M. E. MECHANICAL ENGG. EXAMINATION, 2024

(1st Year, 1st Semester)

CONTACT MECHANICS

Time: Three hours Full Marks: 100

Missing data, if any, may be assumed.

Answer any **five** questions.

1. a) Two rough surfaces contact each other such that applied load vary over a wide range. Explain the approach to model such contact with assumptions to evaluate load-displacement and area-displacement relationship.
   b) A steel sphere of radius 0.02 m impacts with a velocity 2 m/s against a flat steel wall. Determine the contact time and maximum contact pressure. 10+10

2. a) Derive the expressions for contact force and contact radius for contact between a rigid sphere and an elastic half-space.
   b) Explain how the above expressions need modifications in the following cases; i) if both solids are elastic ii) if both bodies are spheres iii) if both bodies are cylinders. 10+10

3. a) A rigid plane comes in contact with a thin elastic sheet wrapped on a rigid cylindrical base. Determine the qualitative relation between contact force and depth of penetration using uniaxial deformation approximation.
   b) Estimate qualitatively the contact force in terms of penetration depth for both elastic and plastic deformation of an elastic half-space in contact with a rigid cylinder. 10+10

4. a) In case of contact between a rigid cone and an elastic body, prove that the force is proportional to the square of the penetration depth for both elastic and plastic deformation.

b) Determine the force-displacement dependence, the effective modulus of elasticity, and the shear stress distribution in a contact plane for a thin, round, elastomer sheet with a radius R and thickness h, assuming that the material is incompressible and the sheet sticks to one surface and slides without friction on the other. 10+10

5. a) What is adhesion? Why is it not considered in normal engineering applications?

b) Two soft elastic solids with large surface energy and radius are in contact. Propose suitable model for such contact. Draw and explain the load-displacement relation. Derive the expressions for contact load and contact radius.

6+14

6. a) What is asperity interaction?

b) Explain the procedure to consider asperity interaction in elastic-plastic contact between rough surfaces.

c) Explain plasticity index and its physical significance. 4+8+8

7. a) Explain elastic-plastic contact of rough surfaces. In this context, elaborate Kogut-Etsion approach to model such contact.

b) What is plastic asperity concept in elastic-plastic contact simulation? Explain it.

c) What is indentation size effect? 10+5+5