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14MMD/MDE41

Fourth Semester M.Tech. Degree Examination, June/July 2016
Tribology & Bearing Design

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions.***
2. ***Use of design data hand book permitted.***

1 a. Define wear and explain any four wear mechanisms with neat sketch. **(10 Marks)**

b. State and explain the Newtons law of viscous flow. Derive Hagen-Poiseuille law for flow through a capillary. **(10 Marks)**

2 a. Two reservoirs A and B are connected by a horizontal capillary tube and the system is filled with a liquid having an absolute viscosity of 2 cp. The manometric pressure in reservoir A is 0.04 MPa and the pressure in reservoir B is 0.014 MPa. The inside diameter of the capillary is 0.635 mm and the length of the capillary is 2 m. Determine the rate of flow through the capillary. Also determine the maximum velocity of the liquid when flowing through the capillary. Plot the distribution of velocity across the capillary tube. **(10 Marks)**

b. Derive Petroff's equation for frictional force and co-efficient of friction. **(10 Marks)**

3 Write a note on Reynolds investigation. Derive the Reynolds equation in two dimensions, also state the assumptions. **(20 Marks)**

4 a. Derive an expression for the load carrying capacity of an idealized plane slider bearing with pivoted shoes. **(10 Marks)**

b. Determine the pressure in fuel journal bearing with following data:
Journal diameter = 38 mm, Length of bearing = 63 mm, Speed = 3000 rpm,
Radial clearance = 2.5×10^{-3} cm, Pressure of oil at inlet hole = 0.31 N/mm^2,
Location of inlet pole 315°, Attitude 0.8, Co-efficient of viscosity 0.0148 N-S/m^2 **(10 Marks)**

5 a. With neat sketches, explain any two-main systems of hydrostatic lubrication. **(10 Marks)**

b. Derive an expression for the load carrying capacity of hydrostatic step bearing. **(10 Marks)**

6 a. Explain the different regimes in EHL constraint and Glublint type solution. **(10 Marks)**

b. A hydrostatic step bearing has the following :

Shaft dia = 130 mm	External pressure = 0 MPa
Packet dia = 55 mm	Expected mean oil film temperature = 60°C
Shaft speed = 1800 rpm	Lubricating oil SAE = 60
Inlet pressure = 3.75 MPa	Oil film thickness = 0.0875 mm

Determine : i) Load the bearing can support. ii) Rate of oil flow through the bearing.
iii) Power loss due to viscous friction. **(10 Marks)**

7 a. Explain antifrication bearing, mention their application. **(10 Marks)**

b. Explain porous bearing with governing equation. **(10 Marks)**

8 a. Explain with a neat sketch, the working of an active and passive magnetic bearings. **(10 Marks)**

b. Explain the applications of magnetic bearing. **(10 Marks)**

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14CAE421

Fourth Semester M.Tech. Degree Examination, June/July 2016
Fracture Mechanics

Time: 3 hrs. Max. Marks:100

Note: 1. *Answer any FIVE full questions.*
2. *Missing data may be assumed.*

1 a. Using the first principles derive an expression for the theoretical tensile strength of an ideal solid. **(10 Marks)**

b. Explain : i) Stress intensity factor ii) Fracture toughness. **(05 Marks)**

c. Distinguish between : i) Constant grip condition and ii) Constant load condition. **(05 Marks)**

2 a. Obtain an expression for plastic zone size according to Von-Mises yield criteria. And sketch the plastic zone plots for plane stress and plane strain. **(10 Marks)**

b. Consider a center crank of length '2a' in an infinite plate subjected to uni-axial tensile stress σ at the plate edges perpendicular to the crank plane. According to Irwin model the effective crank is larger than the actual crack due to plastic zone. Show that the SIF corresponding to effective crack 'Keff' is given by,

$$Keff = \frac{\sigma\sqrt{\pi a}}{\sqrt{\left(1-\frac{\sigma}{2\sigma_Y}\right)^2}}$$

where σ_Y : yield strength of the material. **(06 Marks)**

c. A large plate constains a crack length of 20 mm is subjected to a stress $\sigma = 500$ MPa. σ_Y of the material is 2000 MPa. Find the effective SIF and length of plastic zone. **(04 Marks)**

3 a. Explain with the help of a neat sketch the three modes of fracture. **(06 Marks)**

b. Derive an expression for strain energy release rate, G, for a double cantilever beam specimen under constant load. **(07 Marks)**

c. What is contoured double cantilever beam? Sketch the same showing the variation of crack length and depth of the beam. **(03 Marks)**

d. Explain stress concentration due to an elliptical hole subjected to uniform tension. **(04 Marks)**

4 a. Describe the necessary instrumentation in a fracture toughnss testing. **(04 Marks)**

b. Sketch typical load-displacement behavior during a fracture toughness testing and locate 'PQ' in each of the behaviours. **(06 Marks)**

c. Fracture toughness testing of a steel with $\sigma_y = 800$ MPa is performed using CT specimen check whether test is valid or not from the following data:
W = 12 cm, B = 5 cm, a = 6 cm, PQ = 156 kN and P_{max} = 169 kN
Give comments on the results. **(10 Marks)**

5 a. State the maximum tangential stress criteria and derive an expression for tangential stress 'σ_θ' involving K_I and K_{II}. **(10 Marks)**

b. Determine the crack extension direction. **(06 Marks)**

c. Find critical direction θ_c for a crack opening loading and for a crack sliding mode of loads. **(04 Marks)**

6 a. A large thick plate contains a crack of length 2a and is subjected to a constant amplitude cyclic stress normal to the crack plane. The stress varies from σ_{max} and σ_{min}. The fatigue crack growth is governed by the equation,

$$\frac{da}{dN} = C\left[(\Delta K)^2 - (\Delta Kth)^2\right]$$

Show that the number of cycles N_C required to slow the crack to instable condition is given by,

$$N_C = \frac{1}{C\pi(\Delta\sigma)^2} \ln \frac{\left(\frac{KIC}{\sigma_{max}}\right)^2 - \left(\frac{\Delta Kth}{\Delta\sigma}\right)^2}{\pi a_0 - \left(\frac{\Delta Kth}{\Delta\sigma}\right)^2}$$

where $\Delta\sigma = \sigma_{max} - \sigma_{min}$ **(10 Marks)**

b. A large plate containing an edge crack of size 3.1 mm. The plate is subjected to a constant amplitude of loading σ_{max} 310 MPa and σ_{min} 172 MPa. The plate material has K_{IC} = 165 MPA$\sqrt{m}$. Determine the life for the crack to grow up to 25 mm size. Use C = 6.8×10^{-12} and m = 3.0 as in Paris Law. **(10 Marks)**

7 a. Explain the principles of crack arrest and with a neat sketch describe any two techniques for arresting the propagation of crack. **(10 Marks)**

b. Define J-integral. Show that it is path independent. State the properties of J-integral. **(10 Marks)**

8 Write short notes on :

a. Damage tolerance.

b. Role of NDT in fracture mechanics.

c. Differentiate between cleavage and ductile fracture.

d. Effect of thickness on fracture toughness. **(20 Marks)**

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