B.E. (Mech.) Part-IV 8th Semester Final Examination, 2013

FUNDAMENTALS OF TRIBOLOGY (ME – 804/1)

Time: 3 Hours | Full Marks: 70

Use separate answer script for each half.
Answer SIX questions, taking THREE from each half.
All questions carry equal marks.

FIRST HALF

1. (a) What are the important features of an engineering polished metallic surface at surface and subsurface of few microns?

   (b)What is the objective of a 'Talysurf' instrument? Explain briefly the working principle of the instrument with a neat sketch.

   (c) What are the ranges of resolution and magnification of Optical Microscope and Electron Microscope? Describe briefly Scanning Electron Microscope used for qualitative examination of surface texture.

2. (a) Discuss the sources of friction. Write down the expected coefficient of friction in ascending order with reasoning for boundary lubrication, micro-elasto-hydrodynamic lubrication hydrodynamic lubrication, elasto-hydrodynamic lubrication and hydrostatic lubrication.

   (b) Prove that simple adhesion theory provides a constant value of coefficient of friction for any combination of material pair.

   (c) Why a durable thin oxide layer on the surface due to humid environment helps in reducing coefficient of friction? Prove that the coefficient of friction between two perfectly cleaned dry sliding surfaces approaches towards infinity.

3. (a) Discuss the mechanism of Erosive Wear and its controlling parameters.

   (b) Explain the mechanism of cavitational wear. How this mechanism helps in removal of kidney stone?

   (c) Define adhesive wear and derive Archard's Adhesive Wear Equation. An experiment was carried out on a Pin-on-Disc machine for sliding contact of mild steel pin of 12 mm diameter with EN31 disc. The Disc was rotating at 1000 r.p.m. and the pin was located at a distance of 130 mm from the centre of the disc. If after 5 hours of running in dry condition with a normal load of 3 kg, 0.755 mg of material is removed from the pin, find out the Archard's Wear Coefficient and Archard's Adhesive Wear Equation for mild steel pin.

   Given that

	Mild Steel	EN31
Density (kg/m^3)	7800	8500
Hardness (GPa)	1.78	7.78
Modulus of elasticity (GPa)	200	210

4. (a) Define nominal contact area and real area of contact of two interacting surfaces.

(b) From Greenwood & Williamson's (GW) model, derive the expressions of expected number of asperity contacts, expected area of contact and plasticity index for contact of two rough flat surfaces under a given normal load. State all the assumptions made in GW model and point out all the relevant surface roughness parameters and mechanical properties required for modeling.

5. Write short notes on
   (i) 2-body and 3-body abrasive wear
   (ii) Scuffing & Pitting failure of gears
   (iii) E. Rabinowicz's compatibility chart for work of adhesion
   (iv) Maximum tensile stress and maximum shear stress developed in hertzian point contact
   (v) Skewness and Kurtosis of Gaussian Distribution of surface roughness
   (vi) Transition between corrosive and adhesive wear.

SECOND HALF

6. (a) Establish the expressions for the load capacity and frictional power loss of a circular step thrust bearing.
   (b) The following data is provided for a circular step thrust bearing of a vertical turbo generator:
   Inner diameter of thrust bearing = 80 mm
   Outer diameter = 300 mm
   Film thickness = 0.05 mm
   Viscosity of oil = 0.05 Pa-S
   Speed of runner = 1200 rpm
   Recess pressure = 3.5 MPa
   Determine –
   (i) load capacity (ii) frictional power loss

7. (a) Define the following thrust bearing coefficients:
   (i) load coefficient (C_W) (ii) pumping power coefficient (C_P)
   (b) Establish the expressions for squeeze film pressure and load capacity of an infinitely long journal bearing.

8. (a) Explain the following elasto-hydrodynamic lubrication regimes.
   (i) isoviscous-elastic (ii) piezoviscous-elastic
   (b) Explain Hertzian contact pressure. With the help of this pressure, derive the load capacity of EHL point contact.
   (c) Discuss various dimensionless parameters involved in EHL line contact.

9. (a) Explain the following processes of numerical solution to a lubrication problem on a tilting pad bearing.
   (i) normalizing of lubrication equation
   (ii) discretization by finite central difference technique
   (b) What is the viscosity – index of lubricants? How do you quantify it?
   (c) Discuss various temperature-viscosity relations for lubricants.

10. (a) Explain SAE classifications of lubricants.
   (b) Write short notes on the followings:
   (i) acidity and alkalinity of lubricants (ii) viscosity index improvers
   (iii) pour-point depressants