FMS 2017 **PROBLEMS**

Please staple this sheet to the front of your assignment before you turn it in. Make sure that you have used grid paper, circled all problem numbers, and boxed all answers on your papers. You must show all supporting work in order to receive full credit for a problem.

(1) Suppose that a specimen of some metal had a dislocation density of 2×10^4 mm^{-2} originally. The specimen is then cold-worked and it is found that the dislocation density increases due to this process to 5×10^{10} mm^{-2}. Compare the two situations by computing the total chain lengths in each situation for a 1.0 mm^3 specimen if all of the dislocations could be removed and chained end-to-end. Give answers in meters.

(2) Calculate the planar densities for the (100), (110), and (111) planes for FCC crystal structures.

(3) Calculate the planar densities for the (100), (110), and (111) planes for BCC crystal structures.

(4) From the plot in your text of yield strength versus (grain diameter)$^{-1/2}$ for a 70Cu-30Zn cartridge brass, determine the values of the constants σ_o and k_y. Using this information, predict the yield strength of this alloy when the average grain diameter is 1.0×10^{-3} mm.

(5) What would be the theoretical Poisson's ratio for a material that when strained, does not change in density (and thus volume). Suppose that a material had this Poisson's ratio, how much cold work would be experienced by a specimen of this material that suffered a strain of 0.125?

(6) The lower yield point for an iron that has an average grain diameter of 0.050 mm is 135 MPa. At a grain diameter of 0.008 mm, that yield point increases to 260 MPa. At what grain diameter will the lower yield point be 205 MPa?

(7) Two previously undeformed cylindrical specimens of an alloy are to be strain hardened by reducing their cross-sectional areas (while maintaining circular cross sections). For one specimen, the initial and deformed radii are 16.0 mm and 11.0 mm, respectively. The second specimen, with an initial radius of 12.0 mm, must have the same deformed hardness as the first specimen. Compute the second specimen's radius after the appropriate deformation.

(8) A cylindrical specimen of cold-worked copper has a ductility of 25 %EL. If its cold-worked radius is 10 mm, what was its radius before the deformation?

(9) The average grain diameter for a brass material was measured as a function of time during a period of grain growth at 650 °C. After 30 minutes the average grain diameter was 0.039 mm, and after 90 minutes the average grain diameter was 0.066 mm. Find: (a) the original average grain diameter of the material, and (b) the predicted average grain diameter after 150 minutes of grain growth at 650 °C. Assume that n in the grain-growth equation is 2.0.

(10) An uncold-worked brass specimen of average grain size 0.008 mm has a yield strength of 160 MPa. Estimate the yield strength of this alloy after it has been heated to 600 °C for 1000 minutes (16.7 hours), if it is known that the value of k_y is 12.0 MPa-mm$^{1/2}$.