Tribology Ph.D. Qualifying Exam
Fall 2017

Instructions:

1. You must solve all problems. They are of equal weight.
2. Write your work clearly in dark ink. Define all your variables. If you need to make assumptions, justify those briefly. Do not assume that the examination committee can "guess" what you "mean."
3. Budget your time. Concentrate on concepts and setting up the solution first. Then work out the math as necessary.

Problem 1

One of the key results of the well-known Greenwood-Williamson rough surface contact model is expressed as:

$$A_r = \eta A_n \int_d^\infty \pi R(z - d)\phi(z)dz$$

Derive this result, in detail. Be sure to provide definitions of all parameters.

Problem 2

Two cavitation models are typically used in journal bearings.

(a) Explain each of the two models, their advantages and disadvantages.

(b) Address whether the models are mass conserving, and if they are, explain under which condition(s).

(c) Explain which model is best used for "long bearings" and for "short bearings."

(d) Explain how you would implement the two models when the Reynolds equation is solved numerically.

Problem 3

The standard components of a ball bearing are shown in the figure below.
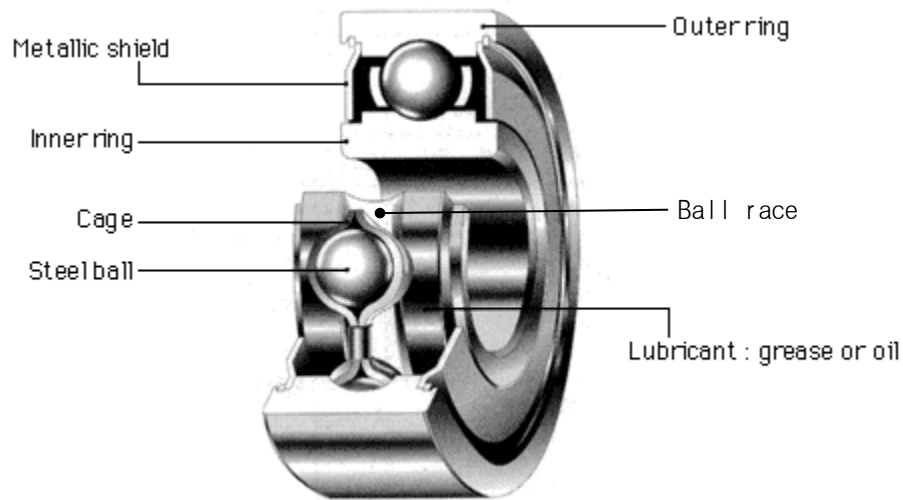
(a) Which pair of the bearing components contributes the most to the bearing friction? Why?

(b) It has long been known that lubrication practically does not affect rolling friction. Why are ball bearings lubricated?

(c) What are the mechanisms of energy dissipation in rolling?

(d) What is the main wear type that can be expected to appear in the inner-ring ball race? Why?