八十九學年度 工程與系統科學 系（所） 熱流(乙) 組碩士班研究生招生考試

熱力學 科號 3202 共 3 頁第 1 頁 *請在試卷【答案卷】內作答

1. Water is compressed from state (1) to state (5). Shown as in Fig. 1. Assume the specific volume of water v_f and its volume expansivity α_p are constant. Water in liquid phase is following the state equation P=AlnT, where A is constant, and the steam in vapor phase is following the state equation P(v-b)=RT, where b is constant. The heat capacity of water is constant; $C_{p(l)}$, and the heat capacity of steam is constant too; $C_{p(v)}$. Given the saturated liquid enthalpy at state(3); h_{f3}, and the saturated vapor enthalpy at state (3'), $h_{g3'}$, P_1, P_2, P_5, are the isobaric lines, $T_4=T_5$, $T_3=T_{3'}$. Define volume expansivity:

$$\alpha_p = \frac{1}{v_f}\left(\frac{\partial v_f}{\partial T}\right)_p$$

(a) Please evaluate enthalpy change $\Delta h_{12'}$(2%) and $\Delta h_{2'2}$(7%) and entropy change $\Delta S_{12'}$(2%) and $\Delta S_{2'2}$(4%) with function of $C_{P(l)}$ T_1, T_2, $T_{2'}$, P_1, P_2, α_p, v_{f2} and A.

(b) Evaluate the enthalpy change $\Delta h_{33'}$ and entropy change $\Delta S_{33'}$ from state (3) to state (3') with function of h_{f2}, h_{g3}, and T_3 (5%)

(c) Evaluate the entropy change $\Delta h_{3'4}$ and the entropy change $\Delta S_{3'4}$ from state (3') to state (4) with function of $C_{p(v)}$, T_3 and T_4 (6%)

(d) Evaluate the enthalpy change Δh_{45} and the entropy change ΔS_{45} from state (4) to state (5) with function of R, b, P_2 and P_5 (4%)

