MASTER OF MECHANICAL ENGG. EXAMINATION, 2017

(1st Year, 2nd Semester)

LUBRICATION ENGINEERING

Time: Three hours Full Marks: 100

Missing data, if any, may be assumed.

Answer any **five** questions.

1. a) Explain the fundamental principles of self-acting gas lubrication.
   b) Explain slip flow and surface roughness effects in gas bearings.
   c) Explain the utility of reduced Reynolds equation for a piezoviscous fluid.

   6+8+6

2. a) State the basic assumptions of the theory of lubrication. Use these assumptions to derive Reynolds equation from Navier-Stokes equations.
   b) Explain the need for continuity equation in solving lubrication problems?
   c) Explain the significance of different terms in Reynolds equation.

   12+4+4

3. a) Explain the mechanism of pressure development in a hydrodynamic bearing.
   b) Starting from integrated form of the Reynolds equation, derive the expression for load capacity of a plane slider bearing with exponential film profile.
   c) A fixed inclination slider bearing of length 100 mm and width 600 mm operates at a sliding velocity of 1m/s. Select a mineral oil such that the bearing operates with a minimum film thickness of 40 μ m at maximum load capacity of 20 kN. Also calculate the coefficient of friction.

   5+7+8

4. a) Explain Reynolds boundary conditions for hydrodynamic journal bearing.
   b) Explain a solution methodology for analysis of a finite length journal bearing.
   c) A normal load of 20 kN is applied to a parallel – plate squeeze film bearing with plates 10 mm long and 1 m wide and a film thickness of $20\mu m$. The oil has viscosity of 0.04 Pa-s. Calculate the time required to reduce the film thickness to $2\mu m$ and the film thickness after 1.5 sec. 5+8+7

P.T.O.

5. a) Explain hydrostatic lift.

b) For a circular step thrust bearing, write down the appropriate Reynolds equation. Hence deduce the expression for load capacity and total power loss for such a bearing.

c) A circular hydrostatic pad thrust bearing is designed for a thrust load of 10 kN to be used in a turbine generator. The outside diameter and recess diameter are 100 mm and 50 mm respectively. A pump with constant flow rate of 10 mm^3/s is used. (a) Select the viscosity of oil such that the film thickness does not drop below $100\mu m$. (b) Calculate the recess pressure and film stiffness. (c) Assuming that the generator is running at 750 rpm, calculate the frictional torque, power loss and temperature rise of oil. Take mass density of oil as $880 Kg/m^3$ and specific heat as 1.88 J/g-K. 3+10+7

6. a) Explain the mechanism of boundary lubrication.

b) The magnitude of a radial force P (in N) acting on a ball bearing varies in a sinusoidal manner given by $P = 750(1-\cos\theta)$ where θ is the angle of rotation ($0 \le \theta \le 2\pi$) and the speed of rotation is 720 rpm. Determine the dynamic load capacity of the bearing for a life of 8000 hr.

c) Derive Stribeck's equation for the static load capacity of ball bearings.

6+8+6

7. a) Explain Viscosity Index. How is it determined?

b) Explain flash point and pour point for lubricants.

c) What is shear thinning? How does the shear stress depend on shear rate for liquid lubricants?

d) Explain the working of a rotational viscometer. 5 x 4

8. Write short notes on:

a) Parallel step slider bearing b) Hydrodynamic instability c) Multi-pad hydrostatic journal bearing d) Full Sommerfeld Boundary Condition 5x4.