Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII • EXAMINATION – SUMMER • 2015

Subject Code: 171905 Date: 06/05/2015

Subject Name: Industrial Tribology

Time: 02.30pm-05.00pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Define the term 'Tribology'. Discuss with examples the economic benefits of tribology. **05**

(b) Define absolute viscosity. Discuss the effect of temperature and pressure on absolute viscosity of the lubricating oil. **05**

(c) What are the types of surface irregularities? States the methods of improving the surface finish. **04**

Q.2 **(a)** Enlist the different types of wear. Derive the Archard's equation for volume of adhesive wear. **07**

(b) State the laws of friction. Prove that co-efficient of friction during ploughing is given by the below equation, where θ=asperity angle. **07**

$$\mu_{plough} = \frac{2}{\pi}\tan\theta$$

OR

(b) A steel disc having 200mm diameter, 10mm thick is required to roll freely on a rigid plane. Find the force required to pull the disc if the steel density is 8000Kg/m^3, Poisson's ratio=0.3, E=2.1x10^{11} N/m^2, Hysteresis loss ε=25%. Compare the result if the disc is required to slide on plane surface having asperity angle=10^0. **07**

Q.3 **(a)** Explain the phenomenon of squeeze film lubrication. Also state the practical application of squeeze film action. **07**

(b) The following data is given for the hydrostatic step bearing of vertical turbo generator, **07**

Thrust Load = 450KN
Shaft Diameter = 400mm
Recess diameter = 250mm
Shaft Speed = 750 RPM
Lubricant Viscosity = 30cP
Draw a neat sketch showing the effect of film thickness on energy losses. Calculate the optimum film thickness for minimum power loss.

OR

Q.3 **(a)** Derive an equation for flow of viscous fluid through rectangular slot. **07**

(b) A hydrostatic step thrust bearing of generator consists of six pads. Neglecting the flow of corner, each pad can be approximated as a circular area of outer and inner diameters of 500 mm and 200 mm respectively. The total thrust load on bearing is 900 KN and film thickness is 0.15 mm. **07**

The properties of lubricating oils are: Absolute viscosity = 300SUS, Density = 0.9 gm/cc, Specific heat = 2.1 KJ/Kg /^{0}C.
If the shaft is rotating at 720RPM, Calculate (1) Supply pressure (2) Flow rate

(3) Frictional and pumping power loss (4) Temperature rise. Assuming total power loss is converted into frictional heat.

Q.4 **(a)** Derive the Petroff's equation for hydrodynamic journal bearings. **04**

(b) An oil ring lubricated full journal bearing is operating in still air. The journal having 75mm diameter rotates at 600RPM and carries a radial load of 4KN. The radial clearance is 0.05mm. If the length of bearing is taken as 75mm and ambient temperature is 25^0C, determine (1) Minimum film thickness (2) Temperature of bearing surface (3) Power lost in friction. The oil used is SAE30. Heat dissipation coefficient = 280W/$m^2/^0$C. **10**

OR

Q.4 **(a)** Explain the principle of elasto-hydrodynamic lubrication. **04**

(b) The following data refers to a six-shoe tapered pad thrust bearing, **10**
No. of pads = 6, Outer diameter of the pads = 1000mm,
Inner diameter of the pads = 600mm, Rotational speed = 240 RPM,
Angle subtended by each pad = 55^0, Minimum oil film thickness = 0.12 mm, Attitude =2.5, Viscosity of oil = 30cP.
Using the narrow approximation, calculate: (1) The load carrying capacity (2) The power lost in bearing (3) The maximum pressure and (4) The ratio of maximum pressure to average pressure.

Q.5 **(a)** State and explain the desirable properties of bearing materials. **07**

(b) Explain the importance of tribological considerations in design of gears. **07**

OR

Q.5 **(a)** Differentiate between oil lubricated bearing and gas lubricated bearings. **07**

(b) Derive the equation of pressure distribution, load carrying capacity and time of approach in case of two parallel circular plates separated by fluid film. **07**

Design Data (for Q.4 - b)

$\frac{1}{d}$	**ε**	$\frac{h_0}{c}$	**S**	**φ**	$(\frac{r}{c})$ **f**	$(\frac{Q}{rcn_s l})$	$(\frac{Q_s}{Q})$	$(\frac{P}{P_{max}})$
1	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

Temperature -Viscosity relationship for SAE-30 Oil

Temperature (^{0}C)	20	30	40	50	60	70	80	90	100
Viscosity (cP)	350	155	77	44	27	17.5	12.5	9	7

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