MECH 340: Engineering Materials
Exam II

Date: 26 April. 2004
Duration: 75 minutes
Closed Book Exam
Write clearly your derivations and answers on the question sheet

Name:

ID#:

Miscellaneous Formulas

$$\tau_R = \sigma \cos\phi \cos\lambda$$

$$\sigma_y = \sigma_0 + k_y d^{-1/2}$$

$$\%CW = \left(\frac{A_0 - A_d}{A_0} \right) \times 100$$

$$d^n - d_0^n = Kt$$

$$\sigma_m = \sigma_0 \left[1 + 2 \left(\frac{a}{\rho_t} \right)^{1/2} \right]$$

Problem 1 [20 points]

A tungsten single crystal (BCC) has a [213] axial orientation.

a. Determine $\cos\phi$, $\cos\lambda$ and $|\cos\phi\cos\lambda|$ for each slip system. Consider only the $\{110\}\langle 1\bar{1}0\rangle$ slip systems.
b. Which slip system(s) will be active when plastic yielding occurs? Explain why.
c. The critical resolved shear stress is $\tau_0 = 100$ MPa. What is tensile stress when yielding occurs?

Problem 2 [30 points]

Sterling silver is an Ag alloy with 7.5%Cu. Using the phase diagram in Figure 9.6, tell what the microstructure would look like if the alloy were melted and cooled slowly under equilibrium conditions to room temperature, sketch the resulting microstructure. Also compute the relative amount of each phase and the composition of phase at a temperature of 400°C

Problem 3 [20 Points]

Consider the tensile stress-strain behavior of the plain carbon steel specimen shown in Figure 6.24 (see last page). The specimen is 10 mm in diameter and 75 mm long. Determine the following:

a. The modulus of elasticity,

b. The yield strength,

c. The maximum load that can be sustained,

d. The change in length of the specimen when subjected to a tensile load of 23,500 N.

Problem 4 [30 points]

A hypo-eutectoid steel contains 44%wt **eutectoid** ferrite. What is the amount of pearlite and pro-eutectoid ferrite it contains, and what is the average carbon steel content. If the steel composition was changed would the pearlite composition change (Use figure 9.21).

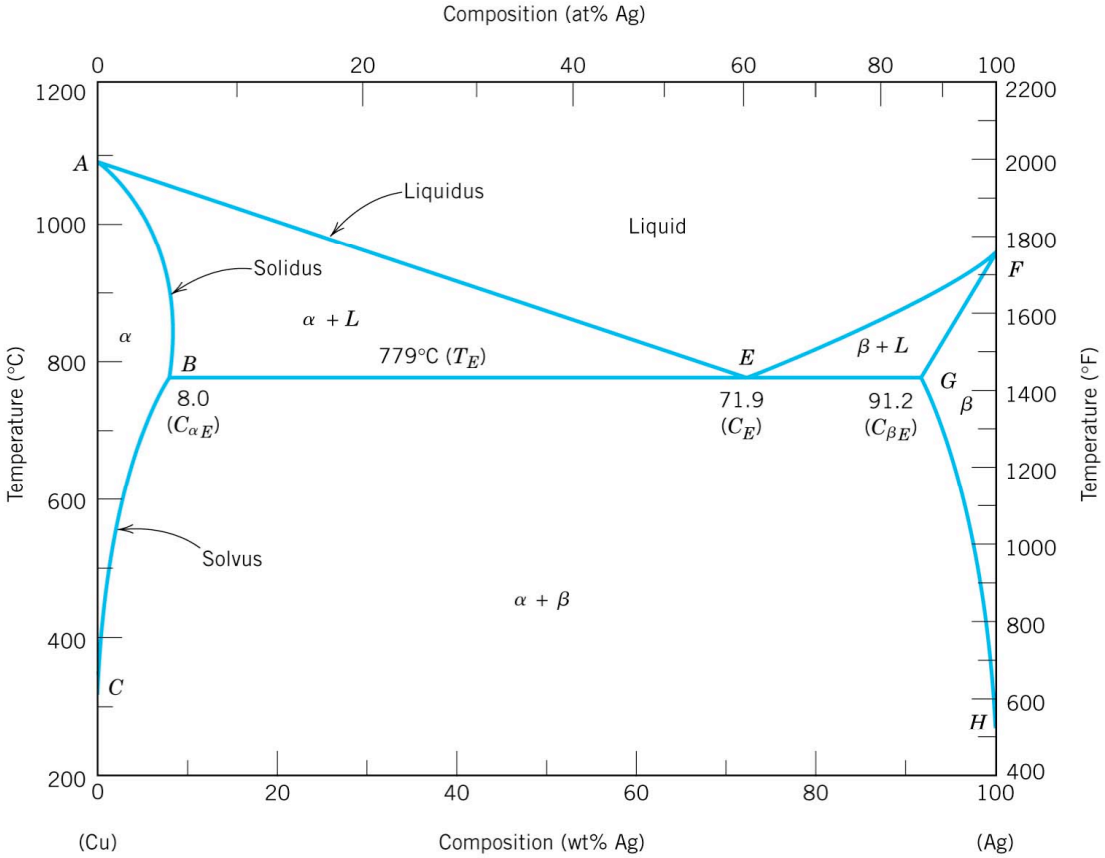

Figure 9.6 The copper–silver phase diagram. [Adapted from *Binary Alloy Phase Diagrams,* 2nd edition, Vol. 1, T. B. Massalski (Editor-in-Chief), 1990. Reprinted by permission of ASM International, Materials Park, OH.]

Figure 6.24 Tensile stress–strain behavior for an alloy steel.