a. *Closed-book exam, no note, and no calculator.*
b. *Total 5 questions, and each question is worth 10 points.*
c. *For brief answers in any question, please explain within several sentences, and with schematic figures if necessary.*
d. *Without a calculator or mathematical handbook, you may not be able to finish for the exact final answer.   The logical procedure is much more important.*
e. *Any cheating = F grade.*

1. (a) In a binary-alloy phase diagram, please derive the lever rule, for the mole fraction of α phase and β phase when both phases coexist in equilibrium.
   (b) Please calculate the values of enthalpy, entropy, and volume when both α and β phases coexist in equilibrium.

2. Please derive the Gibbs phase rule, $F = C + 2 - P$, for a general case.

3. (a) For an ideal solution, please plot schematically G, S, V, H, and E, both after mixing and before mixing.
   (b) Considering two ideal (perfect) gases, please derive the molar Gibbs free energy before mixing, and the molar Gibbs free energy after mixing.   Then, please show the molar Gibbs free energy of mixing.

4. Please clarify why the following phase diagram is not correct, by plotting the Gibbs free energy vs. composition at the necessary temperatures.   Then, please fix the phase diagram.

5. In the following phase diagram, please plot Gibbs free energy vs. composition at three temperatures T_1, T_2, and T_3.