T.E. (Mechanical) (Semester – II) Examination, 2010
(2003 Course)
TRIBOLOGY

Time: 3 Hours Max. Marks: 100

Instrutions : *1) Answers to the **two** Sections should be written in **separate** books.*
*2) **Neat** diagrams must be drawn **wherever** necessary.*
*3) **Use** of logarithmic tables, slide rule, Mollier Charts, electronic pocket calculator is **allowed**.*
*4) Assume suitable data, **if necessary**.*

SECTION – I

1. a) What do you mean by Viscosity Index ? Explain the procedure to find viscosity index of test oil. **6**

   b) A full journal bearing has a journal of 50 mm diameter and runs concentrically inside a 75 mm long bearing with a radial clearance of 0.025 mm. If the journal speed is 1500 rpm and the viscosity of the lubricant is 40 Mpa. sec. at 35°C, calculate the following at this temperature : **6**

   i) The value of the tangential drag force on the journal
   ii) The value of the viscous shear stress, and power loss in viscous friction.

   c) Explain the process and methods of recycling of the used oil. **4**

OR

2. a) What do you mean by tribology ? Explain importance of tribology in Industry. **6**

   b) Explain Extreme Pressure (EP) lubricants. Where they are used ? **6**

   c) Compare sliding contact bearings with rolling contact bearings for following parameters : **4**

   i) Load carrying capacity ii) Noise
   iii) Speed iv) Shaft and Housing Design.

3. a) What do you mean by stiction ? Give examples. What are the methods to reduce stiction ? **6**

b) Derive Archard's equation for volume of adhesive wear with assumptions made. State Laws of wear using above equation. **8**

c) Explain pin-on-disc method to measure coefficient of friction. **2**

OR

4. a) Using modified junction growth theory, prove that the coefficient of friction is given as : $f_a = \frac{k}{\sqrt{4[1-k^2]}}$ with usual notations. **8**

b) Write short note on (i) Fretting wear and (ii) Percussion wear **6**

c) State different techniques used for wear debris analysis. **2**

5. a) With usual notations, derive an expression for pressure distribution in case of infinitely short journal bearings. Show the axial and circumferential pressure distribution. **12**

b) Explain mechanism of pressure development in hydrodynamic lubrication with the help of two non-parallel surfaces separated by convergent film. **4**

c) Derive the relation $\frac{h_0}{C} = 1 - \in$ for hydrodynamic journal bearings. **2**

OR

6. a) The following data refers to a 360° hydrodynamic journal bearing. **12**

Radial load	= 10 kN
Journal Speed	= 1450 rpm
L/D ratio	= 1
Bearing Length	= 50 mm
Radial Clearance	= 20 microns
Eccentricity	= 15 microns
Specific gravity of the oil	= 0.86
Specific heat of the lubricant	= 2.09 KJ/kg°C

Calculate :

i) The minimum oil film thickness

ii) The coefficient of friction

iii) The power lost in friction

iv) The viscosity of the lubricant

v) The total flow rate of lubricant in lpm

vi) The side leakage.

Use the data given below :

$\left(\frac{l}{d}\right)$	ε	$\left(\frac{h_0}{c}\right)$	S	ϕ	$\left(\frac{r}{c}\right)f$	$\left(\frac{Q}{rcn_s l}\right)$	$\left(\frac{Q_s}{Q}\right)$	$\left(\frac{P}{p_{max}}\right)$
1	0	1.0	∞	(85)	∞	π	0	–
	0.1	0.9	1.33	79.5	26.4	3.37	0.150	0.540
	0.2	0.8	0.631	74.02	12.8	3.59	0.280	0.529
	0.4	0.6	0.264	63.10	5.79	3.99	0.497	0.484
	0.6	0.4	0.121	50.58	3.22	4.33	0.680	0.415
	0.8	0.2	0.0446	36.24	1.70	4.62	0.842	0.313
	0.9	0.1	0.0188	26.45	1.05	4.74	0.919	0.247
	0.97	0.03	0.00474	15.47	0.514	4.82	0.973	0.152
	1.0	0	0	0	0	0	1.0	–

Note : Assume linear interpolation for intermediate values.

b) Compare long and short journal bearings with the help of following points : **6**

i) Fluid film pressure, ii) Pressure gradient,

iii) Fluid flow, iv) Load carrying capacity.

