MASTER OF MECHANICAL ENGG. EXAMINATION, 2018

(2nd Semester)

LUBRICATION ENGINEERING

Time: Three hours Full Marks: 100

Missing data, if any, may be assumed.

Answer any **five** questions.

1. 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

2. a) Derive Reynolds equation either from the principle of mass conservation and laws of viscous flow or 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 fixed inclination slider bearing.

   c) A fixed inclination slider bearing of length 100 mm and width 600 mm, with a minimum film thickness of 40 μm, operates at a sliding velocity of 1m/s with a mineral oil of absolute viscosity of 35 cP. Film thickness ratio is adjusted to have maximum load capacity. Calculate the normal load capacity, the shear force experienced by the sliding surface and the coefficient of friction.

   5+7+8

P.T.O.

4. a) Explain Reynolds boundary conditions for analyzing hydrodynamic journal bearing.

b) Explain a solution methodology for the analysis of a finite length journal bearing.

c) A normal load of 10 kN is applied to a parallel – plate squeeze film bearing with plates 10 mm long and 1 m wide and a film thickness of $10\mu m$. The oil has viscosity of 0.04 Pa-s. Calculate the time required to reduce the film thickness to $1\mu m$ and the film thickness after 1.5 sec. 5+8+7

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 hydrostatic circular step thrust bearing has the outside pad diameter of 300 mm and recess diameter of 200 mm. Calculate (a) the recess pressure for a thrust load of 100 kN, (b) the oil flow rate to maintain the film thickness of $120\mu m$ with an oil viscosity of 0.03 Pa-s, (c) the film stiffness, (d) the pumping loss and (e) the oil temperature rise. Take mass density of oil as $880Kg/m^3$ and specific heat as 1.88 J/g-K. 3+10+7

6. 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

7. a) Explain the mechanism of boundary lubrication.

b) Explain single penetration model and multiple penetration model for solid lubrication.

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

6+8+6