Menofiya University Faculty of Engineering Tim Allowed: 3 hours Second Semester Examination, 2014-2015 Date of Exam: 10/ 1 /2015	جامعة المنوفية	Diploma (500 Level) Subject : Stress Analysis Code: PRE 508 Total Mark: 100 Marks Production Eng. Dep.

Answer all the following questions

QUESTION 1 (25 Mark)

a) Determine the principle stresses when all six components of the state of stress are equal. Show that this state of stress is a simple tension.

b) Drive the normal and shear stress on octahedral plane.

c) A three-dimensional state of stress is given w. r. t. an xyz coordinate system by:

$\sigma_x = 50$ MPa $\quad \sigma_y = 0 \quad \sigma_z = 0$

$\tau_{xy} = 30$ MPa $\quad \tau_{yz} = 20$ MPa $\quad \tau_{zx} = -30$ MPa

(i) Show that one principle stress is 20 MPa, and find its direction.

(ii) Find the value of the other two principle stresses.

(iii) Determine the normal stress deviations and octahedral shear stress.

QUESTION 2 (25 Mark)

a) Derive the relation: $\varepsilon_v = \varepsilon_x + \varepsilon_y + \varepsilon_z$

b) Determine whether the following displacement field is possible in a continuous material:

$$\begin{Bmatrix} u \\ v \\ w \end{Bmatrix} = \begin{vmatrix} 0.001 & 0 & -0.003 \\ 0.0005 & 0.002 & 0 \\ 0 & 0.001 & -0.005 \end{vmatrix} \begin{Bmatrix} x \\ y \\ z \end{Bmatrix}$$

i) Calculate the displacement of the point (1,2,1).

ii) Let A (2,0,0) and B (0,1,3) represent two points in the undeformed geometry. What displacement occurs between the points?

c) A 400 x 600 mm rectangular plate OABC is deformed into shape $O'A'B'C'$ shown in Fig. 1, determine:

i) The strain components in matrix form.

ii) The principle strains.

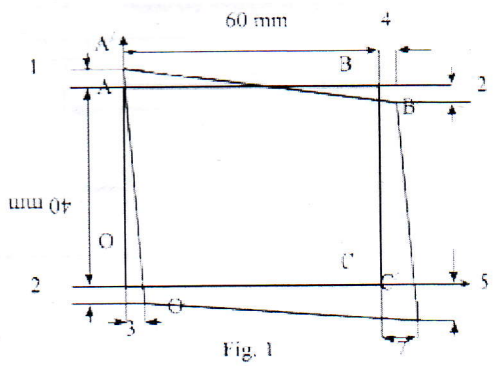


Fig. 1

QUESTION 3 (25 Mark)

a) Define; elasticity, homogeneity and isotropy?

b) A bar of square cross section 100x100 mm parallel to the x-and y-axes has length L=1000 mm and is made of an isotropic steel (E=200 GPa and ν=0.29). The bar is subjected to a uniform state of stress. Considering a state of plane strain, determine the final dimensions of the bar assuming $\sigma_x=\sigma_y=100$ MPa while all shear stresses vanish.

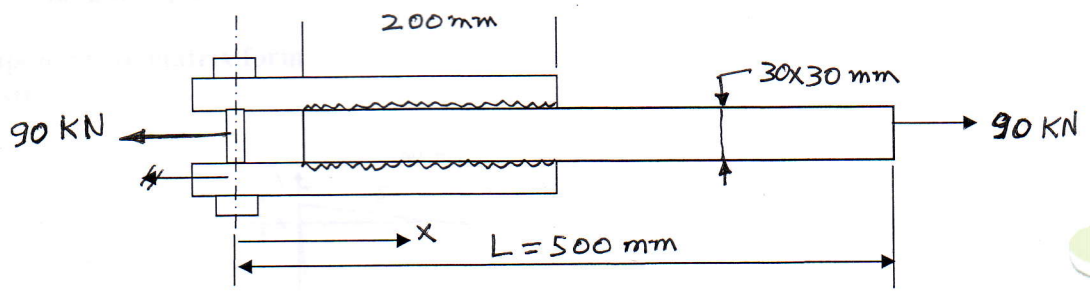
c) A plate is subjected to σ_x= -60 MPa and σ_y=50 MPa, and τ_{xy}=35 MPa. If the plate is subjected to a uniform temperature of 75 °C, find the principal strains taking E= 200 GPa, ν= 0.3, and $\alpha = 12\text{x}10^{-6}$ /°C.

QUESTION 4 (25 Mark)

a) Define: dilatation and distortion.

b) Drive the strain energy for a solid body obeying Hooke's low, starting with the following relation, $(U_o)_\sigma = \int(\sigma_x d\varepsilon_x + \sigma_y d\varepsilon_y + \sigma_z d\varepsilon_z)$ to reach the final form of strain energy in which $U_o=U_{ov}+U_{os}$.

c) A steel bar of length L=500 mm and square cross-section 30x30 mm is welded to a pair of plates along a length of 200 mm as shown in Figure. The bar is subjected to a longitudinal pull of 90 kN. Assuming uniform stress on the cross-section and a linear load distribution along the welded length, determine the strain energy stored in the bar. For steel, take E = 210 GPa.



Good luck

USEFUL INFORMATIONS

$$\varepsilon_x = \frac{1}{E}[\sigma_x - \nu(\sigma_y + \sigma_z)] + \alpha T,$$

$$\varepsilon_y = \frac{1}{E}[\sigma_y - \nu(\sigma_z + \sigma_x)] + \alpha T,$$

$$\gamma_{xy} = \tau_{xy}/G, \qquad \gamma_{yz} = \tau_{yz}/G, \qquad G = \frac{E}{2(1+\nu)}$$