Code :R7420303 **1**

IV B.Tech II Semester(R07) Regular Examinations, April 2011
TRIBOLOGY
(Mechanical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE questions
All questions carry equal marks
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1. (a) State and explain the Newton's law of viscosity.
   (b) Sketch and explain with working principle, the "Saybolt" viscometer.

2. (a) Derive an equation for load carrying capacity of a hydrostatic conical (truncated) thrust bearing. Fluid pressure is pr; shaft outer radius r_0 and the truncated radius is r_i.
   (b) Two circular discs of diameter 200 mm, separated by a film of SAE 30 oil, at the initial thickness of 0.127mm. Viscosity of the oil is 0.1048 N-S/m^2. If the two discs are made to approach each other with a velocity of 2.54 x 10^{-5} m/sec, find the resisting force (load) under initial condition given.

3. (a) A plane slider bearing with fixed shoe is operating under the following conditions;
   Width of the bearing=50mm
   Length to width ratio=1.0
   Sliding velocity=5 m/s
   Minimum film thickness=0.02mm
   Absolute viscosity of the lubricant=0.02 Pa.s (N-s/m^2).
   Attitude i.e, ratio of inlet to outlet film=2.
   By neglecting the side leakage, find the load carrying capacity and coefficient of friction.
   (b) Derive an equation for minimum oil film thickness in hydrodynamic journal bearing.

4. (a) Layout the procedure or method for determining the equilibration temperature for a self contained bearing.
   (b) Calculate the frictional moment on the journal (not on the bearing) with the following data for a full journal bearing;
   Length of the bearing=25 mm
   Bearing diameter=25 mm
   Clearance modulus=0.0016
   Speed of the journal=1800 rpm
   Load acting on the journal=3500N.
   Viscosity of the oil=24 CP.
   Side leakage coefficient=0.61

5. (a) List out the advantages of air-lubricated bearings.
   (b) Derive an equation for air flow (or) volume of air, for compressible isothermal flow, for a circular recess foot step bearing.

6. (a) Explain the influence of i) Pressure and ii) Sliding velocity on the coefficient of dry friction.
   (b) What are the characteristics of good boundary lubricants?

7. (a) Sketch and explain the oil-ring bearing.
   (b) With a basic principle, explain the externally pressurized bearings.

8. (a) In brief explain and compare the following bearing materials for sliding bearing application i) Cast-iron ii) Bronze.
   (b) Compare the following properties of bearing classifications metals and ceramics i) Mass density ii) Modulus of elasticity.

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Code :R7420303 **2**

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1. (a) With working principle, sketch explain the capillary viscometer.
   (b) What do you mean by viscosity index? Explain the procedure to time out the viscosity index of the given oil.

2. (a) Derive an equation for load carrying capacity of circular thrust bearing having step or central recess of radium r_i and the bearing has outer radius r_0, fluid pressure is p_r.
   (b) Two circular plates, 200 mm diameter are separated by a film of SAE 30 oil, 0.127 mm thick. The viscosity of the oil is 0.1048 N.S/m^2. A load of 3350 N is applied to the plate. Find the instantaneous velocity of approach at this film thickness.

3. (a) Derive the two dimensional Reynolds equation related to the pressure distribution in fluid film lubrication from Navier-stokes equation and continuity equation.
   (b) The pivoted shoe bearing has the following details:
   Width of the shoe=500 mm
   Length of the shoe=500 mm
   Load on the shoe=525 N
   End leakage factor=0.44
   Ratio of inlet to outlet oil film=2.
   Viscosity of the oil=0.0368 N-S/m^2
   Linear velocity of sliding=1 m/s.
   Find the minimum oil film thickness and coefficient of friction.

4. (a) Explain the terms i) Bearing modules and ii) Sommerfield number related to the journal bearings.
   (b) Estimate the temperature rise of the lubricating oil for a full journal bearing for the following data.
   Length of the bearings 25mm
   Diameter of the bearing=25mm
   Clearance modulus =0.0016
   Speed=1800 rpm
   Load acting=3.5 kN
   Viscosity of the oil at a film temperature of 40^0 C is 24 CP.
   Assume that that the journal is in concentric with its bearing.

5. (a) Estimate the frictional power for an air-lubricated bearing operating with the following data
   Length of the bearing=100 mm
   Diameter of the bearing=75 mm
   Diametral clearance=0.051 mm
   Speed=1800 rpm.
   Viscosity of the air at atmospheric conditions in 0.018 cp.
   What is the Reynolds number for the air film.
   (b) With an example or application, sketch and explain the hydro static thrust air-lubricated bearing.

6. (a) Explain the influence of i) temperature ii) vibration on the coefficient of boundary friction.
   (b) Sketch and explain the experimental arrangement, for measuring surface temperature rise during dry sliding.

7. (a) What do you mean by hydro static oil pads? Explain.
   (b) Sketch and explain the partial bearing.

8. (a) Discuss the selection of a bearing material for a particular application i.e thrust bearing.
   (b) How are the bearing materials classified? Explain.

