Ex/ME(M2)/PE/B/T/325C/2024

**B.E. Mechanical Engineering - Third Year - Second Semester Examination – 2024**

Time: Three hours Subject: **PRINCIPLES OF ENGINEERING TRIBOLOGY** Full Marks: 100

**All parts of the same question should be answered together.**

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| CO1 [40] | Q. 1 | **Answer any four from (a) to (f) in this block** 10 x 4<br>**(a)** Explain CLA, RMS, Skewness and Kurtosis for a rough surface.<br>**(b)** Define Auto Correlation Function. Explain the working of a surface profilometer with diagram.<br>**(c)** Explain Greenwood-Williamson contact model to evaluate the load and contact area in elastic-plastic contact situation.<br>**(d)** Explain Johnson-Kendall-Roberts model of adhesion. How does it differ from Derjaguin-Muller-Toporov model?<br>**(e)** Explain flash temperature? Explain the use of thermocouples in measurement of surface temperature.<br>**(f)** Explain adhesive wear. Derive Archard's equation for adhesive wear. |
| CO2 [20] | Q. 2 | **Answer any two from (a) to (c) in this block** 10 x 2<br>**(a)** A hard metal ball of 10 mm diameter is slid across a soft metal surface and produces a groove of 3 mm width. Find the coefficient of friction. Derive the formula used.<br>**(b)** In a pin-on-disk wear test, a bronze pin of radius 10 mm is placed with its flat face resting on a steel plate under a normal load of 100 N and at a distance of 200 mm from the centre of the steel plate which rotates about its axis at 5 Hz for 20 hours. At the end of the test, the specimens are separated and weighed and it is found that the mass losses of the bronze and steel are 250 mg and 10 mg respectively. Calculate the wear coefficients for bronze and steel if hardness and density of steel and bronze are 2.4 GPa, 0.8 GPa, 7.8 $Mg/m^3$ and 8.4 $Mg/m^3$, respectively.<br>**(c)** A tungsten carbide ceramic ball of radius 1.5 mm is pressed into a hemispherical recess of 3 mm 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 necessary to initiate yielding in steel plate. Calculate the radius of contact and the depth at which yield first occurs. |
| CO3 [20] | Q. 3 | **Answer any two from (a) to (c) in this block** 10 x 2<br>**(a)** Explain the need for surface engineering. Explain CVD and PVD. Explain the different techniques of hard facing.<br>**(b)** Explain friction behavior of solid lubricants and polymers.<br>**(c)** Describe briefly: i) Pin-on-Disc tribometer, ii) Hutchings equation. |
| CO4 [20] | Q. 4 | **Answer any two from (a) to (c) in this block** 10 x 2<br>**(a)** Draw the contact radius vs. load behavior for contact between a rubber sphere and a rubber flat considering two conditions: a) test is done in air b) test is done in vacuum. Name the theories to explain the behavior in each case.<br>**(b)** Explain the working of an AFM or STM with schematic diagram.<br>**(c)** Explain Hertz equations for contact load and contact area for elastic deformation in spherical contact. Define equivalent radius and equivalent elastic modulus. |