INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR
Postgraduate, M.E. (Mech.) 2nd Semester Examination, 2014
Industrial Tribology (ME - 1011)

Time: 3 Hours Full Marks: 70

Answer question no. 1 and any four questions from the rest.
All questions carry equal marks.

1. Write short notes on the followings:
   (i) Anti-foam Agents
   (ii) Anti-Wear Additives
   (iii) Synthetic lubricants
   (iv) Ferrography
   (v) Solid lubricant
   (vi) Detergents and Dispersants
   (vii) FT-IR Spectrometer

2. Derive the generalized Reynolds Equation from Navier-Stokes and Continuity Equations of fluid film lubrication. State all the basic assumptions made in the above theory of lubrication.

3. (a) Draw a journal bearing, showing all the important geometric parameters.

   (b) Define infinitely long journal bearing & infinitely short journal bearing.

   (c) Find out the expression of pressure distribution and load bearing capacity of an infinitely long journal bearing with full Sommerfeld boundary condition.

4. (a) A fixed inclination slider bearing of length 100 mm and width 600 mm, with a minimum film thickness of 40 μm, operates at a sliding velocity of 1 m/s with a mineral oil absolute viscosity of 0.035 Pa-s. Film thickness ratio is adjusted to have maximum load capacity. Calculate the normal load capacity, the shear force experienced by the sliding surface and the coefficient of friction.

   (b) Explain the significance of terms of Poiseuille's flow, Couette's flow and squeeze flow of hydrodynamic lubrication.

5. (a) A full journal bearing of length 100 cm operates with a shaft of 20 cm diameter, rotating at 1200 rpm, and having a diametral clearance of 200 μm. The lubricating oil has an absolute viscosity at an inlet temperature of 20°C is 0.040 Pa-s. For an eccentricity ratio of 0.7, calculate the minimum film thickness, attitude angle, maximum film pressure, its location and load capacity.

(b) Explain the Petroff's law of bearing friction.

6. (a) What are lubrication mechanisms of gear drive in machine and knee joint of human body.

(b) Explain under what circumstances a lubricated gear may fail either due to severe adhesive wear or abrasive wear instead of surface fatigue wear. What will you observe in teeth of gears and wear debris in the above two cases of failures?

(c) Discuss the lubrication regimes in terms of ratio of film thickness to composite roughness of surfaces, called "Λ" ratio, and draw the qualitative curves of friction & wear resistance showing the lubrication regimes.

The following formulae, if required, may be used for Industrial Tribology (ME 1011) of 2nd Semester PG, ME (Mech.) Examination, 2014.

- ***INFINITELY LONG JOURNAL BEARING:-***

$$\cos\gamma = \frac{\epsilon + \cos\theta}{1+\epsilon\cos\theta}$$

$$\sin\theta = \frac{(1-\epsilon^2)^{1/2}}{1-\epsilon\cos\gamma}\sin\gamma$$

$$\cos\theta = \frac{\cos\gamma-\epsilon}{1-\epsilon\cos\gamma}$$

$$d\theta = \frac{(1-\epsilon^2)^{1/2}}{1-\epsilon\cos\gamma}d\gamma$$

- ***FULL SOMMERFELD NUMBER:-***

$$h_m = \frac{2c(1-\epsilon^2)}{2+\epsilon^2}$$

$$\theta_m = \cos^{-1}\left(\frac{-3\epsilon}{2+\epsilon^2}\right)$$

$$p = \frac{6\eta\omega(\frac{r}{c})^2\,\epsilon\sin\theta\,(2+\epsilon\cos\theta)}{(2+\epsilon^2)\,(1+\epsilon\cos\theta)^2}$$

$$W_z = W\sin\varphi = \frac{12\eta\pi\omega rL\,\epsilon\,(\frac{r}{c})^2}{(2+\epsilon^2)(1-\epsilon^2)^{1/2}}$$

- ***PLAIN SLIDER BEARING:-(with exponential film profile)***

When B cannot reasonably be considered to be large, then the pressure distribution becomes:-

$$p = \frac{6\eta UB}{2{h_2}^2\ln(n)}\{e^{2\alpha x} - \frac{1}{(n^2+n+1)}[n(n+1)e^{3\alpha x}+1]\}$$

The symbols have their usual meaning.