

**RESERVE DESK**

M.E. Ph.D. Qualifier Exam  
FALL Semester 2001

OCT 19 2001

# GEORGIA INSTITUTE OF TECHNOLOGY

The George W. Woodruff  
School of Mechanical Engineering

**Ph.D. Qualifiers Exam - FALL Semester 2001**

Manufacturing

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EXAM AREA

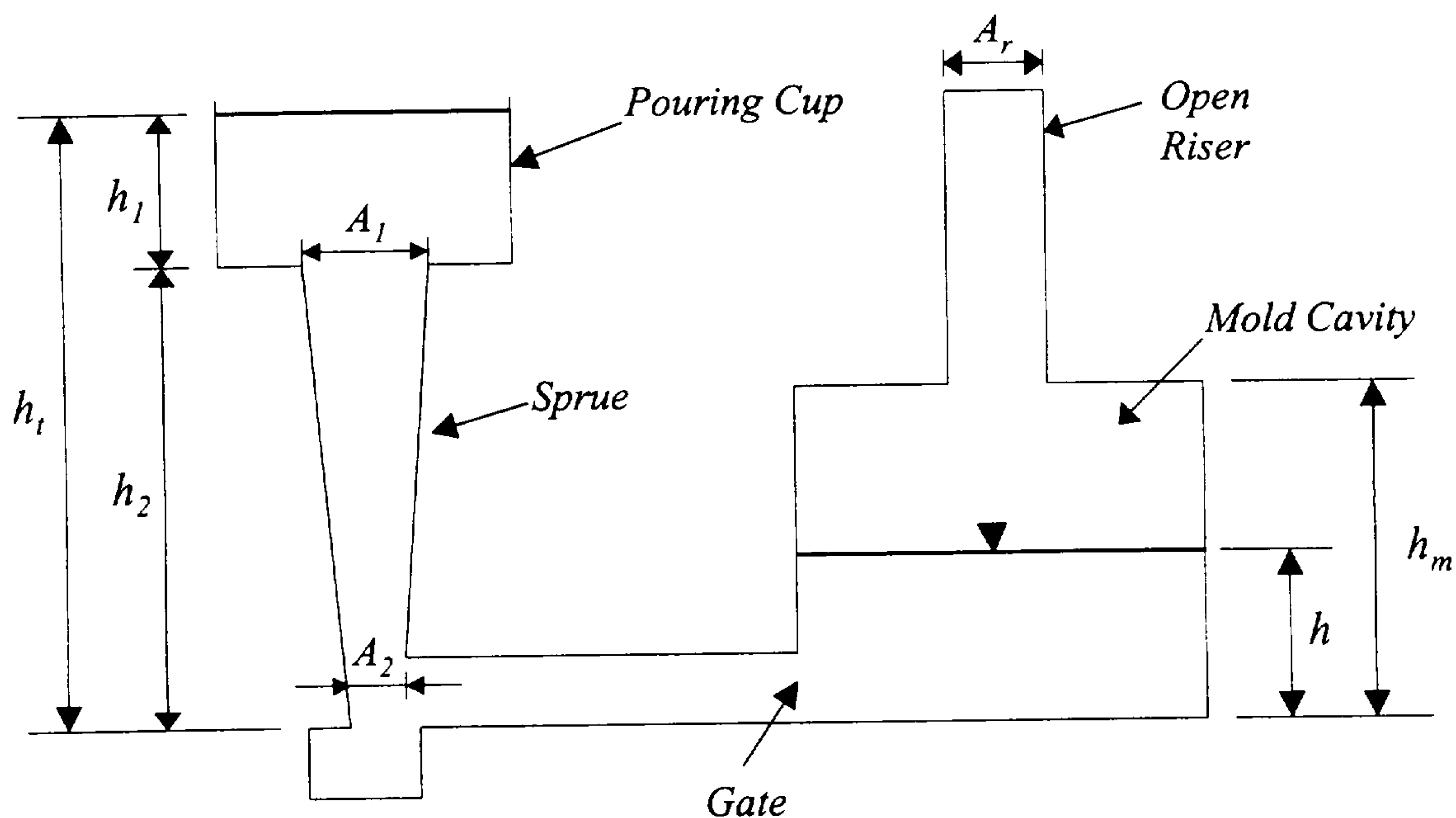
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Assigned Number (DO NOT SIGN YOUR NAME)

