DEPARTMENT OF MECHANICAL ENIGINEERING,
UNIVERSITY OF ENGINEERING & TECHNOLOGY LAHORE (KSK CAMPUS).

Mechanics of Materials-II
6th Semester**----** (Session 2008)

Problem Sheet #1

NOTE: **Solve all the Questions by Complex stress / strain equations & then by drawing Mohr's circle as well. Use graph paper for drawing Mohr's circle.**

Pb. 1 The state of stress at a point in a member is shown in figures (1) & (2) on the element. Determine the stress components acting on the inclined plane using the equilibrium equations. (-4.05 MPa, -0.404 MPa) (31.4 MPa, 38.1 MPa)

Pb. 2 For the state of plane stress shown fig. (3) Determine (a) the principal planes, (b) the principal stresses, (c) the maximum shearing stress and the corresponding normal stress. ((a) 26.6 °, 116.6° (b) 70MPa, -30MPa (c) 50MPa, 20MPa)

Pb. 3 The state of a stress at a point is shown on the element in the figures 4 through 7. Determine (a) the principal stresses and (b) the maximum in-plane shear stress and the average normal stress at that point. Specify the orientation of the element in each case.

Fig. 4 ((a)53MPa,-68MPa,14.9°) ((b) 60.5MPa,-7.50MPa,-30.1°)
Fig. 5 ((a)265MPa,-84.9MPa,60.5°)((b) 175MPa,900MPa,15.5°)
Fig. 6 ((a)4.21Ksi,-34.2Ksi,-70.7°) ((b) 19.2Ksi,-15Ksi,-25.7°)
Fig. 7 ((a)310MPa,-260MPa,71.1°) ((b) 285MPa,25MPa,26.1°)

Pb. 4 A bar of X-section 8 cm^2 is acted upon by an axial tensile force of 72 KN applied at each end of the bar. Determine the normal and shearing stresses on a plane inclined at 30 ° (clockwise) to the direction of loading. Also determine the Maximum shearing stress on this axially loaded bar. (22 MPa, -39 MPa, 45 MPa)

Pb. 5 At a point in a complex stress σ_x = 60 MPa, σ_y = 10 MPa & τ_{xy} = 20 MPa. Determine the stress components & planes on which the shear stress is maximum. (35 MPa, 32 MPa, 64.3°, 154.3°)

Pb. 6 The square steel plate has a thickness of 10 mm and is subjected to the edge loading shown in fig. (8). Determine the maximum in-plane shear stress & the average normal stress developed in the steel. (5KPa, 0)

Pb. 7 The square steel plate has a thickness of 0.5 inch and is subjected to the edge loading shown in fig. (9). Determine the principal stresses developed in the steel. (32 Psi, -32 Psi)

Pb. 8 Draw the Mohr's circle that describes each of the states of stress as shown in Fig. 10 (a, b, c).

Pb. 9 For the following data (a) Determine the principal stresses and show their sense on a properly oriented element (b) find the maximum shear stresses with the associated normal stresses (c) determine (using only Mohr's circle) the angle of plane or planes (if any) where the normal stress is zero, find the magnitude of the shear stresses on these planes (d) Check the invariance of the normal stresses for the solutions in (a) & (b).

(i) $\sigma_x = 0$, $\sigma_y = -40$ MPa & $\tau_{xy} = -30$ MPa.

((a) 16 MPa @ 152°, -56 MPa @ 62° (b) 36 MPa, -20 MPa, 17°, 107° (c) o°, 124°, 30 MPa)

(ii) $\sigma_x = 80$ MPa, $\sigma_y = 20$ MPa & $\tau_{xy} = 40$ MPa.

((a) 100 MPa @ 26.6°, 0 @ 116.6° (b) 50 MPa, 50 MPa, 71.6°, 161.6° (c) 116.6°, 0)

