BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR
B.E. (Mech.) 7TH SEMESTER FINAL EXAMINATION, 2012

TRIBODESIGN OF MACHINE ELEMENTS (ME – 701)

Full Marks: 70   **Time: 3 hrs**
Use separate answer script for each half.
Answer SIX questions, taking THREE from each half.
All questions carry equal marks.

FIRST HALF

1.   The external contracting double shoe brake as shown in the Fig.1 has a coefficient of friction of 0.33 of the lining material against the drum. The allowable maximum contact pressure of shoe lining material is 1.0 MPa. If the applied actuating force (F) is 1500N, stating all the assumptions find the face width of the identical shoes and torque absorbing capacity of the brake. Also calculate the reactions at both the hinge pins, A & B.
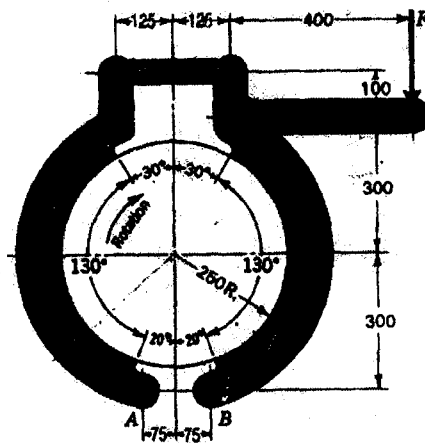

Fig.1
All dimensions are in mm

2   (a) State the appropriate mechanical properties needed in selecting worm and worm wheel materials and cite examples.

(b) The pair of worm and worm wheel as shown in Fig.2 is designated as 2/40/10/5. The input speed of the worm shaft, having RH helix, is 1200 r.p.m.

The gearbox for the worm gears has an effective surface area of 1.35m^2. A fan is mounted on the worm shaft to circulate air over the surface of the fins. The overall coefficient of heat transfer can be taken as 22W/ m^2/°C. The permissible temperature rise of the lubricating oil above the atmospheric temperature is 40°C.
(i)   Find out the speed of worm wheel and its direction of rotation
(ii)   Calculate the power transmitting capacity based on thermal considerations.
The following data of coefficient of friction for given rubbing speed may be used:

Rubbing Speed (m/s)	0.5	1.0	2.5	2.7	3.0	5.0	10
Coefficient of friction	0.065	0.055	0.048	0.042	0.038	0.032	0.025
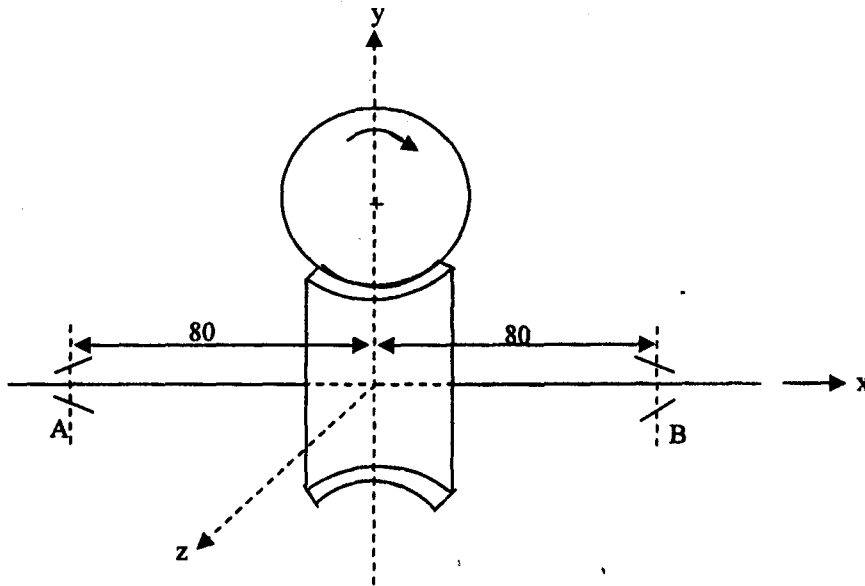
All dimensions are in mm

Fig. 2

3. In the given problem in Q. No.2, assuming for power transmission of 10 kW, draw a complete free body diagram of the shaft and find the reactions at the two tapered roller bearings at A & B. Following AFBMA and Timken's prescription, find out the Required Radial Ratings of the two tapered roller bearings. Given that the desired life of bearings, application factor, the ratio of basic radial rating to basic thrust rating are 15000hrs, 1.25 and 1.5 respectively.

4. (a) Stating all the assumptions, derive the Stribeck's Equation for static load capacity of a single row ball bearing.

    (b) Define "Tribos & Tribology' and State the sources of friction and different wear mechanisms.

    (c) Explain the mechanism of spalling failure of rolling contact bearings.

    (d) A spherical ball of diameter 20 mm is made of EN31 steel and it makes contact with a mild steel flat under a normal load of 50 N. The mechanical properties of EN31 and Mild Steel are given below.

Materials	Modulus of Elasticity	Hardness	Poisson's ratio
EN31	220GPa	7.50 GPa	0.29
MS	200GPa	1.80 GPa	0.30

Find out maximum Hertzian contact stress, maximum tensile stress & shear stress developed and their locations.

Time : 3 hours   Full Marks : 70

SECOND HALF

5. (a) Deduce the expression for the load capacity of a circular step thrust bearing.
   (b) Find out the expressions for the frictional power loss and film stiffness of thrust bearing.

6. (a) Establish the expression for bulk temperature rise of lubricant in a pressure-fed bearing having a circumferential groove without the heat transfer through the bearing wall, assuming the following expression for side flow of lubricant.

$$Q_t = \frac{2\pi R C^3 p_0}{3\eta L}(1.0 + 1.5\varepsilon_0^2) \quad \text{with the usual notations.}$$

   (b) A 50 mm- diameter journal bearing is 50 mm long . It is fed by SAE–30 oil at 50^0 C and 220 kPa supply pressure. The radial clearance is 0.05 mm. The journal speed is 40 rev / s corresponding to a bearing load of 4 kN. The operating eccentricity ratio is 0.5. The SAE – 30 oil has a viscosity of 0.025 Pa-S corresponding to a temperature of 50^0 C. The mass density of oil is 860 kg/m^3 and specific heat C_H is 1760 J / kg – ^{0}C. Find –
   (i) total oil flow rate from bearing   (ii) operating Sommerfeld number
   (iii) bulk temperature rise of oil
   The following data may be consulted to find out f (R/C) corresponding to the operating Sommerfeld number for L / D = 1.0

S	f (R/C)
0.14	3.48
0.16	4.13
0.18	4.54

7. (a) Mention only the various regimes of elasto-hydrodynamic lubrication. Explain any two of them.
   (b) Derive the expression for the deflection at any point within the contact zone between a sphere and a plane due to the distributed Hertzian contact pressure. What is the deflection at the centre of the contact area?

8. (a) Discuss the various dimensionless design parameters for a line contact of EHL.
   (b) Discuss the composition and applications of Tin–based babbit as bearing material.
   (c) Write short notes on the followings:
   (i) Hertzian contact pressure   (ii) Piezo-viscous effect of lubricant