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

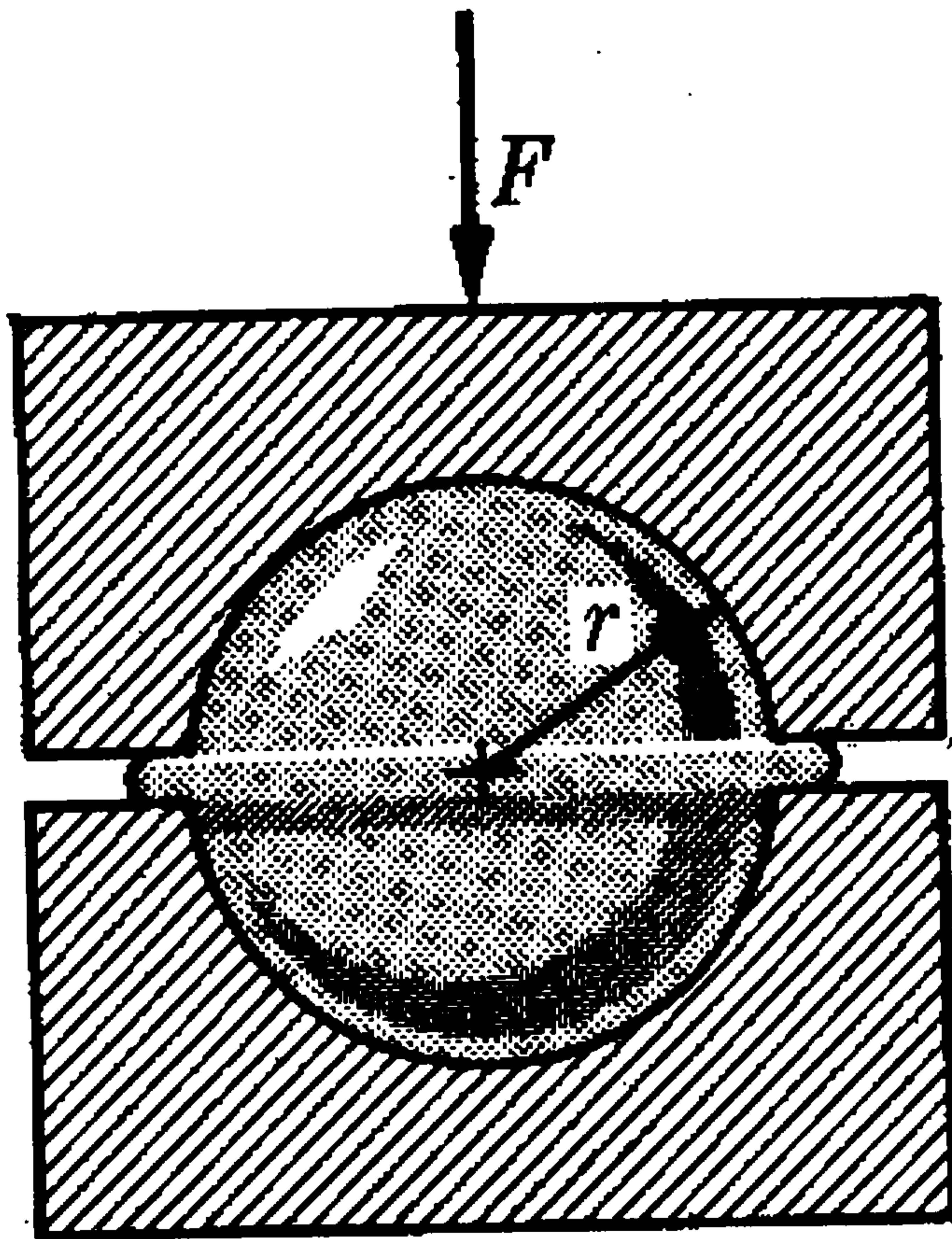
Note that all problems have to be worked on for full credit. Show your work as much as possible.

1. Consider the mold shown in the figure below for sand casting a *square* block of metal.



- (a) Derive an equation for the total time required to completely fill the mold cavity and the open riser, given that the cross-sectional areas of the gate (i.e. where the runner meets the mold cavity), mold cavity, and the riser are  $A_g$ ,  $A_m$ , and  $A_r$  respectively. Note that  $h$  represents the instantaneous height of the molten metal in the mold cavity and the riser height  $h_r = (h_t - h_m)$ . Clearly state all assumptions you make in your derivation.
- (b) Assuming that the open riser in the mold shown above is cylindrical in shape and its height,  $h_r$ , is twice its diameter,  $D_r$ , find the riser dimensions in terms of the given casting (i.e. mold cavity) dimensions such that shrinkage cavities are avoided.

2. Ball-bearing balls are formed cold from wire stock in a closed-die, cold-forging operation (see figure below). Consider a ball 0.2 inches in diameter made from wire having an initial diameter of 0.15 inches. The variation in length of the wire slug sheared from the rod is  $\pm 3\%$ . This gives rise to a variation in the size of the flash. The slug length is adjusted so that at its minimum length, the cavity is just filled. The flash thickness is adjusted to be 0.005 inches.
- a) Find the maximum flash length.
- b) If the average wire shear flow stress ( $\tau_f$ ) is 60,000 psi, and a friction coefficient ( $\mu$ ) of 0.1 is assumed, estimate the maximum forging force. List all assumptions.



3. A carbon steel 10-inch diameter cylindrical workpiece is turned on a lathe with a  $5^\circ$ -rake cutter. This process is done in one pass to reduce the workpiece diameter by 0.2 inch. It takes 30 second to complete the entire axial length of 6 inches at a spindle speed of 1,000 rpm. The power required of the spindle motor is 5 hp when no cutting fluid is used. From data in a tribology handbook we learn that the friction coefficient between the tool and the workpiece material is 0.3 when the contact surfaces are dry. Suppose a cutting fluid sales approaches you with a fluid that can cause the tool and workpiece interface friction to drop to 0.1, and he claims that the application of this fluid will cut down the motor power requirement by 50%. Do you believe him? What is your estimate of the required motor power when this fluid is used?