MASTER OF MECHANICAL ENGG. EXAMINATION, 2017

(1st Semester)

CONTACT MECHANICS

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) 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.

   b) 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. 10+10

2. Consider a thin, round, elastomer sheet with a radius R and thickness h to be in contact between two rigid planes. Elastomer may be assumed to be incompressible. Determine the force-displacement relationship, the effective modulus of elasticity, and the shear stress distribution in a contact plane for the following two cases:

   a) the sheet sticks to two rigid planes on both sides

   b) the sheet sticks to one surface and slides without friction on the other. 10+10

3. 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

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4. a) Consider an impact of an elastic sphere with a flat plane. Determine the contact time and maximum contact pressure.

b) Explain G-W model of contact of rough surfaces with 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) Explain what is meant by hardness. Explain the expanding cavity model of hardness.

b) Explain Brinell hardness and Vickers diamond hardness measurements. 10+10

8. Write short notes on (any Four):

a) Asperity interaction

b) Plastic asperity concept (PAC) model

c) Kogut-Etsion elastic-plastic contact

d) Indentation size effect

e) Plasticity Index

f) Maugis-Dugdale model 5 x 4