1. Explain
   (a) What is the closed system (2%)
   (b) What is the isolated system (2%)
   (c) What is the isothermal process (2%)
   (d) What is isochoric process (2%)
   (e) What is the adiabatic process (2%)
   (f) What is the thermal equilibrium (2%)
   (g) What is the mechanical equilibrium (2%)
   (h) Giving one example of the Intensive properties (1%), one example of the Extensive properties (1%), For which property do you think can be directly measured from the instrument (2%)
   (i) In state principle for simple system, how many independent properties can fix the state of a simple system (2%)

2. (a) The differential of pressure obtained from a certain equation of state is given as the following. Write down the equation of state. (5%)

$$dP = (\frac{R}{V-b^2} - \frac{a}{V^3})dT + [\frac{-RT}{(V-b^2)^2} + \frac{3aT}{V^4}]dV$$

(b) According to the state of equation from problem (a), please derives the internal energy change du with function of temperature、specific volume、pressure etc. (10%), and write down ΔU from state 1 to state 2 with function of P_1,V_1, T_1, P_2,V_2, T_2 and C_v, assume C_v is constant (5%).

3. (a) What is isentropic process (2%) and gives the requirement for the isentropic (2%)
   (b) Give at least two reasons which causes the Irreversible processes (2%)
   (c) Which thermal property is constant in Throtting process (2%) and in a two-phase mixture (Sat. Vap. + Sat. Liquid), which thermal property can be measured through Throtting process (2%) describe how? (2%)
   (d) What is the Clausius Inequality (2%)
   (e) What is the Clausius statement of the second law (2%)
   (f) Write down the Thermal Efficiency of the Carnot engine, η_{th}, in terms of (T_C, T_H) (2%)
   (g) For an ideal gas, define the constant volume specific heat (C_v) and constant pressure specific heat (C_p). What is the relationship between these two specific heats? (2%)

國立清華大學 107 學年度碩士班考試入學試題

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4. As in Fig.1, state 1 to state 2 is isobaric process, state 2 to state 3 is isothermal process, state 2 to state 4 is isochoric process, giving following properties of the liquid and the specific heat capacity $C_{(f)}$ (KJ/Kg,K), and all those properties can be assumed contsnt.

Volume expansivity (1/K) : $\alpha_p = \frac{1}{V_{(f)}}(\frac{\partial V_{(f)}}{\partial T})_p$

Isothermal compressibility (1/bar) : $\beta_T = -\frac{1}{V_{(f)}}(\frac{\partial V_{(f)}}{\partial P})_T$

Isothermal bulk modulus (bar) : $B_T = -V_{(f)}(\frac{\partial P}{\partial V_{(f)}})_T$

Adiabatic compressibility (1/bar): $\beta_s = -\frac{1}{V_{(f)}}(\frac{\partial V_{(f)}}{\partial P})_s$

Adiabatic bulk modulus (bar) : $B_s = -V_{(f)}(\frac{\partial P}{\partial V_{(f)}})_s$

(a) Please drive a general open form solution (integral sign is allowable) of the entropy change from state 1 to state 3 by integral of dP and with function of $C_{(f)}$, T_2, T_1, $V_{(f)}$ and α_p, β_T , B_T, β_s, B_s etc. (5%)

(b) Please derive the value of $(\frac{\partial P}{\partial V_{(f)}})_T$ with function of α_p , β_T , B_T, β_s, B_s, etc. (5%)

(c) Please drive general open form solution (integral sign is allowable) of the entropy change from state 1 to state 3 by integral of dV and with function of $C_{(f)}$, T_2, T_1, $V_{(f),1}$, $V_{(f),2}$, $V_{(f),3}$ and α_p, β_T , B_T, β_s, B_s etc. (5%)

