

**RESERVE DESK**

M.E. Ph.D. Qualifier Exam  
Fall Semester 2002

SEP 17 2002

# GEORGIA INSTITUTE OF TECHNOLOGY

The George W. Woodruff  
School of Mechanical Engineering

**Ph.D. Qualifiers Exam - Fall Semester 2002**

Manufacturing

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EXAM AREA

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**Assigned Number (DO NOT SIGN YOUR NAME)**

- Please sign your name on the back of this page—

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Please **print** your name here.

**The Exam Committee will get a copy of this exam and will not be notified  
whose paper it is until it is graded.**

### Question #1

You are cold drawing a metal wire from initial diameter = 0.5 mm to final diameter = 0.33 mm.

You have two options to consider:

- (a) drawing the wire through one die.
- (b) drawing the wire through multiple dies (i.e., draw from 0.5 mm to  $D_1$ , and then draw from  $D_1$  to 0.33). (N.B. For this option, there is no buffer and no annealing of the wire between the dies.)

The material has strength coefficient  $K = 315$  MPa and a strain hardening coefficient  $n = 0.54$ . The die has angle  $\alpha = 4^\circ$ , and friction coefficient  $\mu = 0.05$ .

Which option would you select and why? Be quantitative in your answer (e.g., draw force, power, etc.).

$$\frac{\sigma_{x\_draw}}{2\tau_{flow}} = \left( \frac{1+B}{B} \right) \left( 1 - \left( \frac{D_{final}}{D_{initial}} \right)^{2B} \right) + \frac{\sigma_{x\_back}}{2\tau_{flow}} \left( \frac{D_{final}}{D_{initial}} \right)^{2B}$$

$$B \equiv \frac{\mu}{\tan \alpha}$$

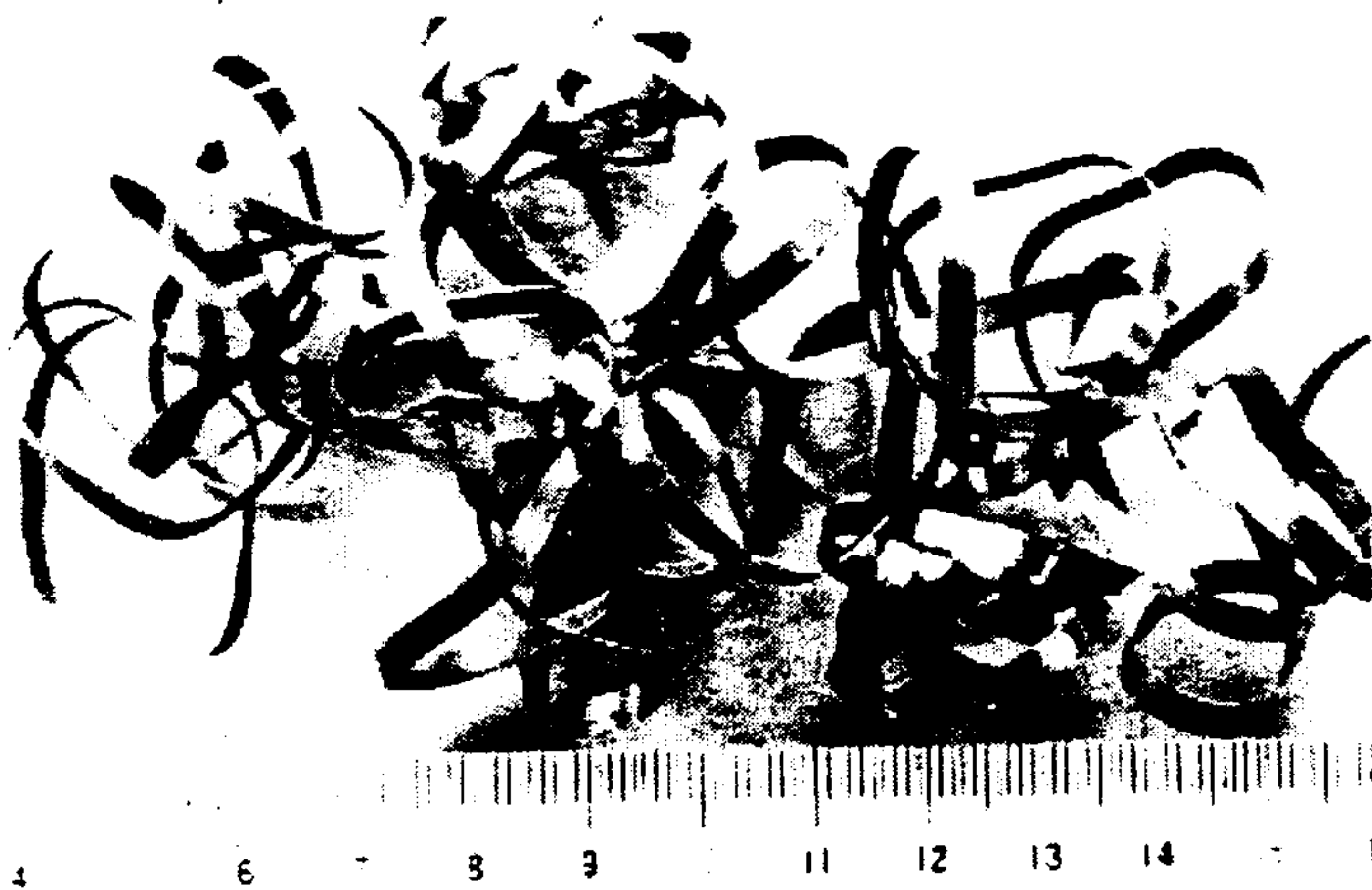
$$2\tau_{flow} = \frac{K\varepsilon^n}{n+1}$$



Question #2

In the figures below are two types of chip geometries produced by the turning of an aluminum bar on a lathe.

- a. Which of these two types of chips is preferred? Why?
- b. Explain what conditions/parameters can affect the formation of these two types of chips.
- c. After the machining operation, which surface would you expect to be "smoother"? Explain.





Problem #3

- a) Describe the solidification process in casting a metal alloy. Part of your answer should make use of a phase diagram. Sketch and label a generic phase diagram indicating the location of the alloy you are considering.
- b) Draw two cooling curves. One for a pure metal and another for the alloy you indicated in part 1a.
- c) What is "coring" and how does it occur? Give a detailed description using a phase diagram.
- d) Describe investment casting.

