MASTER OF MECHANICAL ENGG. EXAMINATION, 2025

(1st Semester)

LUBRICATION ENGINEERING

Time: Three hours Full Marks: 100

Missing data, if any, may be assumed.

Answer any **five** questions.

1. a) State the basic assumptions of the theory of lubrication. Use these assumptions to derive Reynolds equation from Navier-Stokes equations.
   c) Explain the need for continuity equation in solving lubrication problems.
   c) Explain the physical significance of different terms in Reynolds equation. 12+4+4

2. 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 an efflux viscometer. 5 x 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 $40\,\mu$m, 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

4. a) Explain full Sommerfeld boundary conditions for analyzing hydrodynamic journal bearing.
   b) Explain the design procedure 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 the need for hydrostatic bearings.
   b) For a circular step thrust bearing, deduce the expression for load capacity and total power loss for such a bearing.
   c) For a circular step thrust bearing, deduce the geometrical condition that produces the minimum pumping power loss. 4+10+6

6. a) Explain the working of squeeze film bearings with applications.
   b) A hydrostatic circular step thrust bearing has the outside pad diameter of 40 cm and recess diameter of 250 cm. Calculate (a) the recess pressure for a thrust load of 125 kN, (b) the oil flow rate to maintain the film thickness of $100\mu m$ 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 $880 Kg/m^3$ and specific heat as 1.88 J/g-K. 10+10

7. a) Define static load carrying capacity of rolling element bearings. Derive Stribeck's equation for the same.
   b) A ball bearing is operating on a work cycle consisting of three parts – a radial load of 3000 N at 1440 rpm for one quarter cycle, a radial load of 5000 N at 720 rpm for one half cycle and a radial load of 2500 N at 1440 rpm for the remaining cycle. The expected life of the bearing is 10,000 hr. Calculate the dynamic load carrying capacity of the bearing. 10+10

8. a) Explain the fundamental principles of self-acting gas lubrication.
   b) Explain slip flow and surface roughness effects in gas bearings.
   c) Explain elastohydrodynamic lubrication 6+8+6