Assignment 1 **MECH 421** **Due Mon. Jan. 31, 2006**

Question 1:

Consider the heading operation shown below. An aluminum rod of 0.3 inch diameter is deformed to 0.375 inch diameter. The final height of the head is 0.25 inch. Assume a coefficient of fiction at the die of 0.4. The material stress-strain relationship is:

$$\sigma = 5000 + 20000\ \varepsilon^{0.2} \text{ psi}$$

i- Determine the force applied when the head diameter is 0.375 inch.
ii- What is the work required to complete this operation?

Question 2:

(a) Briefly explain why HCP metals are typically more brittle than FCC and BCC metals.

(b) Does plastic deformation of polycrystalline materials occur at stresses that are equal to the theoretical strength of their perfect crystals? Why?

Question 3:

A 0.5 m wide sheet of 5052-O aluminum (K = 210 MPa and n = 0.13) is reduced in thickness from 6 mm to 4 mm in two passes through a rolling mill. The thickness is reduced 1.0 mm during each pass. The roll diameter is 250 mm. The initial sheet is 1 m long. Assuming the friction is insignificant,
(a) estimate the rolling force on the first pass.
(b) estimate the rolling force on the second pass.
(c) estimate the length of the 4 mm thick sheet.

Question 4:

i- An AISI 1015 steel slab of h_o = 300 mm thickness and w_o = 1000 mm width is hot rolled at 1000°C on a mill with rolls of diameter 600 mm. The presence of scale reduces friction to μ = 0.3. A reduction of 27 mm is taken. Roll speed is 1.2 m/s. Calculate roll force and power requirement.

ii- After hot rolling the material is cold rolled on a mill of roll diameter 400 mm at speed of 700 m/min. Calculate the force and power requirement for rolling from 1.0 mm to 0.6 mm, if a lubricant reduces the coefficient of friction to 0.05.

(Hint: for AISI 1015 steel C = 120 MPa, m = 0.1, K = 620 MPa and n = 0.18)

Question 5:

A metal is deformed in a tension test into its plastic region. The starting specimen had a gage length = 2.0 in and an area = 0.50 in^2. At one point in the tensile test, the gage length = 2.5 in and the corresponding engineering stress = 24,000 lb/in^2; and at another point in the test prior to necking, the gage length = 3.2 in and the corresponding engineering stress = 28,000 lb/in^2. Determine the strength coefficient and the strain hardening exponent for this metal.

Question 6:

With appropriate sketches, explain the rolling defects.