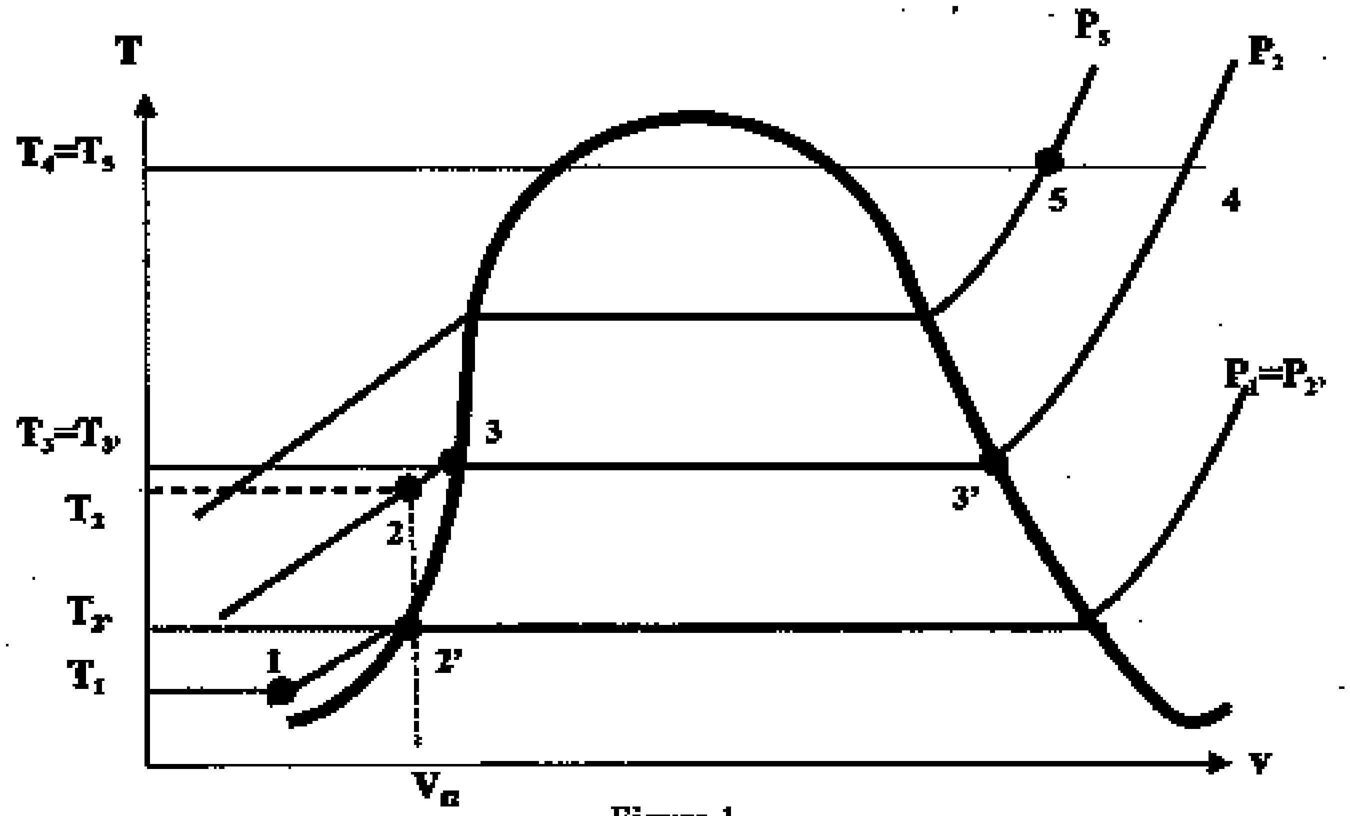
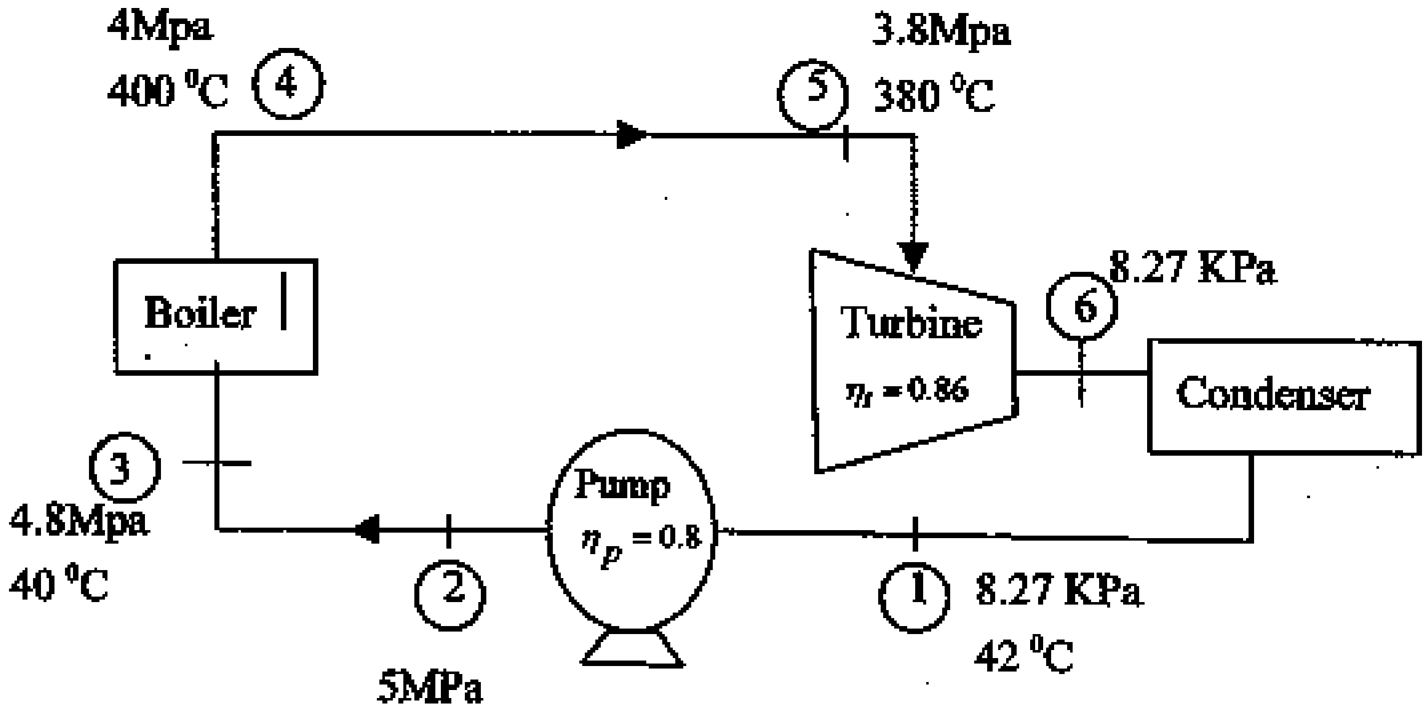


