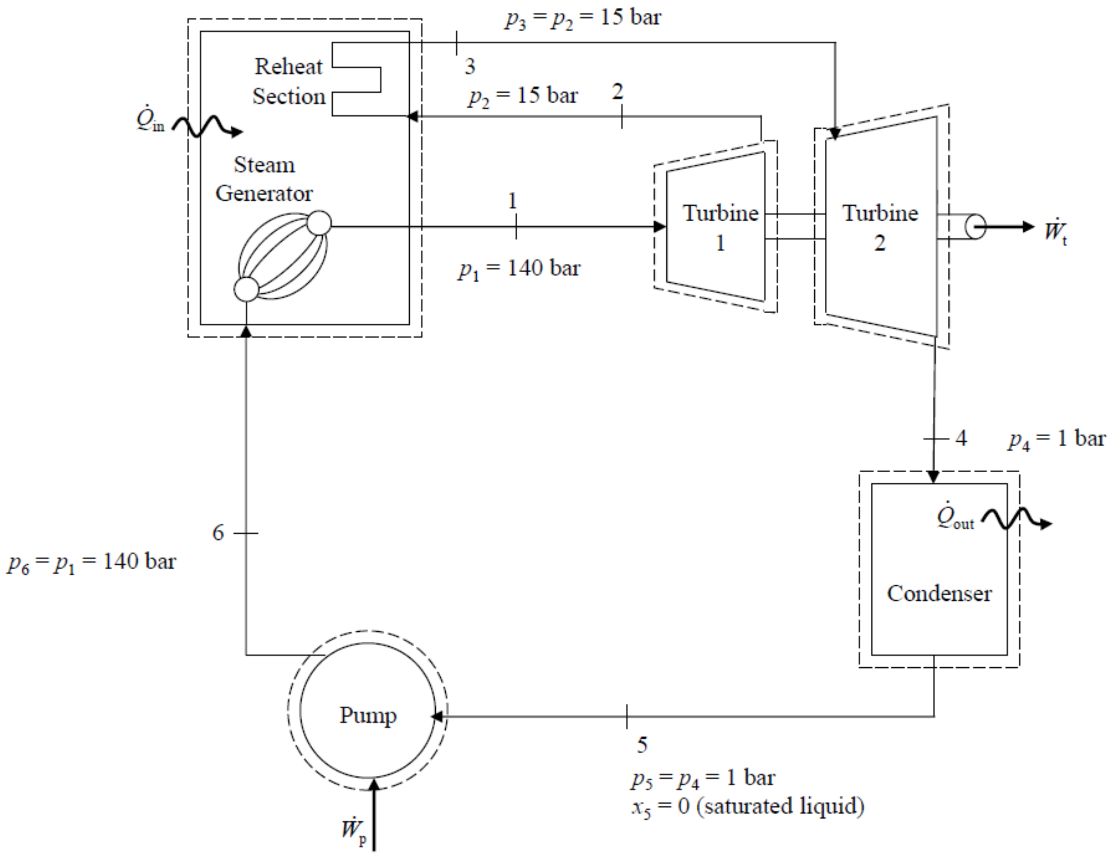
Hi Bella, this problem can be on the right-hand-side of the front page (the half sheet). Rest of the problems will need full sheet of paper

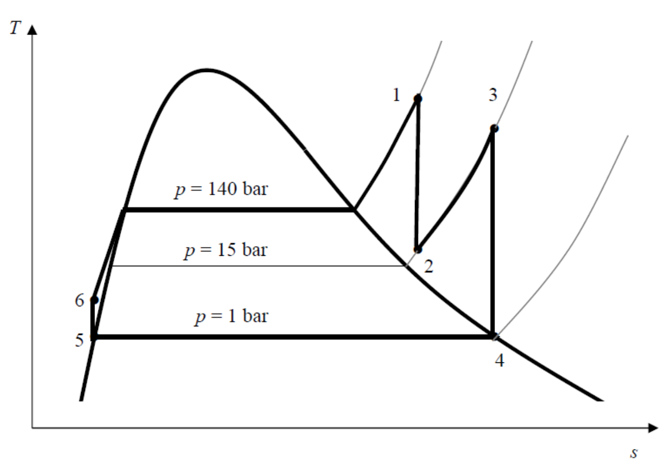
Problem 3 (15 pts)

Steam is the working fluid in the ideal reheat cycle shown in the figure together with operational data. If the mass flow rate is 1.3 kg/s, determine

a) the power developed by the cycle, in kW

b) the cycle thermal efficiency. 8.27



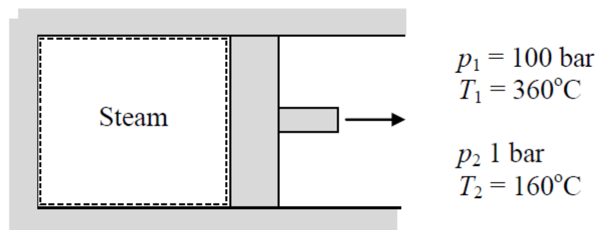


State	p (bar)	T (°C)	h (kJ/kg)
1	140	520.0	3377.8
2	15	201.2	2800.0
3	15	428.9	3318.5
4	1	99.63	2675.5
5	1	99.63	417.46
6	140		431.96

Problem 4 (25 pts)

Steam undergoes an adiabatic expansion in a piston-cylinder assembly from 100 bar, 360 °C to 1 bar, 160 °C. 6.45

