GEORGIA INSTITUTE OF TECHNOLOGY

The George W. Woodruff
School of Mechanical Engineering

Ph.D. Qualifiers Exam - Spring Quarter 1999

Tribology
EXAM AREA

Assigned Number (DO NOT SIGN YOUR NAME)

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

Please **p r I n t** your name here.

The Exam Committee will get a copy of this exam and will not be no i whose paper it is until it is gra ed.

Question #1

We want to build a device which includes a vertical shaft supportin a concentric rotatin of 100 kg. We plan two journal bearings to the maintain radial posi on of the shaft. One journal bearings will also incorporate an axial thrust bearing below e drive motor to ca vertical load of 100 kg. The other journal bearing is 1 meter lower o the shaft and is jus the 100 kg rotating load. This lower journal bearing is the subject o he problem. It will b with a mineral oil having a viscosity of 10 mPaS at the inlet tempe ure of 100 C. The oi be fed at a low pressure at three equally spaced locations arou the bearing, whicl sufficient flow to keep the gap in the bearing full of oil. The shaft otation speed will in from zero to 3600 RPM linearly at a rate of 360 RPM/minute, hold s ady for thirty minut then decelerate at the rate of 360 RPM/minute to rest. The shaft di meter at the journal l e is 5 cm and the radial gap is 50 micrometers.

a) Provide an estimate of the torque that will be required to t the bearing throu cycle and a graph to indicate the expected torque (in N-m as a function of ti n minutes). (State all your assumptions and show your analysis

b) Discuss possible deviations from your prediction and why the may occur.

Question #2

Many contact models require the characterization of surface topography, which is performed after
discrete sampling of the surface.

a) Provide expressions relating the sampled data points of a 1-D profile to the following parameters:

   i) σ, the rms roughness
   ii) R, the mean radius of curvature of the asperities

b) Which of the two terms above is more sensitive to the choice of horizontal sampling resolution? EXPLAIN.

c) List 3 sources of error in measuring a surface profile.

Question #3

In the analysis of abrasive wear, the asperities of the harder surface are modeled as conical in shape and assumed to plow through the softer surface. Using the figure below and making appropriate assumptions:

a) Derive an expression for the wear rate—volume removed per distance slid—in terms of the load, the hardness and the other relevant parameters.

b) Discuss the effect of the sharpness of the asperities on the wear rate.