Figure 1

2. A steam power plant operates on a cycle with pressure and temperatures as designed in following figure. The efficiency of the turbine is 86% and the efficiency of the pump is 80%. Determine
   (a) The isentropic pump work W_{PS} (2%), The actual pump work W_a (2%)
   (b) The enthaply of state 2 (2%)
   (c) The temperature of state 2, T_{2S} , if the pump working as the reversible and adiabatic (isentropically) process (2%)
   (d) The actual temperature of state 2, T_2 (2%)
   (e) The entropy of state 2, S_2 (2%)
   (f) The quality of state 6, X_{6S} (2%) and The enthalpy of state 6, h_{6S} (2%), if the turbine working as the reversible and adiabatic (isentropically) process
   (g) The actual turbine work W_t (2%), The actual enthalpy of state 6, h_6 (2%)
   (h) The actual quality of state 6, X_6 (2%) , The actual entropy of state 6, S_6 (2%)
   (i) The net work of cycle W_{net} (2%), The heat input of the boiler q_H (2%)
   (j) The thermal efficiency of the cycle η (2%)



State (Unit)	T (°C)	P (Mpa)	V_f (m³/Kg)	V_g (m³/Kg)	U_f (KJ/Kg)	U_g (KJ/Kg)	h_f (KJ/Kg)	h_g (KJ/Kg)	S_f (KJ/Kg.°K)	S_g (KJ/Kg.°K)
Superheat	380	3.8		0.0741		2877.3		3158		6.7159
Superheat	400	4.0		0.07341		2919.6		3213.6		6.769
Saturated	40	7.38×10^{-3}	0.00108	19.52	167.56	2430.1	167.57	2574.3	0.5725	8.257
Saturated	42	8.27×10^{-3}	0.001	17.4	178	2433	178.01	2578.7	0.6057	8.2109
Saturated	46	10×10^{-3}	0.001	14.67	191.82	2437.9	191.83	2584.7	0.6493	8.1502
Saturated	262	4.8	0.00128	0.04	1138.2	2597.86	1146.5	2795.3	2.9	5.987
Subcooled	40	5	0.001		166.95		171.97		0.5705	
Subcooled	60	5	0.00101		250.23		255.3		0.8285	

3. Explain the followings, and also give two thermodynamic properties as the examples for each of the four cases.

   (a) State function (5%)

   (b) Non-state function (path function) (5%)

   (c) Intensive properties (5%)

   (d) Extensive properties (5%)

4. Show that any flow of heat between two heat reservoir at temperature T_H and T_C where $T_H > T_C$, must be from the hotter to the cooler reservoir. (5%)

5. Please draw the T-S diagram for the ideal Carnot Cycle (5%) and calculate the cycle efficiency if the cycle is operating between high temperature reservoir T_H and low temperature reservoir T_L. (10%)