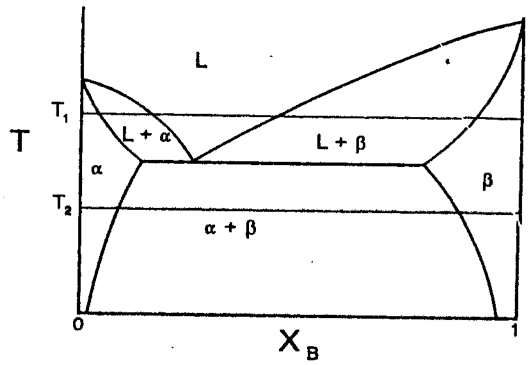
國立臺灣科技大學
九十一學年度碩士班招生考試試題
系所組別： 工程技術研究所材料科技學程
科　目： 熱力學

(共 4 題，總分 100 分)

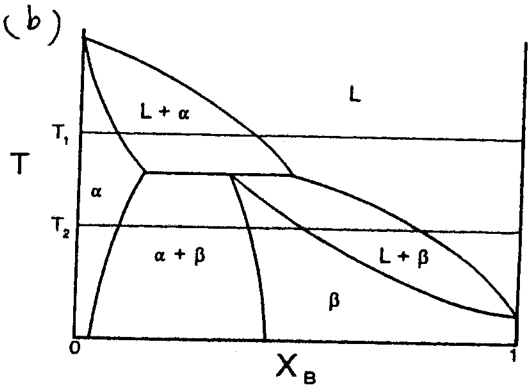
1. (20%) For an open system containing N components, each component has n_I moles; $I = 1, 2, 3, \ldots N$.
(a) (10%) please derive the universal criteria for an irreversible process. (Gibbs-Duhem equation)
(b) (10%) please describe in details how to determine the most stable state.

2. (30%) Please draw appropriately molar Gibbs free energy versus composition diagrams at the indicated temperatures for the two A and B binary systems whose phase diagrams appear below.

(a)



(b)



3. (30%) A real gas is described by Van der Waals equation $\left(P + \frac{a}{v^2}\right)(v - b) = RT$, where P is pressure, v is molar volume, T is temperature, R is the gas constant, and a and b are positive constants. Below the critical point T_{cr}, the liquid and the gas phases can coexist.
(a) (6%) Please plot the corresponding P versus v at $T > T_{cr}$, $T = T_{cr}$, and $T < T_{cr}$, respectively.
(b) (4%) What is the change of molar Gibbs free energy Δg from state 1 with P_1, v_1 to state 2 with P_2, v_2 when T is a constant?
(c) (6%) Please plot the corresponding Δg versus P at $T > T_{cr}$, $T = T_{cr}$, and $T < T_{cr}$, respectively.
(d) (6%) Are the P-v curves of part (a) and the Δg-P curves of part (c) corresponding the truly most stable state curves? If not, please draw the P-v curves and Δg-P curves corresponding to the most stable states.
(e) (8%) Please determine the critical temperature, critical molar volume, and critical pressure.

4. (20%) Please find the work W, the heat Q, the change of internal free energy ΔU, the change of enthalpy ΔH, and the change of Gibbs free energy ΔG, for an isothermal reversible expansion from an initial volume V_1 to a final volume V_2 for n moles of a gas which obeys the equation $P(V - nb) = nRT$.
(Hint: $\left.\frac{\partial U}{\partial V}\right|_T = T\left.\frac{\partial P}{\partial T}\right|_V - P$)