Part I. 50%

(15%) 1. Compare the two processes of phase transformation: Spinodal decomposition and Homogeneous nucleation and growth in (a) thermodynamic (b) kinetic aspects (c) the resulting structures.

(15%) 2. How did you ascertain in your experiments:

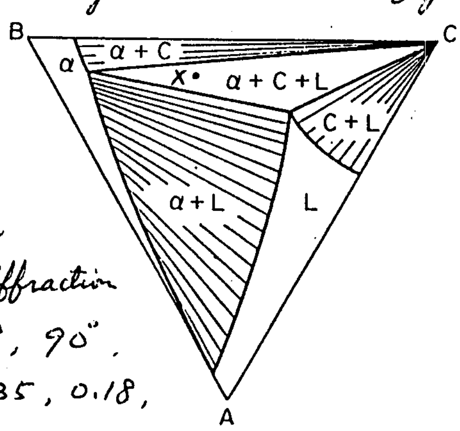
(a) Whether diffusion in a given temperature range occurred by an intrinsic or extrinsic mechanism.

(b) Diffusion in a given polycrystalline material was predominantly along grain boundaries or through the lattice.

(c) Sintering rate in an oxide was controlled by the diffusion of its cation or anion or both.

(10%) 3. (a) How many phases (max.) you are possible to identify in a 3-component phase equilibrium diagram which was constructed in one atmosphere.

(b) Calculate the percentage of each phase in point X in the phase diagram shown in figure.



(10%) 4. The crystal structure of a material was determined by x-ray diffraction with $Cu_{K\alpha} = 1.54 Å$. In the diffraction pattern, $2\theta = 43°, 50°, 74°, 90°$. ($\sin^2\theta$ of these angles are 0.135, 0.18, 0.36 and 0.49 respectively).

(a) Calculate and determine the crystal structure of the material (FCC, BCC, or hcp)

(b) What is the lattice constant of the material (a in Å)

Part II : 50%

1. (a). Explain why martensitic transformations are very rapid in growth rate (about one-third the sound velocity in Fe-Ni-C martensites). (10%)

   (b). Some martensites display thermoelastic characteristics whereas some do not. Explain the reason. (10%)

2. (a). In structural applications, the Ostwald ripening (i.e., coarsening of second phase particles) in alloys should be avoided. Why? (7%)

   (b). How do you control the metallurgical factors in alloy design to suppress Ostwald ripening? (8%)

3. (a). Describe the operation mechanisms (procedures) of Frank-Read source during plastic deformation. (5%)

   (b). Consider the applied work as a driving force. Is it possible to form a dislocation loop by nucleation? (10%)

   Hint: (i). The work required to glide a dislocation segment of unit length is about σb times the glide distance, where σ and b are the resolved shear stress and the magnitude of Burgers vector, respectively.

   (ii). To create a dislocation segment of unit length, the amount of free energy increase of the crystal is about $\frac{1}{2} G b^2$, where G is the shear modulus.