

**College of Engineering Pune**  
(An Autonomous Institute of Govt. of Maharashtra)  
END Semester Examination  
(PE-405 Elective -I) Tribology

Programme: B.Tech. (Production S/W)  
Duration: 3 hrs.  
Instructions:

Year: 2013 - 14  
Max. Marks: 60

- 1) Use of non-programmable calculator is allowed.
- 2) Assume suitable data, if necessary.
- 3) Attempt all questions.

- Q 1 a) What is mean by junction growth. Using adhesion theory of metals with contaminant film, show that coefficient of friction can be written as 6

$$\mu = \frac{C}{[\alpha(1-C^2)]^{1/2}}$$

Where C- fraction of the Critical shear strength ( $S_0$ ) of the metal and  $\alpha = \left(\frac{P_0}{S_0}\right)$ , where  $P_0$  is normal stress.

- b) Derive an expression for the volume of abrasive wear per unit sliding distance with conical asperity contact. 6

A hard steel alloy surface consisting of an array of conical asperities of an average attack angle of  $30^\circ$  slide on a soft lead surface ( $H=75$  Mpa) under a load of 20 N. Calculate the volume of lead displacement in unit slide distance. Given that the volume of lead material removed is  $10^{-5}$  m<sup>3</sup> for a sliding distance 1.4 km, calculate the wear coefficient of lead.

- Q 2 a) State the properties of lubricants. Explain different types of lubricant oils 6  
b) State laws of friction and explain different methods of measurements of friction. 6

- Q 3 a) In hydrostatic bearing explain Constant Supply Pressure System and The Constant-flow System. Also state applications, advantages and limitations of hydrostatic bearings. 6  
b) Derive expression for pressure distribution & load carrying capacity in case of Hydrostatic conical step bearing. 6

- Q 4 **Answer Any Two** 6

- a) Clutch plate having squeeze velocity V, show that load 'W' supported by squeeze film using polar coordinates is :

$$W = \frac{3}{2} \cdot \frac{\pi\eta R^4 V}{h^3}, \quad \text{where R is radius of the plate, } \eta \text{ is absolute viscosity of fluid}$$

and h- oil film thickness.

Also show that the time of approach for the film thickness to be squeezed from  $h_1$  to  $h_2$  is given by

$$\Delta t = \frac{3}{4} \cdot \frac{\pi\eta R^4}{W} \left( \frac{1}{h_2^2} - \frac{1}{h_1^2} \right)$$

- b) A hydrodynamic plane slider bearing designed to support thrust of 40 kN at Sliding speed 2m/s. if Bearing width to length ratio = 4; Attitude=2.0; minimum oil thickness is 0.025 mm; Viscosity of oil = 40 cP. Neglecting the side leakage, calculate: 6
- (i) the bearing dimensions;
  - (ii) the pressure at a distance of 50 mm from leading edge;
  - (iii) the frictional force;
  - (iv) the coefficient of friction, and
  - (v) the power lost in friction.
- c) A shaft 16 cm diameter rotates at 2100 rpm inside a bearing 16.06cm in diameter and 20 cm long. The space is filled with oil of viscosity 0.02 Ns/m<sup>2</sup>. What power is needed to overcome the resistance in the bearing if coefficient of friction is 0.16 and eccentricity ratio of bearing is 0.6. Also find temperature rise of oil having mass density and Specific heat of lubricating oil are 860 kg/m<sup>3</sup> and 1.76 KJ/Kg°C. 6

Q 5

**Answer Any Two** 6

- a) State Advantages and Limitations of Rayleigh Step Bearing. Derive expression for pressure distribution in entry and exit zone. 6
- b) A guide-way bearing of a machine tool operates under the hydrodynamic conditions and has the following details: 6
- |                            |              |
|----------------------------|--------------|
| Width of bearing           | = 200 mm     |
| Length of bearing          | = 1000 mm    |
| Sliding velocity           | = 2.4 m/s    |
| Minimum oil-film thickness | = 20 microns |
| Absolute viscosity of oil  | = 0.03 Pa-s  |

Assuming the ratio of film thickness as 2.2.

Calculate:

- (i) the load carrying capacity,
  - (ii) the coefficient of friction;
  - (iii) the power lost in friction, and
- c) State different types of hydrodynamic thrust bearings. Derive expression for pressure distribution in hydrodynamic narrow width taper pad bearing. 6

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