MASTER OF MECHANICAL ENGG. EXAMINATION, 2017

(1st Semester)

PRINCIPLES OF TRIBOLOGY

Time: Three hours   Full Marks: 100

Missing data, if any, may be assumed.

Answer any **five** questions. All parts of same question must be answered together.

1. a) Explain the different surface layers of a typical metal surface.

    b) Distinguish between physisorption and chemisorption.

    c) Distinguish between roughness, waviness, lay and flaw.

    d) How to remove form error from roughness data in surface profilometry?

    e) A rough surface profile is sinusoidal with wavelength λ and amplitude A_0. Show that R_a of the profile is independent of wavelength.   3 x 4+8

2. a) Explain G-W model of contact of rough surfaces with assumptions.

    b) For an exponential distribution of asperity heights, show that average area of contact is independent of load.

    c) A ceramic ball of radius 5mm is pressed into a hemispherical recess of 10mm radius in a steel plate. Elastic modulus, Poisson's ratio and hardness of ceramic material and steel are 450 GPa and 200 GPa, 0.3, 0.3, 20 GPa and 5 GPa respectively. Find the normal load to initiate yielding in steel plate. Calculate the radius of contact and the depth at which yield first occurs.   10+4+6

3. a) What is adhesion? How does it differ from cohesion?

    b) A rubber sphere of diameter 20 mm is brought in contact with a flat smooth glass plate with an initial joining load of 4 g. Now if external load is gradually reduced, explain the contact radius vs. load behavior with the help of graphs for the following two situations: i) the experiment is carried out in normal atmospheric condition ii) the experiment is carried out in vacuum. Mention the respective theories to explain the behavior.

    c) What is stiction? State the remedial methods.

    d) Explain elastic adhesion index and plastic adhesion index.   4+8+4+4

4. a) Explain the causes for friction at the contact between two surfaces. Hence explain the basic theories of friction.

b) Consider a micro-scale friction measurement using a hard ball of radius 2.83 mm sliding against a soft and flat surface. The overall friction coefficient is measured as 0.25, and the groove produced during sliding has a width of 1 mm. The interfacial shear strength at the contact is found to be one-tenth of the bulk value. Assuming friction due to multiple mechanisms acting in additive mode, calculate the contribution from different mechanisms towards friction.

c) Explain how friction of polymers differs fundamentally from that of metals.

8+8+4

5. a) Explain flash temperature and the use of radiation detectors for its measurement.

b) Explain the need for surface engineering. Briefly classify the methods of surface engineering.

c) Explain briefly the principle methods of physical vapor deposition process.

8+6+6

6. a) Explain Archard's theory of adhesive wear. How to distinguish between mild wear and severe wear?

b) Explain abrasive wear. Explain how it differs from adhesive wear and corrosive wear.

c) Explain how rate of erosive wear depends on angle of attack for brittle and ductile materials.

d) In a solid particle erosion test of steel plate, the erosion ratio is found to be 10^{-4} at an impact velocity of 50m/s and an impact angle of $20°$. Find the proportion of displaced material that result in wear debris if hardness and density of steel be 2.4 GPa and 7.8 Mg/m^3.

5+5+5+5

7. Write short notes on (any Four):

a) Atomic Force Microscope

b) Wear Regime Map

c) Pin-On-Disc Test Setup

d) Weierstrass Mandelbrot Function

e) Hard facing

f) Surface Profilometer

5 x 4