

MASTER OF MECHANICAL ENGG. EXAMINATION, 2018

(1st Semester)

CONTACT MECHANICS

Time: Three hours

Full Marks: 100

Missing data, if any, may be assumed.

Answer any five questions.

1. a) Explain Hertz contact problem. For this, derive the expressions for contact force and contact radius.
b) Estimate the maximum pressure and the size of the contact area in a steel rail-wheel contact where the maximum load per wheel is around 10^5 N for cargo trains and the wheel radius is 0.5 m. 10+10

2. a) Consider the contact between a rigid plane and a thin elastic spherical cap which is bound to another rigid plane. Use uniaxial deformation approximation to determine the qualitative relation between contact force and depth of penetration.
b) A rigid sphere is in contact with an elastic half-space. Estimate qualitatively the contact force in terms of penetration depth for both elastic and plastic deformation of the half-space. 10+10

3. 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. Consider two cases:
a) the sheet sticks to both rigid planes
b) the sheet sticks to one surface and slides without friction on the other. 10+10

10+10P.T.O.Page 1 of 2

4. a) Consider an impact of an elastic sphere with a flat plane. Determine the contact time and maximum contact pressure.
b) Explain Greenwood-Williamson model of contact of rough surfaces. State its limitations.
- 10+10
5. a) Explain adhesive contact. Why is adhesion not so prominent in normal engineering applications?
b) Draw and explain the load-displacement relation for contacting solids following JKR adhesive contact.
c) Derive JKR equation for contact load and contact radius
- 5+5+10
6. a) What is depth sensing indentation?
b) Draw and explain typical load-displacement curve in depth sensing indentation.
c) Explain how unloading curve can be used to determine the combined elastic modulus.
- 4+8+8
7. a) What is the meaning of hardness? Explain the expanding cavity model of hardness.
b) Explain Brinell hardness and Vickers diamond hardness measurements.
- 10+10
8. Write short notes on:
a) Asperity interaction
b) Plastic asperity concept (PAC) model
c) Kogut-Etsion elastic-plastic contact
d) Maugis Dugdale adhesive model
- 5 x 4