GEORGIA INSTITUTE OF TECHNOLOGY

The George W. Woodruff
School of Mechanical Engineering

Ph.D. Qualifiers Exam - Spring Quarter 1996

TRIBOLOGY

EXAM AREA

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

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

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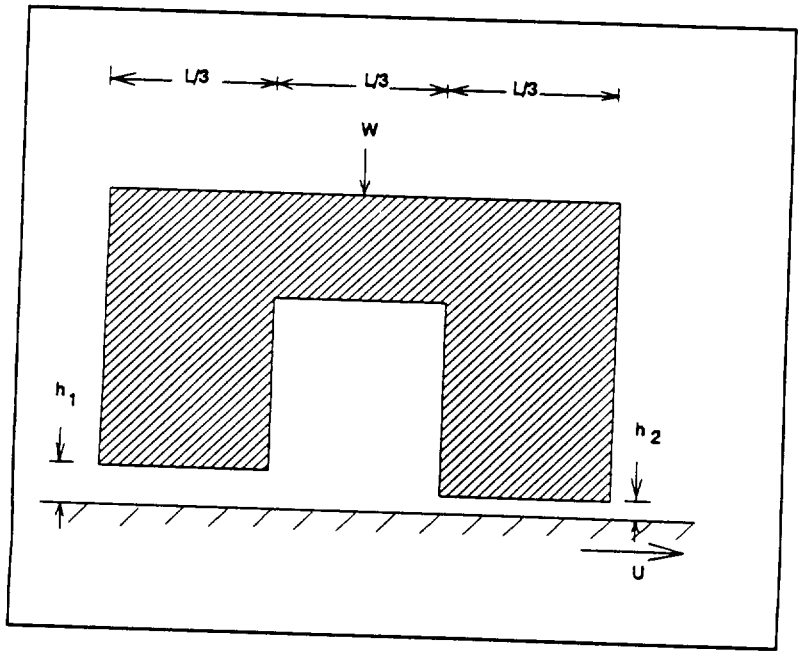
Spring Quarter, 1996
Tribology Qualifying Exam

1. Consider the modified Rayleigh Step two-dimensional slider bearing shown in the figure. The lubricant is a liquid with viscosity μ. The centrally placed recess is of much greater depth than the film thicknesses h_1 and h_2. In terms of the parameters of the problem, find:

   i. the pressure distribution in the film, and sketch it

   ii. the maximum pressure

   iii. the load per unit width, W



2. A ball trust bearing with 7 balls is loaded axially across its races through the balls. The 7 spherical balls are 10 mm in diameter, and the races are flat. All parts are hardened steel. The axial load is 100 N per ball. What is the size of the contact area on a race, and what are the stresses developed in the balls and the races? What is the depth of the maximum shear stress in the ball? Assume that the load is shared equally by the 7 balls, and that the speed is sufficiently slow that this can be considered a static loading problem. *[It is requested that you carry out as much calculations as possible. In the event that you cannot recall the exact form of an equation, give at least its functional form and a layout (e.g., flowchart) of how you would bring this problem to a complete solution.]*

3. When two surfaces are moved relative to one another with a normal load between them the mechanical work required to do this is primarily converted into thermal energy. Discuss the following issues associated with this situation:

- If all the mechanical work is not converted into thermal energy, what other mechanisms of energy dissipation might there be,
- To the extent that the mechanical work is converted into thermal energy which increases the temperature distribution in the solid,
    - describe the temperature distribution as a function of space and time,
    - how is the temperature distribution influenced by the operational parameters such as normal load, relative sliding speed, and normal load per unit projected area,
    - how is it influenced by the thermal properties of the two solids,
    - how is it influenced by the surface geometry.
- Explain the basis for Amonton's "law", and de Vinci's observation, that the friction force is essentially independent of the nominal surface area for a given material, load and sliding speed.