BE / B Tech (Full Time) DEGREE ARREAR EXAMINATIONS NOV / DEC 2011

MATERIALS SCIENCE & ENGINEERING BRANCH

SIXTH SEMESTER

ME-9030 – INDUSTRIAL TRIBOLOGY

(REGULATIONS 2008)

Time : 3 hrs. Max. Mark : 100

Instructions : 1. Read questions carefully. Write 'to the point' answers
2. Question Nos. 1 to 11 are compulsory

Answer ALL Questions

Part – A (10 x 2 = 20 Marks)

1. Draw a representative engineering metal surface under operation. Show the various layers and dimensions.
2. Define R.M.S. value of roughness.
3. Name four operating parameters that affect the coefficient of friction.
4. Mica does not obey Amonton's laws of friction. Justify.
5. What is rubbing factor?
6. State the principle of 'falling body viscometer' for the determination of viscosity.
7. What is elastohydrodynamic lubrication?
8. State the basic principle of the Nitriding process.
9. Draw the shear stress vs. shear rate plot for (a) dilatant fluid *or* (b) Bingham plastic
10. Name four synthetic organics that are used as lubricants.

Part – B (5 x 16 = 80 Marks)

11. (a) Write brief notes on *any two* of the following: (i) corrosive wear, (ii) fatigue wear and (iii) erosive wear. (4+4)
(b) Define abrasive-wear-resistance. Discuss the dependence of abrasive-wear-resistance on *any three* of the following parameters: i) hardness, ii) elastic modulus, iii) heat-treatment and iv) grain orientation. (2+6)

12. (a) (i) What are the material requirements for the fluid-film lubricated bearings operating at high stresses? (ii) Name two different material systems suitable for such applications.
(iii) Why whitemetals (babbitts) are selected for the low stress application in case of fluid-film lubrication?
(iv) Write brief note on selection of materials for the '*rolling elements and races of the bearing*'. (5+2+3+6)

OR

(b) (i) Explain the effect of (A) *normal load* and (B) *vacuum* on wear of materials. (8)
(ii) In a wear vs. time plot, show the various zones of wear encountered in the life span of a component. Write down the mathematical expressions for wear in these zones. (2+3)
(iii) Explain why '*wear rate*' is not a meaningful parameter in describing the *useful life* of rolling element bearing. (3)

13. (a) (i) State the differences between transformation hardening and surface melting processes. (4)
(ii) Write short notes on: 'Frictional considerations in design for material selection' for the cases of (A) high vacuum, (B) very high speed and (C) very low temperature. (3x4)

OR

(b) Write short notes on *any four* of the following processes: (i) flame hardening, (ii) nitro-carburizing, (iii) pack carburizing, (iv) carbonitriding, (v) physical vapour deposition and (vi) chemical vapour deposition. (4x4)

14. (a) (i) State the *Bowden & Tabor's simple adhesion theory* of friction. What are the drawbacks of this theory? (8)
(ii) Derive Archard's equation for adhesive wear stating the *assumptions* clearly. (8)

OR

(b) (i) What is Ratchet mechanism? (3)
(ii) Derive an expression for the coefficient of friction μ_{Rat} in terms of the slant angle θ and the true adhesive component of the coefficient of friction μ_0. (6)
(iii) The flat face of a brass annulus having an outside diameter of *20 mm* and an inside diameter of *10 mm*, is placed on a flat carbon-steel plate under a normal load of *10 N* and rotates about its axis at *100 rpm* for *100 hour*. As a result of wear during the test, the mass losses of the brass and steel are *20 mg* and *1 mg*, respectively. Calculate *wear coefficients* for the bronze and the steel.
Use: hardness of steel = *2.5 GPa*, hardness of brass = *0.8 GPa*, denity of steel = *7.8 Mg/m^3*, denity of brass = *8.5 Mg/m^3*. (7)

15. (a) (i) What is the principle of hydrodynamic lubrication? Write Reynolds equation for combined longitudinal and normal motion. (3+3)
(ii) Define load capacity. (2)
(iii) Draw a hydrostatic bearing and show different parts of it. (4)
(iv) What are the basic differences between the hydrodynamic and hydrostatic lubrication systems? (4)

OR

(b) (i) Consider the *step bearing* as shown in ***Fig. 1***. Starting from the *Reynolds equation* for pressure gradient for the longitudinal motion, obtain the *pressure distribution function, p(x)*, along the length of the step bearing. (8)
(ii) Also, derive the expression for *load capacity* for the step bearing in terms of maximum pressure, p_S. (4)
(iii) Define *reduced pressure parameter*. Why is it used? (4)

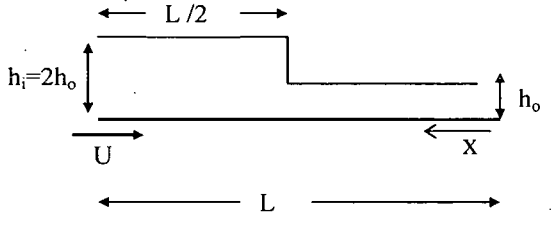

Fig. 1

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