BE / B Tech (Full Time) DEGREE END SEMESTER EXAMINATIONS APRIL / MAY 2012

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. Illustrate with the help of neat sketches wherever necessary

Answer ALL Questions

Part – A (10 x 2 = 20 Marks)

1. Define C.L.A. value of roughness.
2. Draw a representative engineering metal surface under operation. Show the various layers and dimensions.
3. Static friction is higher than the kinetic friction. Give reason.
4. What are the 'geometrical characteristics' of an engineering surface?
5. Name four synthetic organics that are used as lubricants.
6. What is rubbing factor?
7. Why whitemetals (babbitts) are selected for the low stress applications in case of fluid film lubrication?
8. What is elastohydrodynamic lubrication?
9. How is the viscosity dependent on pressure? Write down the mathematical expression.
10. Draw the shear stress vs. shear rate plot for (a) dilatant fluid *or* (b) Bingham plastic.

Part – B (5 x 16 = 80 Marks)

11. Define abrasive-wear-resistance. Discuss the dependence of abrasive-wear-resistance on *any four* of the following parameters: i) hardness, ii) elastic modulus, iii) heat-treatment, iv) grain orientation, and v) relative melting point. (2+14)

12. (a) State deformation (ploughing) theory of friction. Derive the expression for the coefficient of friction (μ_P) for *any three* of the following asperity geometries: (i) conical, (ii) spherical, (iii) transverse-cylindrical and (iv) upright-cylindrical asperities. (4+12)

OR

(b) (i) Write brief note on 'modified adhesion theory' of friction. (4)

(ii) Derive Archard's equation for adhesive wear stating the assumptions clearly. (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*. (6)

13. (a) (i) State the *basic principles* of the following surface engineering processes:

(A) Flame hardening, (B) pack carburizing, (C) chemical vapour deposition. (9)

(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. (7)

OR

(b) (i) Write short notes on: (A) surface melting, (B) carbo-nitriding and (C) physical vapour deposition. (9)

(ii) Write short notes on '*Frictional considerations in design* for the *normal condition* of operation'. (7)

14. (a) (i) For the design of (A) rolling element and (B) cage of a roller bearing, discuss about the required material properties and candidate materials. (10)

(ii) Write brief notes on '*Effect of metaliurgical conditions on wear*' (6)

OR

(b) (i) In a wear vs. time plot, show the various zones of wear encountered in the life span of a component. Write down the mathematical expression for each zone. (6)

(ii) What are the four types of erosive wear? Write brief notes on *any two* of these processes. (2+6)

(iii) Explain why '*wear rate*' is not a meaningful parameter in describing the *useful life* of rolling element bearing. (2)

15. (a) (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) Draw a *hydrostatic bearing* and state its *working principle*. (4)

OR

(b) (i) Consider the slider bearing as shown in ***Fig. 2***. Starting from the *Reynolds equation* for pressure gradient for the longitudinal motion, obtain the *pressure distribution function, p(x)*, along the length of the slider bearing. (8)

(ii) Also, derive an expression for the location (x^*) of maximum pressure. What is the value of maximum pressure? (2+2)

(iii) Draw a *journal bearing* and state its *working principle*. (4)

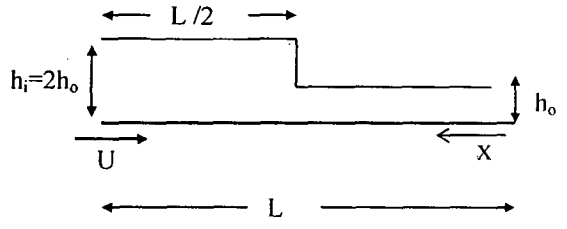

Fig. 1

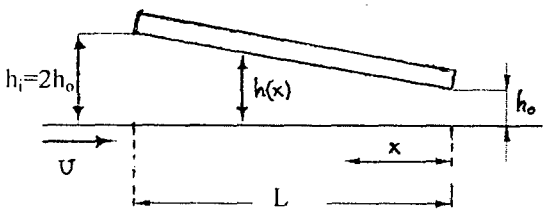

Fig. 2