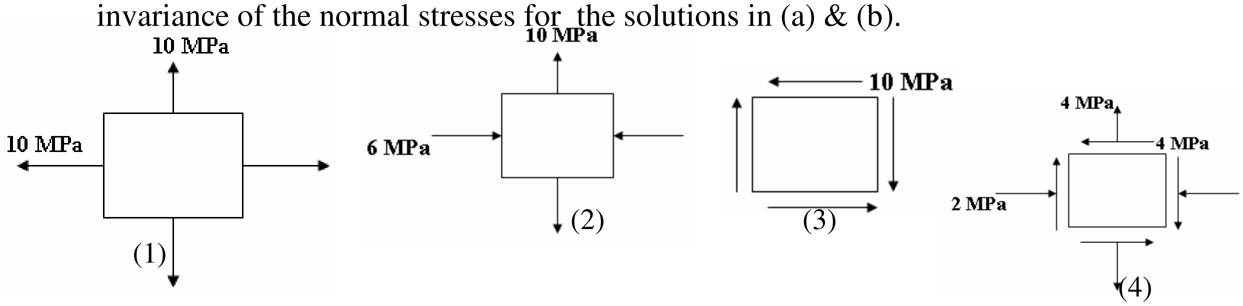
(iii) $\sigma_x = -40$, $\sigma_y = -30$ MPa & $\tau_{xy} = 25$ MPa.

((a) -9.5 MPa @ 50.7°, -60.5 MPa @ 140.7° (b) 25.5 MPa, -35 MPa, 5.7°, 95.7° (c) Nill)

(iv) $\sigma_x = 20$, $\sigma_y = 0$ & $\tau_{xy} = -15$ MPa.

((a) 28 MPa @ 152°, -8 @ 62° (b) 18 MPa, 10 MPa, 17°, 107° (c) 33.7°, 90°, 15 MPa)

Pb. 10 For the state of stress shown in following figures (a) Determine the principal stresses and show their sense on a properly oriented element (b) find the maximum shear stresses with the associated normal stresses (c) determine (using only Mohr's circle) the angle of plane or planes (if any) where the normal stress is zero, find the magnitude of the shear stresses on these planes (d) Check the invariance of the normal stresses for the solutions in (a) & (b).



1- ((a) 10 MPa on each plane, (b) 0, 10 MPa, (c) Nil)
2- ((a) 10 MPa @ 90°, -6 MPa @ 0° (b) 8 MPa, 2 MPa, 45°, 135° (c) 38°, 142°, 7.75 MPa)
3- ((a) 10 MPa @ 135°, -10 MPa @ 45° (b) 10 MPa, 0, 0°, 90° (c) o°, 90°, 10 MPa)
4- ((a) 6 MPa @ 116.6°, -4 MPa @ 26.6° (b) 5 MPa, 1 MPa, 71.6°, 161.6° (c)66°, 167°, 4.9 MPa)

Pb. 11 A state of 2-D strain is $\varepsilon_x = 0.0007$, $\varepsilon_y = 0.0006$, $\gamma_{xy} = 0.0003$. Calculate the principal strains in magnitude & direction.

(0.000717, -0.000617)

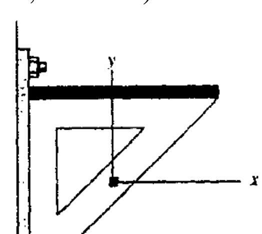


Fig. 11

Pb. 12 The state of strain at the point on the bracket has components $\varepsilon_x = -200\ (10^{-6})$, $\varepsilon_y = -650\ (10^{-6})$, $\gamma_{xy} = -175\ (10^{-6})$.
Use the strain transformation equations to determine the equivalent plane stains on the element shown in Fig.11 oriented at an angle of 20 ° counterclockwise from the original position. Sketch the deformed element due to these strains within x-y plane.

($\varepsilon_{x'} = -309\ (10^{-6})$, $\varepsilon_{y'} = -541\ (10^{-6})$, $\gamma_{x'y'} = -423\ (10^{-6})$)

Pb. 13 A differentials on the bracket is subjected to plane strain has Components $\boldsymbol{\varepsilon_x} = 150\ (10^{-6})$, $\boldsymbol{\varepsilon_y} = 200\ (10^{-6})$, $\gamma_{xy} = -700(10^{-6})$. Use the strain transformation equations to determine the equivalent plane stains on the element shown in Fig.12 oriented at an angle of 60 ° counterclockwise from the original position. Sketch the deformed element due to these strains within x-y plane
($\varepsilon_{x'} = -116\ (10^{-6})$, $\varepsilon_{y'} = -466\ (10^{-6})$, $\gamma_{x'y'} = 393\ (10^{-6})$)