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Code :R7420303 **3**

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(Mechanical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE questions
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1. (a) Sketch and explain with working principle the "Falling Sphere" viscometer.
   (b) Explain the effect of temperature and pressure on viscosity.
2. (a) The hydrostatic thrust bearing of a generator consists of six pads. Each pad is having 100 mm inner diameter and 500 mm outer diameter. The total thrust on the bearing is 900 kN and the oil film thickness is 0.05 mm. the viscosity of the oil is 58.86 CP. Neglecting the flow over corners, calculate i) the supply pressure and ii) the flow requirement.
   (b) Derive equation for instantaneous load carrying capacity of a squeeze film between two rectangular plates, approaching each other with constant velocity ϑ. The ratio of the two dimensions b/l (b=width in Y direction and l is length in x-direction) is assumed large, so that-oil flow will occur only in one direction, x-direction. Assume the viscosity of the oil is μ and the oil film thickness is h.
3. (a) Derive the petroff's equation applicable to the journal bearing. What are the limitations there in?
   (b) Write a short notes on "oil whirl" in hydrodynamic journal bearings.
4. (a) Explain the following parameters, with respect to the practical considerations of journal bearing design.
   i) Clearance between bearing bush and shaft.
   ii) Length to diameter ratio.
   (b) Calculate the oil flow out (from one side) of the bearing and the temperature rise of the oil for the following data;
   Full journal bearing operating at 500 rpm
   Bearing length = 100 mm; load =17.5 kN;
   Diameter clearance =0.0064
   (clearance modulus=0.00256)
   Oil viscosity at film operating temperature =23.4 CP, Assume eccentricity=0.937.
5. (a) The following data refer to a air lubricated hydrodynamic journal bearing;
   Length of the bearing=100 mm
   Diameter of the bearing=90 mm
   Diameter clearance=0.0762 mm
   Load on the journal=250 N
   Speed of the journal =6000 rpm.
   Viscosity of the air at room temperature =0.018 CP.
   Calculate i) Minimum film thickness and ii) Frictional torque.
   (b) What are the advantages and disadvantages of an air-lubricated bearing?
6. (a) Explain the influence of i) surface roughness ii) moisture on the coefficient of boundary friction.
   (b) Explain the Tomlinson's theory of molecular attraction or cohesive dry friction.
7. (a) With a neat sketch explain the partial bearing.
   (b) Sketch and explain the bearing testing machine working on the principle of hydrostatic oil pads.
8. (a) What are the properties required for a good bearing material?
   (b) Compare the usage of tin-and lead base babbitts as bearing materials.

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1. (a) Distinguish between absolute viscosity and kinematic viscosity.
   (b) Sketch and explain the "Redwood" viscometer with working principle.
2. (a) The following data relate to circular step thrust bearing that is hydrostatically lubricated.
   Radius of the shaft=75 mm
   Recess radius (at the bottom of the shaft) =50 mm
   Thrust load acting on the shaft=50 kN
   Shaft speed=900 rpm.
   Viscosity of the oil=2.4 x 10^{-2} N.S/m^2
   If the desired film thickness is 100 mm, determine the
   i) recess pressure ii) flow data iii) power loss
   (b) Sketch and explain "hydrostatic lift".
3. (a) Derive the two dimensional Reynolds equation related to the pressure distribution in fluid film lubrication, using principle of mass conservation and laws of viscous flow.
   (b) Find the coefficient of friction and frictional torque using Petroff's equation for a full journal bearing and the details are as follows.
   Length of the bearing=25 mm
   Diameter of the journal=25 mm
   Radial clearance=0.0203 mm
   Speed of the journal=1800 rpm
   Load on the journal =600 N
   Oil film viscosity=31.5 CP.
4. (a) Explain the following factors, with respect to the practical considerations of journal bearing design
      i. Bearing pressure
      ii. Shaft misalignment
   (b) Calculate the frictional moment on the bearing (not on the journal) with the following data for a full journal bearing ;
   Length of the bearing:50mm
   Diameter of the bearing=54.0156 mm
   Diameter of the shaft;53.9292 mm.
   Speed of the journal =3400 rpm
   Load acting on the shaft= 3000 n
   Lubricating oil kinematic viscosity=15.85 cs
   and absolute viscosity 13.42 CP.
5. (a) List out the disadvantages of air-lubricated bearings.
   (b) Sketch and explain the air lubricated Kingsbury thrust bearing. (Hydrodynamic type).
6. (a) Explain the influence of:
      i. Temperature and
      ii. Vibration on the coefficient of dry friction.
   (b) Explain different types of friction.
7. (a) Sketch and explain the pressure feed bearing.
   (b) Sketch and explain the wick oiled bearing.
8. (a) Write a short notes on the following bearing materials with their applications.
   i. Carbon graphite ii. Nylon
   (b) Explain the following standard requirements for a good bearing material.
   i. Deformability ii. Fatigue strength.

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