MENOUFIYA UNIVERSITY
Faculty of Engineering, Shebin El-Kom
Prod. Eng. & Mech. Design Dept.
1st Semester Examination 2015/1016
Date : 13/1/2016 M

Subject; Elasticity& Plasticity
Code : PRE 212
Year: Second
Time Allowed : 3 hours
Total Mark: 70 Mark

ANSWER THE FOLLOWING QUESTIONS

QUESTION # 1 (14 marks)

A) Defined the following; Principle stresses - Pure shear - Distortion - Strain rosettes. (4)

B) For a plane equally inclined to the principal axes (octahedral planes), derive the normal and the resultant shear stress. (4)

C) In a metal hot forming operation, the state of stress is given by: $\sigma_x = \sigma_y = \sigma_z = -80$ MPa, $\tau_{xy} = -60$ MPa and $\tau_{xz} = \tau_{yz} = 0$. Calculate the normal stress acting on the plane whose direction cosines are; 2/3, 2/3, –1/3. Find the hydrostatic pressure and the principle stress deviations; also obtain the maximum shear stresses and its direction cosines. **(6)**

QUESTION # 2 (14 marks)

A) Derive the relation: $\varepsilon_v = \varepsilon_x + \varepsilon_y + \varepsilon_z$ (3)

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

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

i) Calculate the displacement of the point (1,2,1). (3)

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

C) The square plate of 1m length in the Figure.1 is loaded so that the plate is in a state of plane strain. Determine the displacements for the plate in matrix form given the deformation shown and also strain components for x\ and y\ coordinates axes. **(5)**

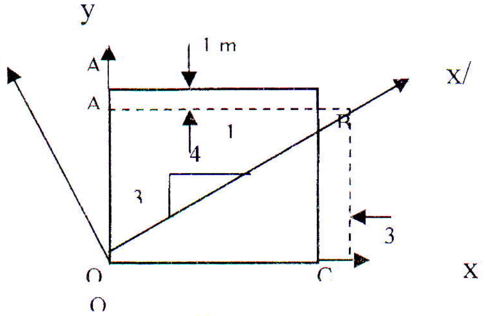
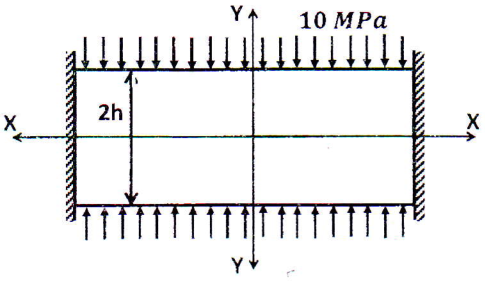


Fig. 1

QUESTION # 3 (14 marks)

A) A brass sheet 20x30x2 mm is clamped in a very rigid frame whose coefficient of thermal expansion is almost zero. Given that the temperature drops by 100 °C, calculate the resulting stresses in the sheet. If the element is free in the z–direction, determine the change in sheet thickness. For brass, E=120 GPa, ν=0.33, and $\alpha = 16\times10^{-6}\ C^{-1}$. (7)

B) A rectangular strip of unit thickness and width 2h shown in the figure is subjected to a temperature distribution given by $T = T_0 - ky^2$. The strip axis is x-axis. If the edge ± h are subjected to a uniformly distributed compressive stress 10 MPa and the end are fixed in the x direction. Determine the stress in the strip. Take $\varphi = ax^2 + by^2 + ey^4$ (7)



QUESTION # 4 (14 marks)

A) A long thick-walled cylinder of 50 mm and 75 mm inner and outer radii used to conduct heat linearity at steady state from 100 ^{0}C at inside to 25 ^{0}C at outside surfaces respectively. The temperature is given as; T= -3000 r + 250 ^{0}C at any radius r (r is measured in meter), Find the expression of σ_r, σ_θ and σ_z under plane strain condition. Take E=200 GPa, ν = 0.3 and $\alpha = 12\times10^{-6}\ /^0C$ (8)

B) If a fluid of pressure 50 MPa is passed inside the cylinder besides the temperature gradient, find the resulting stress distribution. (6)

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QUESTION # (14 marks)

A) Defined the following; True stress and true strain – Strain hardening – Yield criterion (6)

B) A cube of metal having constant yield strength of Y = 300 MPa is subjected to a state of stress σ_1, $\sigma_2 = 0.4\ \sigma_1$ and $\sigma_3 = -0.6\ \sigma_1$. If the stresses are increased gradually with constant ratios, determine

i) σ_1 at yielding using both von-Mises and Tresca yield criteria. (5)

ii) Which criterion; Tresca or Mises is more conservative. (3)

With best wishes

This exam measures the following ILOs															
Question number	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5
skills	A1	A3	A3	A1	A2	B2	B2	B4	B2	B4	C1	C1	C3	C3	C3
	Knowledge & Understanding					Intellectual					Professional				

***USEFUL INFORMATIONS*:**

$$\nabla^2\nabla^2\varphi = -\alpha E\nabla^2 T \qquad \sigma_x = \frac{\partial^2\varphi}{\partial y^2} \qquad \sigma_y = \frac{\partial^2\varphi}{\partial x^2}$$

$$\begin{bmatrix}\sigma_r \\ \sigma_\theta\end{bmatrix} = \frac{P_i}{\lambda^2 - 1}\left(1 \mp \frac{r_o^2}{r^2}\right), \quad \sigma_r = \frac{A}{r^2} + 2C - \frac{\alpha E}{r^2}\int Trdr, \quad \sigma_\theta = -\frac{A}{r^2} + 2C - \alpha E\left[T - \frac{1}{r^2}\int Trdr\right]$$

$$Y = \sigma_1 - \sigma_3, \qquad Y = \frac{1}{\sqrt{2}}\left((\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2\right)^{1/2}$$

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