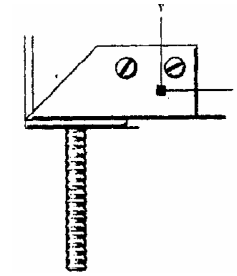


Fig. 12

Pb. 14 The state of strain at the point on the gear tooth has components $\boldsymbol{\varepsilon_x} = 850(10^{-6})$, $\boldsymbol{\varepsilon_y} = 480\ (10^{-6})$, $\gamma_{xy} = 650\ (10^{-6})$.
Use the strain transformation equations to determine (a) the plane principal stains on the element shown in Fig.13 (b) the maximum in plane shear & the average normal strain. In each case specify the orientation of the element with the x-y plane
(1039 (10^{-6}), 291(10^{-6}), 30.2 °, 120 °)

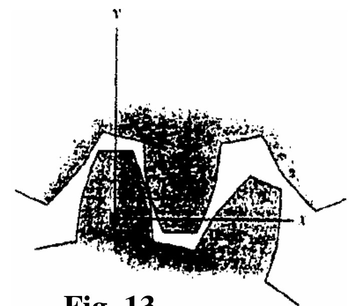


Fig. 13

Pb. 15 At a point on the surface of a stressed body mutually perpendicular normal strains $\boldsymbol{\varepsilon_x} = 400(10^{-6})$, $\boldsymbol{\varepsilon_y} = -200\ (10^{-6})$ occurs with shear strains $\gamma_{xy} = 800\ (10^{-6})$. Determine the magnitude of the principal strains, the maximum shear strains & the angles on which they act.
(600 (10^{-6}) @ 26.6° , -400(10^{-6}) @ 116.6°,100(10^{-6}),71.6°,161.6°)

Pb. 16 If a rectangular block having sides a = 4cm, b = 2cm & c = 3cm is subjected to a uniform pressure of P=20 KPa, determine the dilatation & change in length of each side. Take E = 600 KPa & $\nu = 0.45$. Also find the values of bulk modulus 'K' & modulus of rigidity 'G' using the relation between elastic constants equations.
(-0.01 cm^3 / cm^3 , -0.0133 cm, -0.00667 cm, - 0.0100 cm)

