GEORGIA INSTITUTE OF TECHNOLOGY

The George W. Woodruff
School of Mechanical Engineering

Ph.D. Qualifiers Exam - Fall Semester 2003

Tribology
EXAM AREA

Assigned Number (DO NOT SIGN YOUR NAME)

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

TRIBOLOGY QUALIFYING EXAM
FALL 2003

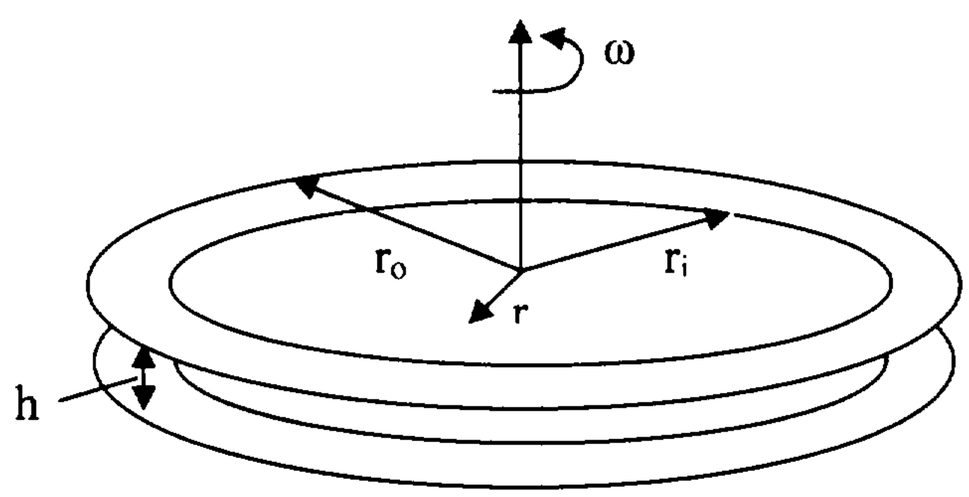
PROBLEM 1

My mother-in-law, who is not an engineer, asked me recently why the front brakes on her car always seem to wear out long before the rear brakes. What should I tell her?

While we are at it, I am aware that the inside pads usually seem to wear out before the outside pads. Why is that?

Wear maps were developed by Lim and Ashby for a variety of materials. Sketch a typical wear map, define the variables employed and briefly discuss the different wear regimes.

PROBLEM 2



A machine contains two washers (annular discs), shown schematically above. The upper washer rotates with angular speed ω; the lower washer is stationary. To lubricate the interface between the washers, oil with constant viscosity μ is supplied at the inner radius (r_i) at pressure p_i. The pressure at the outer radius (r_o) is p_o. There is full film lubrication (no mechanical contact), with an oil film thickness h (which can vary with location). The washers are very narrow, $(r_o-r_i)/r_o << 1$.

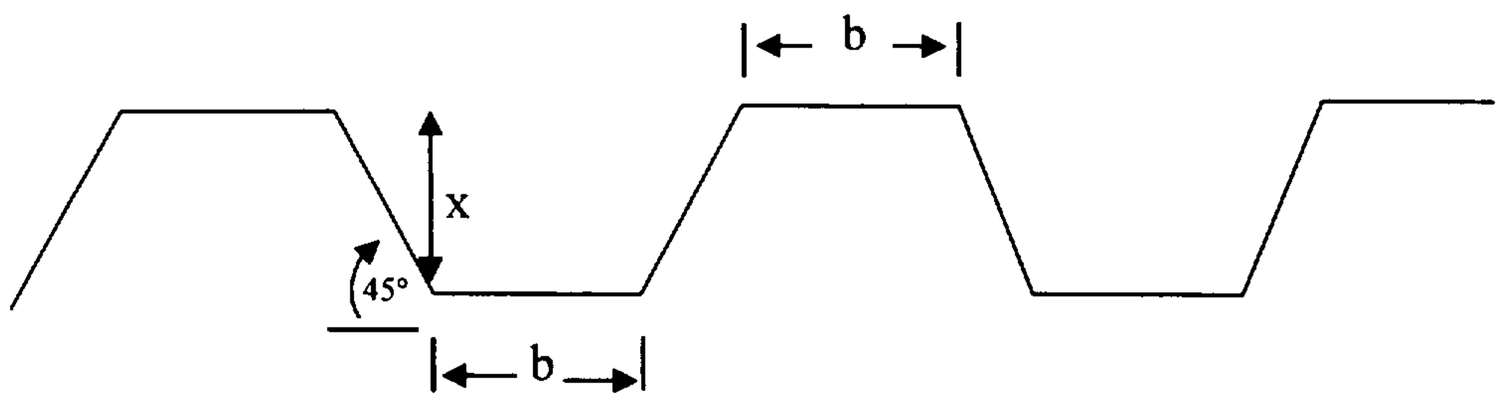
i) Write down the differential equation governing the pressure in the lubricating film (Reynolds equation), applicable to this problem.

ii) Simplify the equation in part i, assuming h only depends on the radial location (r); it is independent of the circumferential location (θ).

iii) The film thickness distribution is given by $h = Ar^B$, where A and B are constants. Find the pressure distribution, p, in terms of r, r_i, r_o, p_i and p_o.

PROBLEM 3

This problem has to do with describing and analyzing the roughness of engineering surfaces. For example, the surface shown below is said to have a certain roughness that can be described by a probability density function and roughness parameter R.



i) Sketch the form of the probability density function.

ii) Evaluate R_a and R_q for a surface having this type of geometry.

iii) How would the lay of a machined surface manifest itself in the measurement of R_a and R_q.