

M. E. MECHANICAL ENGG. EXAMINATION, 2024

(1st Year, 1st Semester)

PRINCIPLES OF TRIBOLOGY

Time: Three hours

Full Marks: 100

Missing data, if any, may be assumed.

Answer any five questions.

1.
 - a) Define CLA, RMS, Skewness and Kurtosis for a rough surface.
 - b) For a Gaussian distribution, evaluate the ratio of RMS to CLA roughness.
 - c) Explain how ACF distinguishes between open and closed texture.

8+8+4
2.
 - a) Explain Greenwood-Williamson contact model of rough surfaces with assumptions. State its limitations.
 - b) A smooth plane surface is in contact with a rough plane covered with spherical asperities of the same radius R and having a uniform distribution of peak heights given by $\phi(z) = \frac{1}{2\sqrt{3}\sigma}$. Considering η as asperity area density, derive expressions for real area of contact A and total load P as functions of the normal approach δ for both plastic and elastic modes of asperity deformation. Show that $A \propto P$ for plastic case and $A \propto P^{\frac{4}{5}}$ for elastic case.

12+8
3.
 - a) What is adhesion? Explain the factors influencing adhesion.
 - b) Compare the different models of adhesion in a adhesion map in terms of Maugis parameter.
 - c) Deduce the expression for ploughing component of friction using a spherical asperity model.

6+6+8

[Turn over

4.
 - a) Explain how friction behaviour of metals depends on normal load and sliding speed.
 - b) Two hard conical sliders of semi angles 75° and 80° are slid across an unlubricated metal surface and the measured friction coefficients are in the ratio 11:10. The experiment is then repeated with the surfaces under lubrication and the measured friction coefficients are then found to be in the ratio 13:10. Find the coefficients of adhesive friction in the two cases.
 - c) Explain stick-slip mechanism of friction. 8+8+4

5.
 - a) Explain Archard's theory of adhesive wear.
 - b) Establish Hutching's equation for erosive wear.
 - c) In a wear test, a brass annulus having an outside diameter of 25mm and an inside diameter of 12.5mm is placed with its flat face resting on a flat carbon steel plate under a normal load of 10 N and rotated about its axis at 100 rpm for 50 hr. As a result the mass losses of the brass and steel are 25mg and 1 mg respectively. Calculate the wear coefficients and wear depths for brass and steel. Take hardness and density for steel and brass as 2.5 GPa, 0.8 GPa, 7.8 Mg/m^3 and 8.5 Mg/m^3 respectively. 5+5+10

6.
 - a) Explain the use of radiation detectors in measurement of surface temperature.
 - b) Explain vapor deposition processes with illustration.
 - c) Explain briefly the applications of AFM. 8+6+6

7. Write short notes on:
 - a) Surface profilometry
 - b) Ferrography
 - c) Rehbinder effect
 - d) Plasticity index 5 x 4