UNIVERSITY OF JORDAN
FACULTY OF ENGINEERING & TECHNOLOGY
MECHANICAL ENGINEERING DEPARTMENT

Power Plants
Course No. 0954443
First Exam
Inst.: Prof. Ali Badran

Part -2 (Open Book)
15 points

Student Name: .....
Student Seat No. ....
Date: 20/10/2013
Time: 40 minutes

In a steam plant of the single reheat type, the steam is supplied to the high pressure turbine at a throttle (turbine inlet) pressure of 3500 kPa and temperature of 425 °C, and the temperature at the low pressure turbine is the same as the above. The condenser pressure is 1.7 kPa and the cycle works at it's maximum ideal efficiency, but the actual efficiency of the cycle is given by the relationship:

$$\eta_{actual}\% = \eta_{ideal}\% - 20$$

The feed water pump efficiency is 70%, the boiler efficiency is 8.. and the turbine efficiency of the high pressure turbine is 5% greater than the low pressure one.

a) Sketch the flow diagram of the plant and the cycle on the T.S. diagram, starting the cycle at turbine inlet. Put your sketches within the spaces indicated in this page.

b) Find the enthalpies at all the points of the cycle assuming isentropic compression, expansion and that the throttling pressure drop is neglected. Put your answers in their places indicated within the table shown next page.

c) Find the pump work.

d) Find the efficiency of each turbine.

e) What is the heat rate of the plant?

Notes:
- The attached Figure represents the plant performance
- 3500 kPa = 35 bar = 500 psi
- ½ inch Hg = 1.7 kPa
- 425 °C = 800 °F

Solution

a) Cycle sketch

T-s Diagram
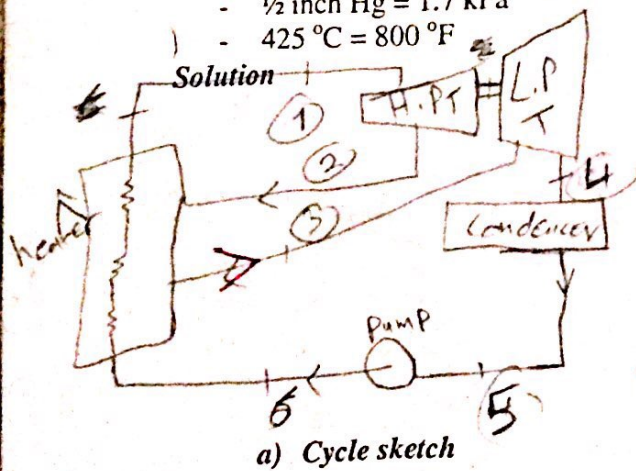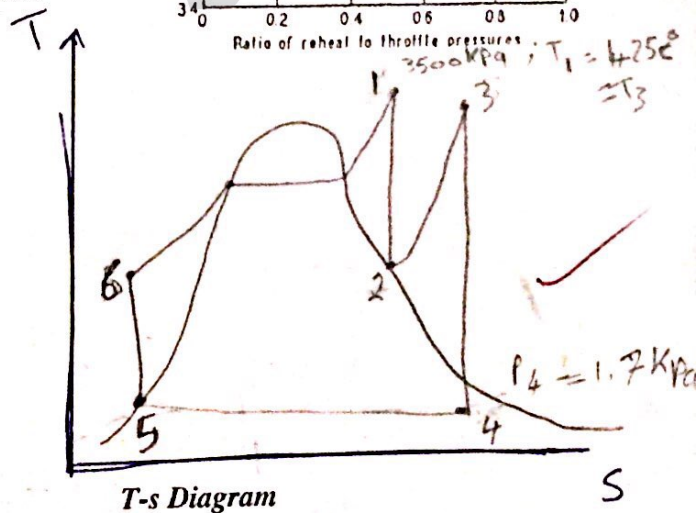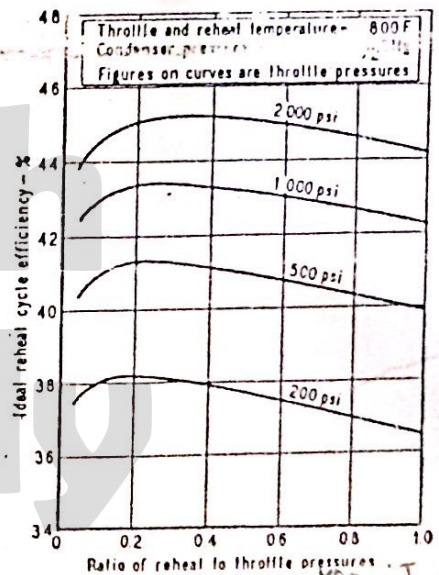
$$1.5 \rightarrow 54.688$$
$$1.7 \rightarrow x$$
$$2 \rightarrow 73.433$$

$$\frac{1.7 - 1.5}{2 - 1.5} = \frac{x - 54.688}{73.433 - 54.688}$$

$$x = 62.19$$

b) Enthalpies

state 5

$h_5 = h_f$ @ $1.7 kPa$ = by intarblation = 62.19 kJ/kg

$T_5 = T_{sat} \Big|_{1.7 kPa} \approx 20 c°$

state 6

$WP_{5-6} = h_6 - h_5 = Vf_5 (P_6 - P_5)$

state 4

state 2

$S_2 = S_1 = 6.924$

$T_2 =$

state 1

super, heated

$h = 3280.7$

$S = 6.924$

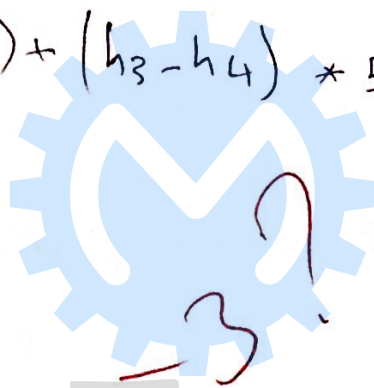| Point	1	2	3	4	5	6
Pressure, kPa	3500	?	4~~5~~	1.7	1.7	3500
Temperature, °C	425	?	425	?	20	
Enthalpy, kJ/kg	3280.7	.	?	?	62.19	3281
Entropy, kJ/kgK	6.924	6.924	?	.	0.318	

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c) Pump Work

$$h_6 - h_5$$

-2?

d) Turbine efficiency

turbine work =

$$(h_1 - h_2) + (h_3 - h_4) * 5\%$$

-3?

e) Heat rate

-1?