Thermodynamics, MECH2010 Fall 2019, Test 2a 2019/11/12

Prof Fu-Lin Tsung

Name Chinese_____ Name, Pinyin _____Student number _____

Name, English_____

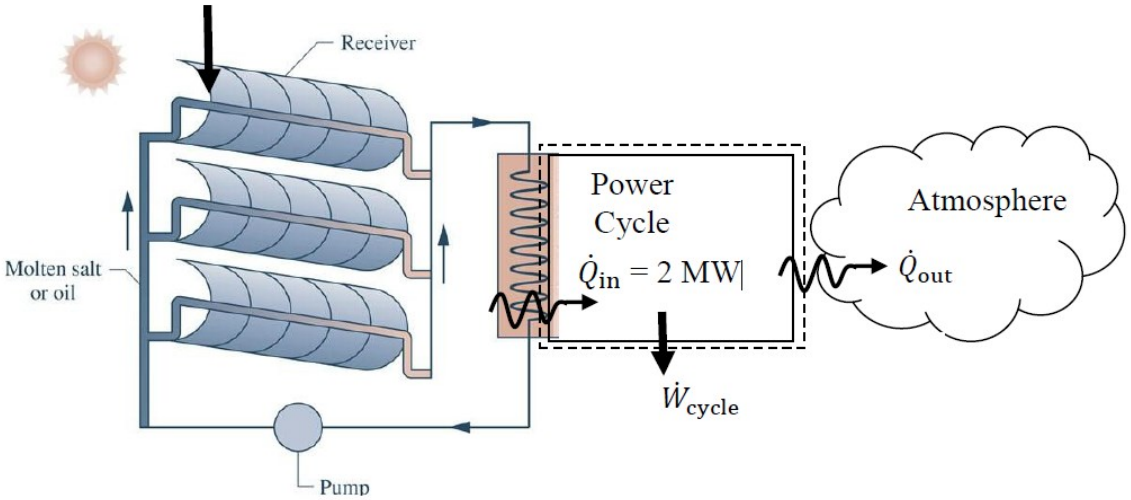
1	2	3	4	5	6	7	Total
20	15	25	25	15			100

Sign your name

I, _____, will/did not cheat/copy any portion of this test.

Estimate your score. If it's within +/- 2 points, you get one extra point _____

1) A concentrating solar collector system provides energy by heat transfer to a power cycle at a rate of 2 *MW*. The power cycle thermal efficiency is 36%. The air temperature is 27 °C, the molten salt in the heat exchanger is ~800 °C.
   a) (4) Determine the power developed by the cycle, in *MW*
   b) (6) What is the theoretical max η for the cycle?
   c) (4) What is the change in entropy rate, $\Delta\dot{S}$, for the cycle in kW/k ?
   d) (6) What is the rate of entropy generation, $\dot{\sigma}$, for the cycle in kW/k?



2) An electric in-line water heater is installed in the JCI washroom. For water flowing at a rate of 1 liter/min,
the heater can heat 15 °C water to 30 °C. What is the power input of the heater?
Assume pipe diameter = 1 cm before and after the heater

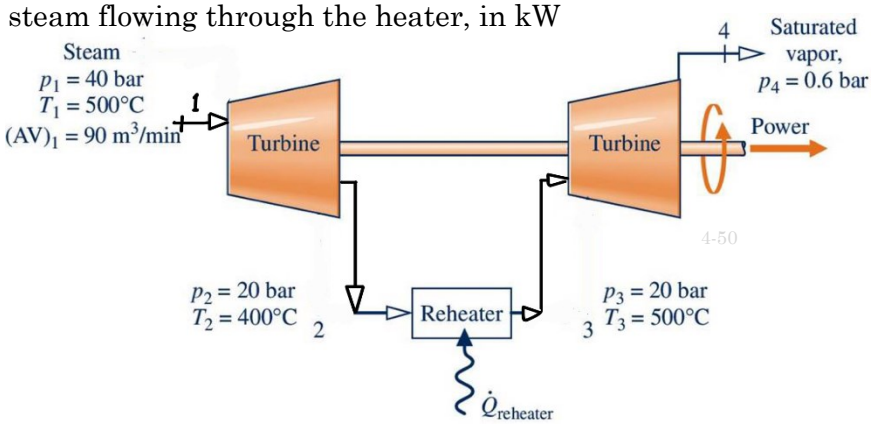
1 liter = 0.001 m^3,

3) Steam enters the first-stage turbine w/ a volumetric flow rate of 90 m^3/min, exits to a constant pressure heater before entering a second-stage turbine. For a steady-state operation w/ negligible stray heat transfer, K.E. and P.E. effects, determine

a) (5) mass flow rate of the steam, in kg/s

b) (10) total power produced by the two-stage turbine, in kW

c) (10) rate of heat transfer to the steam flowing through the heater, in kW



4) 1.2 kg/s of water vapor enters a steady-state turbine at 5 bar, 320 °C and expands adiabatically to an exit state of 1 bar, 160 °C. K.E. and P.E. are negligible. For the turbine, determine

a) (5) the power developed, in kW

b) (5) the rate of entropy production, in kW/K

c) (10) the turbine efficiency

d) (5) draw the T-s diagram indicate all relevant states

5) (15) An open feedwater heater is a direct-contact heat exchanger used in vapor power plants. With water as the working fluid at steady state, ignoring stray heat transfer from the heat exchanger to its surroundings, K.E. and P.E. effects, determine the rate of entropy production, in kW/K.

6.88