Department of Mining and Materials Engineering

Faculty of Engineering, Prince of Songkla University

Final Examination 2nd Semester	Academic Year 2004
Date: 3rd March 2005	Time: 13.30pm-16.30pm
Subject: 237 – 302 Materials forming	Room: R300

Instructions:

1. There are 4 problem sets in total. Please **do all questions 1 to 3** and **one topic of question 4** and write your answer in the answering sheets provided.
2. Only one piece of A4-size note is allowed. You may write on both sides and please return it with your answers.
3. Dictionary, calculator and stationary are also allowed
4. Textbook and other studying materials are not allowed.
5. This final exam is accounted for 45% of the total grade point.

"ทุจริตในการสอบ โทษขั้นต่ำ คือ พักการเรียน 1 ภาคการศึกษาและ ปรับตกในรายวิชาที่ทุจริต"

Question 1 (20 marks)

(a) The drawing stress required to draw a titanium rod through a die with an approach angle of 10° was 550MPa. When the same rod was passed through a die with the same diameter, but with an approach angle of 20°, the drawing stress was 450MPa. Ignoring redundant work, use this information to estimate the friction coefficient between the die and the rod and state any assumptions you made.

(b) Compression tests conducted on the titanium rod prior to drawing showed that the material displayed minimal work hardening, such that the flow stress of the rod (σ) could be assumed to be constant during drawing, and equal to 800 MPa. Ignoring redundant work, calculate the minimum die diameter that a 10mm diameter rod could be drawn in one pass.
Use the friction coefficient calculated in part (a) with a die approach angle of 10°.

(c) Briefly discuss the three main processes for tube drawing which are sinking, plug drawing and mandrel drawing, including the advantages and disadvantages of each.

Data:

The stress required for wire drawing, σ_D, is given by the following equation. (Ignoring redundant work)

$$\sigma_D = \bar{\sigma}.\ln\frac{A_0}{A_1}(1+\mu.\cot\alpha)$$

where

A_o = Initial wire cross section

A_1 = Final wire cross section

μ = Coefficient of friction

α = Approach angle in radian

$\bar{\sigma}$ = Average yield strength of the material being drawn

Question 2 (15 marks)

Sheet metal of two different alloys is produced by rolling to 0.100inch thickness. You must select one of those alloys for a deep drawing operation. To make the selection, tensile samples are cut from each alloy at 0°, 45° and 90° to the rolling direction. The gauge section of each tensile sample is 0.75inch in width. After subjecting all samples to the same tensile load, the samples plastically deformed and the width and thickness for each alloy is measured, with the following results:

	Alloy A		Alloy B	
Cut	width (in)	thickness (in)	width (in)	thickness (in)
At 0°	0.65	0.092	0.70	0.082
At 45°	0.63	0.093	0.69	0.083
At 90°	0.67	0.087	0.71	0.078

Answer all the following questions:

(a) Which material will have the greater limiting draw ratio (LDR)? Support your answer by calculation.
(**Hint:** *use the relation between the average normal anisotropy and the LDR)*

(b) Explain the term "earing" and which material will exhibit the worst "earing"?

(c) Which of the two alloys would you select for the deep drawing operation? Give your reason.

Data:

The *drawability* of a metal is measured by the ratio of initial blank diameter (D_o) to the diameter of the cup drawn from the blank or punch diameter (D_p) and represents as *a limiting draw ratio* (LDR);

$$\text{LDR} = \frac{D_o}{D_p}$$

$$\text{Normal anisotropy (R)} = \frac{\varepsilon_w}{\varepsilon_h} = \frac{\ln(w_o - w)}{\ln(h_o - h)}$$

where w_o and w are the initial and final width of tensile test specimen

h_o and h are the initial and final thickness of tensile test specimen

$$\text{Average normal anisotropy } (\bar{R}) = \frac{(R_0 + 2R_{45} + R_{90})}{4}$$

where R_0, R_{45}, R_{90} are normal anisotropy for the 0°, 45° and 90° directions to rolling.

$$\text{Planar anisotropy } (\Delta R) = \frac{(R_0 + R_{90} - 2R_{45})}{4}$$

Question 3 (10 marks)

A solid cylindrical workpiece made of annealed copper is 150mm in diameter and 100mm high. It is forged by open-die forging at room temperature with flat dies and is reduced in height by 40 percent. Assuming that the coefficient of friction is 0.15, calculate the forging force at the end of the stroke.

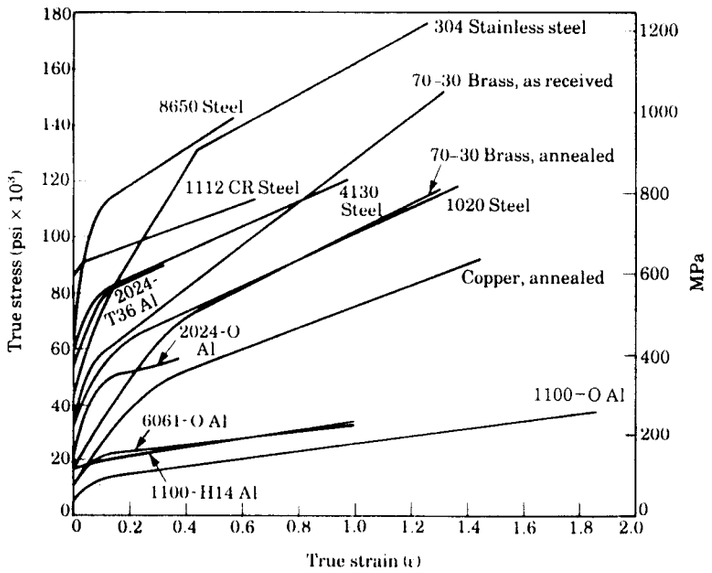
Given that the force F required for an open-die forging operation on a solid cylindrical piece is to be estimated as: -

$$F = Y_f \pi . r^2 (1 + \frac{2\mu . r}{3h})$$

Y_f = flow stress of material,

μ = coefficient of friction

r and h = radius and height of the product respectively.



True stress- true strain curves in tension at room temperature for various metals.

Total of 50 marks

Good luck!!!

Question 4: Please <u>choose one topic</u> of the followings: (5 marks)

(a) Compare and contrast the compression and injection molding processes used in the plastic industry.

(b) Discuss the production of WC-Co hard metal cutting tools via powder metallurgy route.

(c) Compare and contrast including advantages and disadvantages of the stretch forming over stamping processes.

Total of 50 marks

Good luck!!!