Name: **Student ID:**

<u>Question 1</u> *{5 marks}*

(i) Cite the phases that are present and the phase compositions for the following alloys:

2.12 kg Zn and 1.88 kg Cu at 500°C

(ii) Determine the relative amounts (in terms of mass fractions) of the phases for this alloy at 500°C.

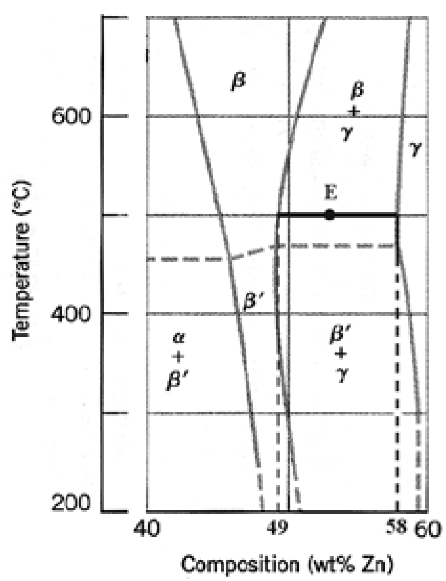
<u>Solution:</u>

For an alloy composed of 2.12 kg Zn and 1.88 kg Cu and at 500°C, we must first determine the Zn and Cu concentrations, as

$$C_{Zn} = \frac{2.12 \text{ kg}}{2.12 \text{ kg} + 1.88 \text{ kg}} \times 100 = 53 \text{ wt\%}$$

$$C_{Cu} = \frac{1.88 \text{ kg}}{2.12 \text{ kg} + 1.88 \text{ kg}} \times 100 = 47 \text{ wt\%}$$

That portion of the Cu-Zn phase diagram (Figure 9.19) that pertains to this problem is shown below; the point labeled "E" represents the 53 wt% Zn-47 wt% Cu composition at 500°C.



(i) Point E lies within the β + ϒ phase field. A tie line has been constructed at 500°C; its intersection with the β/β + ϒ phase boundary is at 49 wt% Zn, which corresponds to the composition of the β phase. Similarly, the tie-line intersection with the β + ϒ/ ϒ phase boundary occurs at 58 wt% Zn, which is the composition of the ϒ phase. Thus, the phase compositions are as follows:

$$C_{\beta} = 49 \text{ wt\% Zn-51 wt\% Cu}$$

$$C_{\gamma} = 58 \text{ wt\% Zn-42 wt\% Cu}$$

(ii) Inasmuch as the composition of the alloy C_0 = 53 wt% Zn and application of lever rule leads to

$$W_b = \frac{C_g - C_0}{C_g - C_b} = \frac{58 - 53}{58 - 49} = 0.56$$

$$W_g = \frac{C_0 - C_b}{C_g - C_b} = \frac{53 - 49}{58 - 49} = 0.44$$

Question 2 *{5 Marks}*
Consider 2.5 kg of austenite containing 0.65 wt% C, cooled to just below 727°C.
(a) How many kilograms each of total ferrite and cementite form?
(b) How many kilograms each of pearlite and the proeutectoid phase form?

Solution:

(a) For this portion of the problem, we are asked to determine how much total ferrite and cementite form. For ferrite, application of lever rule yields
$W_{\alpha} = (C_{Fe3C} - C_0)/(C_{Fe3C} - C_{\alpha}) = (6.70 - 0.65)/(6.70 - 0.022) = 0.91$
which corresponds to (0.91)(2.5 kg) = 2.275 kg of total ferrite.
Similarly, for total cementite,
$W_{Fe3C} = (C_0 - C_{\alpha})/(C_{Fe3C} - C_{\alpha}) = (0.65 - 0.022)/(6.70 - 0.022) = 0.09$
Which corresponds to (0.09)(2.5 kg)=0.225kg of total cementite.

(b) Now consider the amounts of pearlite and proeutectoid ferrite. Using Equation 9.20
$W_p = (C_0' - 0.022)/0.74 = (0.65 - 0.022)/0.74 = 0.85$
This corresponds to (0.85)(2.5 kg) = 2.12 kg of pearlite. Also, from Equation 9.21,
$W_{\alpha'} = (0.76 - 0.65)/0.74 = 0.15$
Or, there are (0.15)(2.5 kg) = 0.38 kg of proeutectoid ferrite.