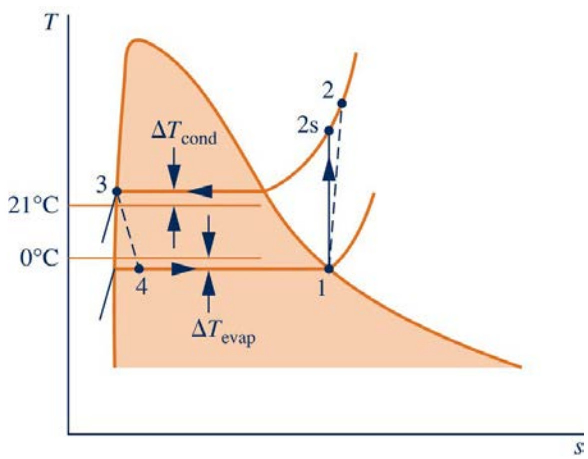
a) (5) What is work per kJ per kg of steam for the process?
b) (5) Calculate the amount of entropy produced, in kJ/K per kg of steam.
c) (10) What is the maximum theoretical work that could be obtained from the given initial state to the final pressure?
d) (5) Sketch both processes on a T-s diagram with temp and pressure of state 1 and 2 labeled

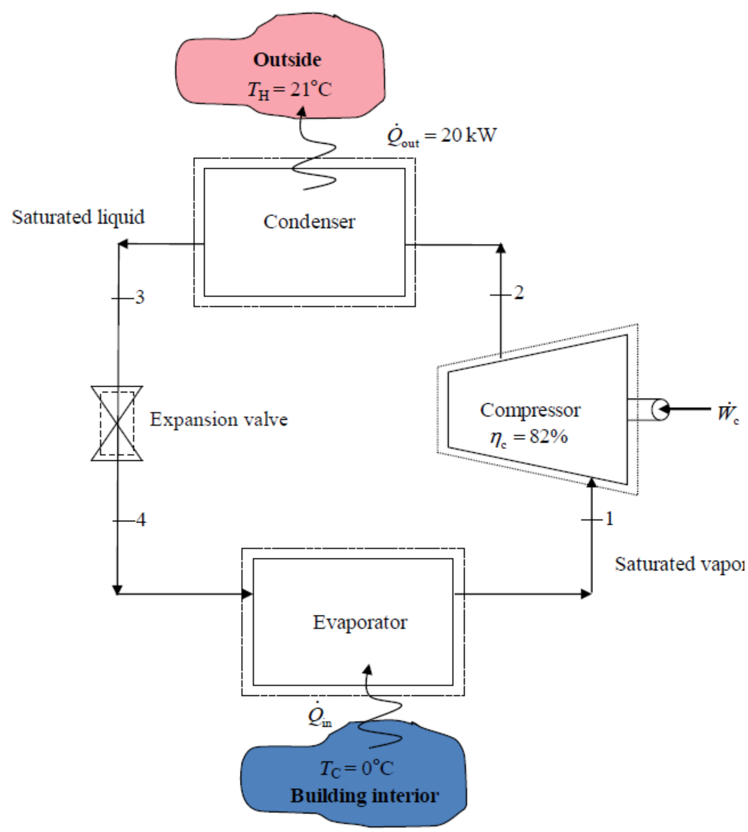


Problem 5 (25 pts) 10.37

An office building requires a heat transfer rate of 20 kW to maintain the inside temperature at 21° C when the outside temperature is 0° C. A vapor-compression heat pump with Refrigerant 134a as the working fluid is to be used to provide the necessary heating. Assume the compressor's isentropic efficiency is 82%. Specify appropriate evaporator and condenser pressures of a cycle for this purpose assuming the temperature at ΔTcond = ΔTevap = 10° C as shown in the figure. The refrigerant exits the evaporator as saturated vapor and exits the condenser as saturated liquid at the respective pressures. Determine the

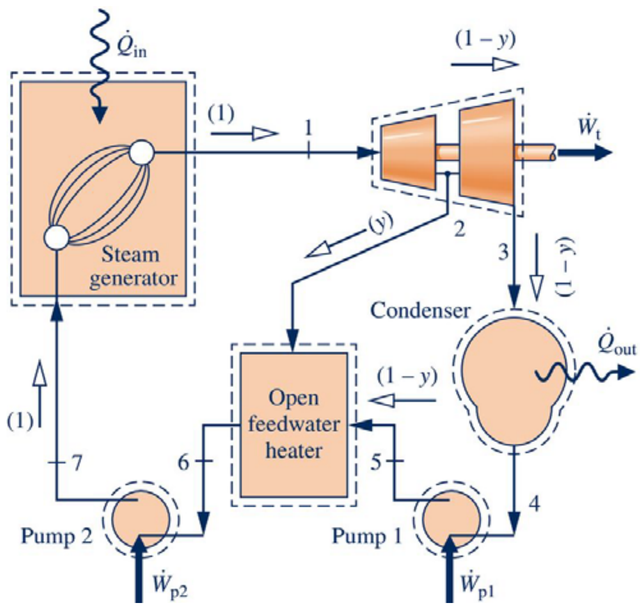
(a) mass flow rate of the refrigerant, in kg/s.
(b) compressor power, in kW.
(c) coefficient of performance and compare with the coefficient of performance for a Carnot heat pump cycle operating between the reservoir temperatures.





Problem 6 (20 pts)

A regenerative vapor power cycle with one open feedwater heater is shown.
The mass flow rate $\dot{m}$ = [y + (1-y)] $\dot{m}$. (the mass flow rate through each circuit is denoted inside the parenthesis "( )")
For this cycle



a) Label the states, 1 – 7, on the T-s diagram shown on the bottom

b) Write the equation for the total turbine work $\dot{W}_t$ / $\dot{m}_1$ in terms of h, and y (note $\dot{m}_1 = \dot{m}_2 + \dot{m}_3$)

c) Write the equation for the total pump work $\dot{W}_p$ / $\dot{m}_1$