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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2017

Mechanical Engineering

(Machine Design)

04 ME 6509 INDUSTRIAL TRIBOLOGY

Max. Marks: 60 Duration: 3 Hours

Use of approved design data handbooks are permitted

PART A

Answer All Questions
Each question carries 3 marks

1. State and explain the laws of friction.
2. From first principles, estimate the coefficient of friction due to ploughing component of friction alone.
3. Explain the various important properties of a lubricant.
4. Explain the mechanism of pressure development in hydrodynamic lubrication with a suitable example.
5. Explain the working principle of a simple hydrostatic thrust bearing with a neat sketch.
6. Compare capillary tube and orifice restrictors.
7. Explain the classification of wear processes.
8. Explain static and dynamic load carrying capacity of an anti-friction bearing.

PART B

Each question carries 6 marks

9. What are the various kinds of friction and state the causes of sliding friction.

OR

10. Write down the Navier-Stokes equation for compressible unsteady state viscous fluid flow. State the assumptions made, obtain Reynolds equation for incompressible viscous fluid flow.

11. For an infinitely long plane slider bearing, obtain the expression for pressure distribution if inlet and outlet film thicknesses are h_1 and h_2 respectively. Draw the pressure distribution curve also.

OR

12. 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 1 m/s with a mineral oil of absolute viscosity of 35 cP. Film thickness ratio is adjusted to have maximum load capacity. Calculate: (a.) the normal load capacity, (b.) the shear force experienced by the sliding surface, (c.) the coefficient of friction, (d.) maximum pressure, (e.) location of maximum pressure, (f.) volumetric flow rate, (g.) power loss due to viscous friction, and (h.) average temperature rise of the lubricant. Take mass density and specific heat of oil as 880 kg/m^3 and 1.88 kJ/kg-K, respectively.

13. For an infinitely long journal bearing using full Sommerfeld conditions write down the equation for pressure distribution and from this equation derive the equations for load carrying capacity and attitude angle.

OR

14. A full journal bearing is having the following specifications: Journal diameter = 100 mm, L/D = 1, Radial clearance = 0.025 mm, Journal speed = 3000 rpm, operating eccentricity ratio = 0.6, average viscosity of lubricant = 0.02 PaS. Using narrow bearing approximation of the above bearing, calculate: (a.) load carrying capacity, (b.) oil flow rate, (c.) coefficient of friction.

15. Design a journal bearing for the following specifications: Speed = 1200 rpm, Load = 900 N, Bearing pressure = 1 N/mm^2, L/D = 1, C/D = 0.001. Oil used is SAE 30 at 55 ℃ and ambient temperature is 25 ℃. Find equilibrium oil temperature for thermal stability.

OR

16. The following data is given for a 360° hydrodynamic bearing: Radial load = 10 kN, Journal speed = 1440 rpm, Unit bearing pressure = 1000 kPa, Clearance ratio (r/c) = 800, Viscosity of the lubricant = 30 mPaS. Assuming that the total heat generated in the bearing is carried by the oil flow in the bearing, calculate (a.) Dimensions of the bearing, (b.) Coefficient of friction, (c.) Power lost in friction, (d.) Total flow of oil, (e.) Side leakage, (f.) Temperature rise.

17. The following data is given for a hydrostatic step bearing of a vertical turbo generator: Thrust load = 450 kN, Shaft diameter = 400 mm, Recess diameter = 250 mm, Shaft speed = 750 rpm, Viscosity of the lubricant = 30 cP. Draw a neat sketch showing the effect of film thickness on energy loss. Calculate the optimum film thickness for minimum power loss.

OR

18. For a circular step hydrostatic bearing, derive an expression for pressure distribution and flow rate of lubricant using neat sketches.

19. A ball bearing for the spindle for machine tool rotates at 3000 rpm is subjected to a radial load of 2 kN and an axial load of 1 kN. It is to work for 10 years serving 5 days per week 10 hours per day. Design and select a suitable bearing for the spindle.

OR

20. Derive Archad's wear equation for adhesive wear using a suitable model. State also, the assumptions made in formulating the model.