MASTER OF MECHANICAL ENGG. EXAMINATION, 2024

(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, flash point, pour point and shear thinning.
   b) Explain how viscosity-temperature relation of gas lubricants differs from that of oil lubricants.
   c) Explain the function of different additives in lubricants. 10+4+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 Taylor number, Froude number and Euler number.
   c) Explain the significance of different terms in Reynolds equation. 10+6+4

3. a) Explain metal working lubrication.
   b) Explain static and dynamic load capacity of rolling element bearings. How is the dynamic load capacity calculated for cyclic loads and speeds?
   c) Derive Stribeck's equation for the static load capacity of ball bearings. 4+10+6

4. 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

5. 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 μ 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

6. a) Explain Full Sommerfeld 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 10μm . The oil has viscosity of 0.04 Pa-s. Calculate the time required to reduce the film thickness to 1μm and the film thickness after 1.5 sec. 5+8+7

7. a) Explain the essential features of a hydrostatic bearing.

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 120μm 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. 5+8+7