GEORGIA INSTITUTE OF TECHNOLOGY

The George W. Woodruff
School of Mechanical Engineering

Ph.D. Qualifiers Exam - Spring Quarter 1998

Tribology
EXAM AREA

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Assigned Number (DO NOT SIGN YOUR NAME)

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

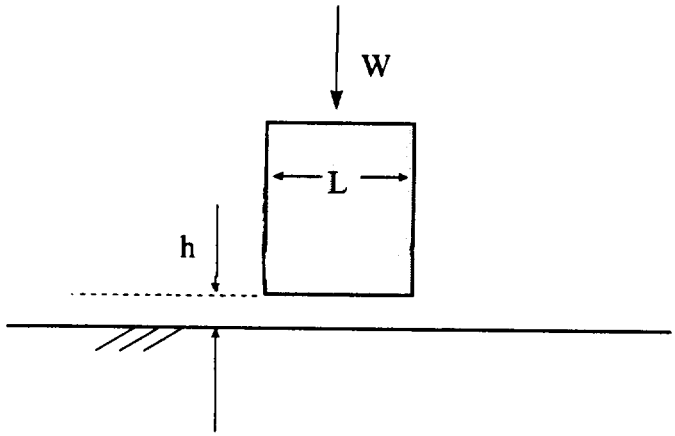
Please **print** your name here.

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

With reference to the figure below, the governing equation for "squeeze" film motion for the long bearing (long into the page) is given by:

$$\frac{\partial}{\partial x}\left(h^3 \frac{\partial p}{\partial x}\right) = 12\mu \frac{\partial h}{\partial t}$$



(a) Find p(x) in terms of μ, L, and $\frac{\partial h}{\partial t}$, assuming p=0 @ x=0 and x=L.

(b) Find the load per unit depth into the page, w (i.e., W/B, where B is the depth into the page), in terms of parameters above.

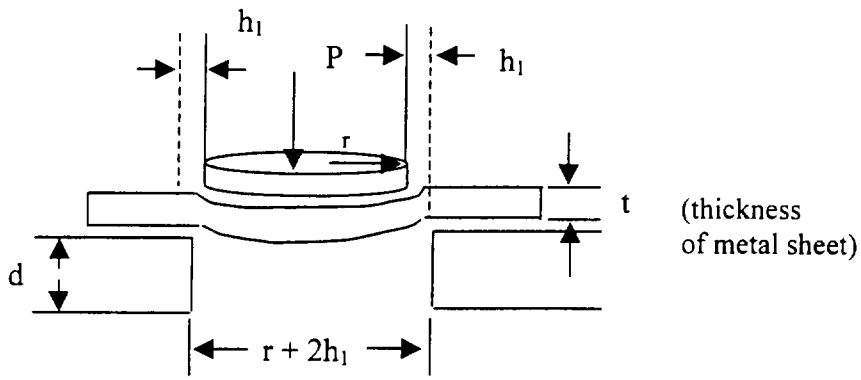
(c) Neglecting inertia, determine the time for the film thickness to go from 1 mm to 1 μm, given the following data:
μ = 0.1 Pa-s, L = 2 cm, B = 10 cm, W = 10.0 N

Question #2

This problem relates to the contact, deformation and shearing of metals, and the influence of the frictional contact on deformation. The diagram below shows a punch being used to shear a metal sheet. The elementary analysis for the calculation to determine the maximum load to cause shear gives

$$P_{\text{to cause shear}} = \sigma_{\text{yield}} \cdot \pi r t$$

a.) Include frictional forces in this analysis and derive an equation for P that includes the coefficient of friction at the punch/die interface.



b.) Is P increased or decreased when friction is included?

c.) Is P increased or decreased when the loading rate (punch speed) is increased?

Question #3

a.) If you look up the stairs in an old building, for example the Coon building, you may notice that the steps show more wear on the right hand side of the stairs than on the left. Why do you suppose that is? Please discuss your answer in terms of basic issues associated with wear phenomena.

HINT: I have noticed that people tend to traverse stairs by proceeding on the right hand side - that is, either up or down on the right. Hence when looking up the stairs you see more wear on the right side and less on the left.

c.) Estimate the temperature rise of the shoe sole surface when you take a step up the stairs, and when you take a step down the stairs. Explain your method and assumptions.