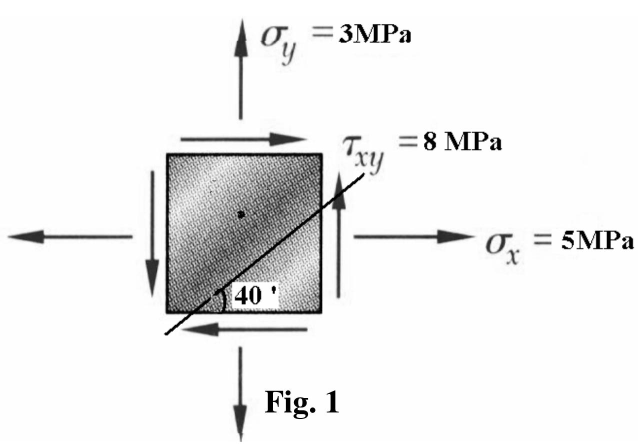


Fig. 1

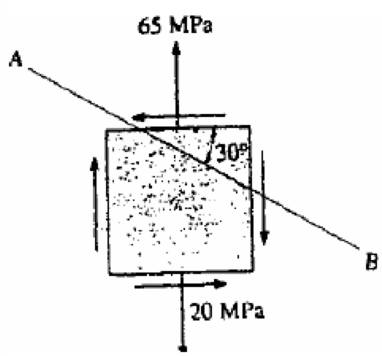


Fig. 2

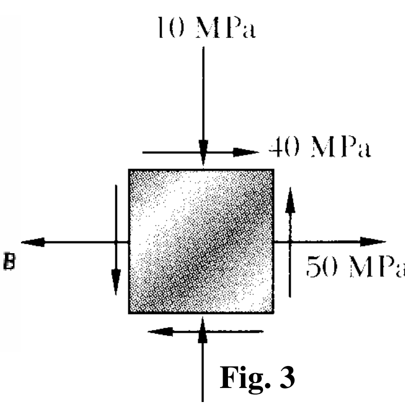


Fig. 3

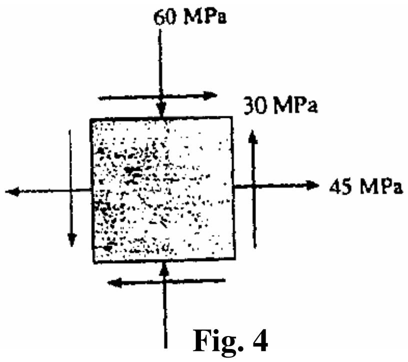


Fig. 4

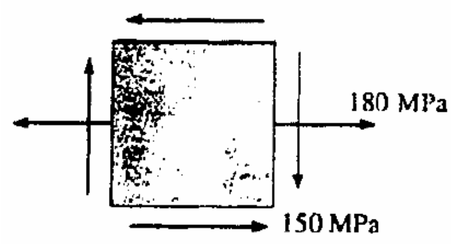


Fig. 5

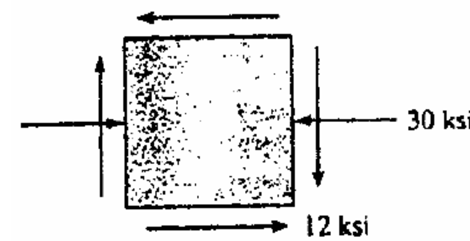


Fig. 6

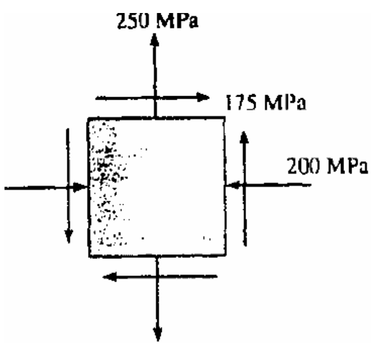


Fig. 7

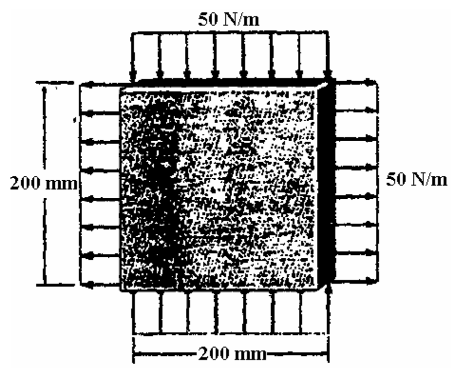


Fig. 8

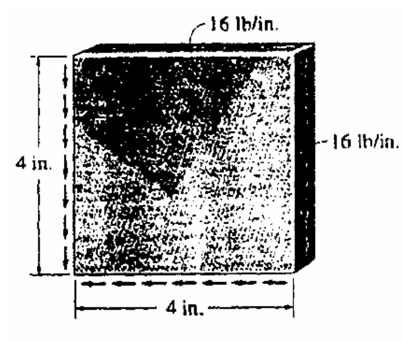


Fig.9

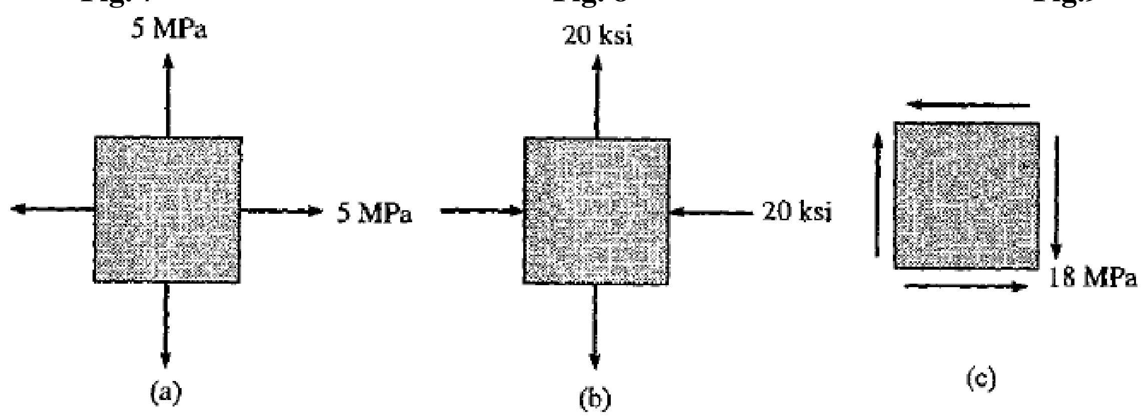


Fig. 10

Prepared By,

Mr. Muhammad Farooq
Lecturer,
Mechanical Engineering Department,
UET Lahore (KSK – Campus)