(d) According to answer of (a) and (c), please give the close form solution of $\int V_{(f)}dP$ with function of $C_{(f)}$, T_2, T_1, $V_{(f),1}$, $V_{(f),2}$, $V_{(f),3}$ and α_p, β_T , B_T, β_s, B_s etc. (5%)

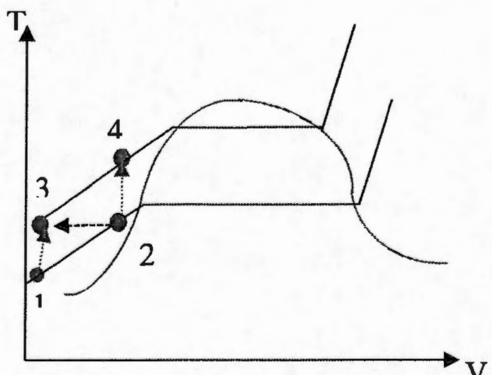
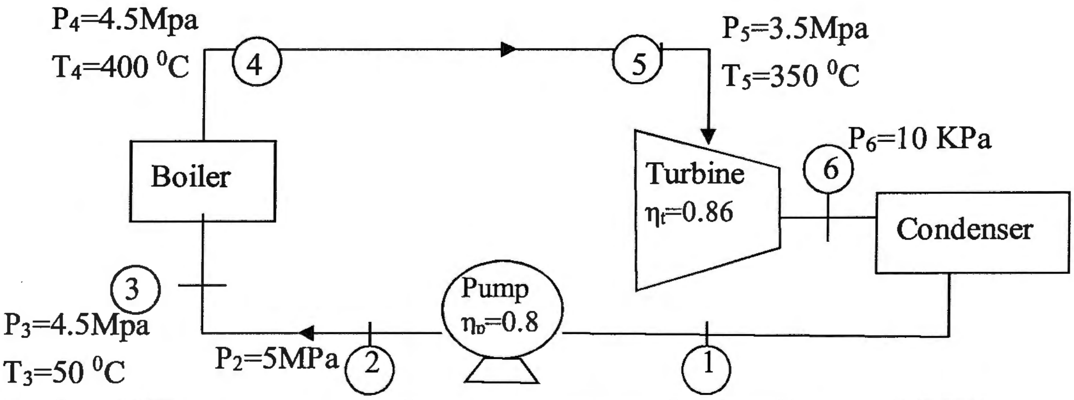


Fig. 1

5. 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%. Assume there is no addition friction pressure drop between condenser, Determine
   (a) The quality of state 6, X_{6S} (1%) and The enthalpy of state 6, h_{6S} in KJ/Kg (1%), if the turbine working as the reversible and adiabatic (isentropical) process
   (b) The actual turbine work $W_{act,t}$ in KJ/Kg (1%), and isentropic turbine work $W_{s,t}$ in KJ/Kg (1%).
   (c) The actual quality of state 6, X_6 (1%). The actual enthalpy of state 6, h_6 (2%). The actual entropy of state 6, S_6 (1%).
   (d) Pressure at stage 1, P_1 in MPa (1%).
   (e) The isentropic pump work $W_{S,P}$ in KJ/Kg (1%) and the actual pump work $W_{act,p}$ in KJ/Kg (1%), enthalpy of state 2, h_2 in (KJ/Kg) (1%) and the actual temperature of state 2, T_2 in ℃ (2%) and actual temperature of state 1 T_1 (1%).
   (f) The net work of cycle W_{net} in KJ/Kg (2%), the heat input of the boiler Q_H in KJ/Kg (2%)
   (g) The thermal efficiency of the cycle η_{th} (1%)



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	350	3.5						3104		6.6579
Superheat	380	3.8		0.0741		2877.3		3158		6.7159
Superheat	400	4.0		0.07341		2919.6		3213.6		6.769
Superheat	400	4.5						3204.7		6.704
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	45.8	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	50	12.35×10^{-3}					209.33	2583.2		
Subcooled	60	5	0.00101		250.23		255.3		0.8285	