



Answer all the following questions

QUESTION NO. 1

(20 Mark)

a) For the indicated stress distribution, determine what the conditions of equilibrium are satisfied in the absence of body forces. If the stress distribution does not satisfy the equilibrium conditions, Calculate the body forces per unit volume required to achieve equilibrium.

$$\begin{aligned} \sigma_x &= x \sin \frac{2\pi y}{L} & \sigma_y &= -y \sin \frac{2\pi x}{L} & \sigma_z &= 0 \\ \tau_{xy} &= \frac{L}{2\pi} \cos \frac{2\pi y}{L} + z & \tau_{yz} &= 0 & \tau_{zx} &= 0 \end{aligned}$$

b) 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.

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

$$\begin{aligned} \sigma_x &= 50 \text{ MPa} & \sigma_y &= 0 & \sigma_z &= 0 \\ \tau_{xy} &= 30 \text{ MPa} & \tau_{yz} &= 20 \text{ MPa} & \tau_{zx} &= -30 \text{ MPa} \end{aligned}$$

- (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 principle stress deviations and octahedral shear stress.

QUESTION NO. 2

(20 Mark)

a) Derive the relation: $\epsilon_v = \epsilon_x + \epsilon_y + \epsilon_z$

b) A 400 x 600 mm rectangular plate OABC is deformed into shape O'A'B'C' shown in Fig. 1, determine the strain components in matrix form.

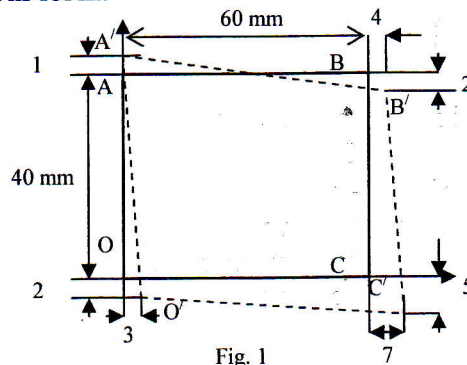


Fig. 1

QUESTION NO. 3

(20 Mark)

a) Deduce the total strain energy density?

b) An element is subjected to a stress σ_z . the element is free in the x-direction and restricted in the y- direction. Show that the apparent young's modulus is given by

$$E' = \frac{1}{1 - \nu^2}$$

c) A flat steel plate 200x400x20 mm is compressed by forces in the plane of the plate so that the new lateral dimensions are 199.98 x 399.975 mm. Assuming that the plate is free in the thickness direction and that it is uniformly stresses (Take E=200GPa and $\nu=0.3$), determine:

- The change in thickness.
- If the plate thickness was constrained to remain constant, what stress would be applied in the thickness direction?
- Calculate the strain energy stored in the plate.

QUESTION NO. 4**(20 Mark)**

A rectangular strip is bounded by $x \pm a$, $y \pm b$. For what value of k will the expression $\Phi = ax^2 + by^3 + kx^2y^2$ be a stress function (neglected body forces)? With the proper expression for Φ , determine the displacements along the boundary of the strip.

QUESTION NO. 5**(20 Mark)**

a) Show with neat sketch the stresses distribution of thick walled cylinders in the following causes:

-Internal pressure - External pressure - Shrink fits

b) A steel tank having diameter of 1200 mm is subjected to an internal pressure of 10 MPa. The tensile and compressive yield stresses of the material are 400 MPa. Assuming a factor of safety 2, determine the wall thickness using maximum shear criterion.

***** GOOD LUCK*****

Question number	Q1	Q2	Q3	Q5	Q2	Q3	Q4	Q5	Q2	Q3	Q4	Q5
Skills	a-1- 1	a-2- 2	a-3- 1	a-4- 1	b-1- 1	b-2- 4	b-4- 1	b-4- 3	c-1- 1	c-2- 2	c-4- 3	c-4- 4
	Knowledge & understanding skills				Intellectual skills				Professional Skills			

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