SECTION – II

7. a) Derive the equation for flow rate through rectangular slot. **8**

b) State the advantages of hydrostatic bearings. **2**

c) Prove that the optimum stiffness of hydrostatic bearing is : **6**

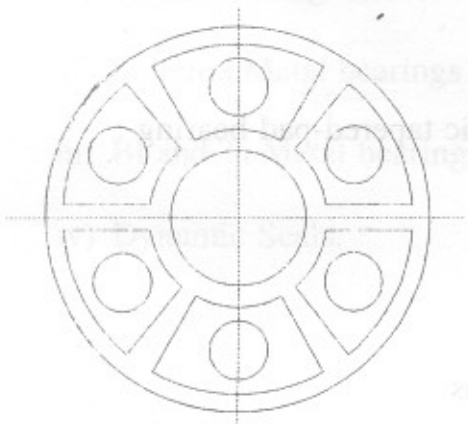
$$K_b = \frac{3W}{h_0}$$

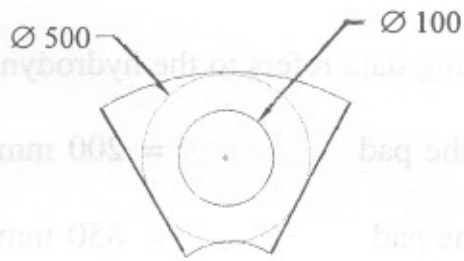
where, W – load carrying capacity, K_b = bearing stiffness and h_0 = oil film thickness.

OR

8. a) The hydrostatic step bearing consists of six pads as shown. Neglecting the flow over corners of each pad can be approximated as a circular area of outer and inner diameter of 500 mm and 200 mm resp. The total thrust load is 900 KN and the film thickness is 0.15 mm. The viscosity and density of the oil are 30 cP and 0.9 gm/cc resp. The specific heat of the lubricant is 2.09 kJ/kg °C. If the shaft is rotating at 720 rpm, calculate : **10**

i) supply pressure ii) lubricant flow rate iii) frictional power loss iv) pumping power loss and v) temperature rise.





Single pad

b) Derive an expression for flow of fluid through annular area between piston and cylinder and velocity of piston. **6**

9. a) Explain squeeze film lubrication action with examples. **6**

b) Two parallel plates 3 cm long and infinitely wide are separated by oil of viscosity 0.6 Ns/m^2 and are approaching each other. If a load of 30 KN per meter width is applied, what will be the film thickness after one second ? Initial film thickness is 25 μm. **6**

c) Discuss in detail, lubrication required for Cold metal working and hot metal working. **4**

OR

10. a) Derive the expression for pressure distribution, load carrying capacity and time of approach for squeeze film lubrication between parallel circular plates. **12**

b) State the advantages and limitations of Gas lubricated bearings. **4**

11. Derive an expression for load carrying capacity of Rayleigh step bearing which has entry zone gap of h_1 over a length of B_1 and exit zone gap of h_0 over a length of B_0 and sliding with a velocity of U. **18**

$$\left[\frac{h_1}{h_0} = 1.87 \text{ and } \frac{B_1}{B_0} = 2.588\right]$$

The following data refers to the hydrodynamic tapered-pad bearing :

Length of the pad = 200 mm

Width of the pad = 850 mm

Maximum oil film thickness = 150 microns

Minimum oil film thickness = 75 microns

Viscosity of the lubricant = 0.05 Pa-sec.

Sliding velocity = 5 m/sec.

Calculate :

i) the load carrying capacity of bearing

ii) the pressure at a distance of 100 mm from leading edge

iii) coefficient of friction

iv) power lost in bearing.

OR

12. a) A fixed pad hydrodynamic thrust bearing of length 'L' and width 'B' has a fluid film shape given by relation : **8**

$$h = h_0 e^{-ax}$$

Where h_0 = minimum film thickness and a = constant. Assuming side leakage as zero, derive an expression for pressure distribution.

b) Give the applications of Elastohydrodynamic lubrication. **2**

c) Write short note on following (**any two**) : **8**

i) Plastic bearing materials

ii) Sintered Metal bearings

iii) Bi and Ti Metal bearings

iv) Dynamic Seals.
