



## P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

**Third Semester, M. Tech. - Mechanical Engineering (MMDN)**

**Semester End Examination; Dec - 2017/Jan - 2018**

### Tribology and Bearing Design

*Time: 3 hrs*

*Max. Marks: 100*

*Note: i) Answer FIVE full questions, selecting ONE full question from each unit.*

*ii) Use of Design Data Hand is permitted.*

#### UNIT - I

- |      |  |   |
|------|--|---|
| 1 a. | State and explain laws of friction.  | 8 |
| b.   | What is wear? Explain how it is classified?  | 6 |
| c.   | Explain the mechanism of adhesive wear and abrasive wear.  | 6 |
| 2 a. | What are the types of lubricant? Briefly explain them.   | 6 |
| b.   | Explain the effects of temperature and pressure on viscosity of oil.   | 8 |
| c.   | A rectangular plate of 75 mm x 50 mm slides over a stationary plate and it is separated by oil of viscosity $50 \times 10^{-3}$ Pa.sec at $35^\circ\text{C}$ . The clearance between the plates is 0.25 mm and the tangential velocity of plate is 4 m/s. Calculate the following at this temperature; | 6 |
|      | i) Tangential drag force on moving plate   | 6 |
|      | ii) Viscous shear stress   |   |
|      | iii) Power loss in viscous friction.   |   |

#### UNIT - II

- |      |  |    |
|------|--|----|
| 3 a. | Two tanks A and B connected by a capillary tube and the system is filled with a liquid of viscosity 2 cP. The monometric pressure in tank A and B are 0.01 MPa and 0.04 MPa respectively. The diameter of capillary tube is 0.635 m and its length is 2 m. Assuming laminar flow, determine rate of flow through capillary tube. | 4  |
| b.   | Derive expressions for friction force and power loss in lightly loaded journal bearing.  | 6  |
| c.   | A lightly loaded bearing has the following specifications :  |    |
|      | Bearing length = 57 mm, Bearing diameter = 25 mm, radial clearance = 0.0508 mm, journal speed = 25000 rpm, radial load 910 N and viscosity of lubricant $24 \times 10^{-3}$ Pa.sec. Calculate;   | 10 |
|      | i) Power loss      ii) Coefficient of friction.  |    |
| 4 a. | Explain the mechanism of pressure development in an oil film.  | 6  |
| b.   | A rectangular plain slider bearing with fixed shoe with no end leakage has the following data:<br>Bearing length = 90 mm; Width of shoe = 90 mm; Load on bearing = 7.8 kN<br>Sliding velocity = 2.5 m/s; Inclination = $-0.00035$ radians; Viscosity of oil = 40 cP.   | 14 |
|      | Determine; i) Minimum film thickness      ii) Power loss      iii) Coefficient of friction.  |    |

**UNIT - III**

- 5 a. Obtain an expression for friction force of an idealized full journal bearing. 10
- b. List the important practical considerations to be followed while designing bearing and discuss their influence on bearing performance. 10
- 6 a. Explain Sommerfeld number and its significance in bearing design. 6
- b. An idealized full journal has the following specifications :  
Diameter of journal 50 mm, length of bearing 65 mm, speed of journal 1200 rpm, radial clearance 0.025 mm, average viscosity 0.01132 Pa.sec and attitude 0.8. Determine;
- i) Load carrying capacity 14
- ii) Frictional force
- iii) Coefficient of friction
- iv) Power loss due to friction.

**UNIT - IV**

- 7 a. Obtain an expression for load carrying capacity of hydrostatic step bearing. 10
- b. A hydrostatic step bearing has the following specifications :  
Shaft dia = 130 mm, pocket dia = 55 mm, shaft speed = 1800 rpm, inlet pressure = 3.75 MPa, external pressure = 0 (atm), desirable oil film thickness = 0.0875 mm and viscosity of oil = 72.5 cP. Determine; 10
- i) Load the bearing can support
- ii) Rate of oil flow through the bearing
- iii) Power loss due to friction.
- 8 a. Explain different regions in EHL contacts. 10
- b. Derive Grubin's solution for EHL contact. 10

**UNIT - V**

- 9 a. List the advantages of gas lubricated bearings and mention their applications due to these advantages. 6
- b. Write the generalized Reynolds equation for a gas lubricated bearing and explain how it can be modified for the gas obeying polytropic relation? 4
- c. Derive Reynolds equation for porous bearing. 10
- 10 a. With a neat sketch, explain the principle of magnetic bearing. 10
- b. List and discuss various benefits of Magnetic bearings. 10

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