Answer all the following questions

QUESTION NO. 1 (30 Mark)

A) Defined the following;

- Mohr's Circle - Plan stress - Octahedral Planes

B) The stress components in a body are given by:

$$\sigma_x = x^2 + y^2 \qquad \sigma_y = y^2 + z^2 \qquad \sigma_z = z^2 + x^2$$
$$\tau_{xy} = x\,y \qquad \tau_{yz} = y\,z \qquad \tau_{zx} = z\,x$$

Determine what the conditions of equilibrium are satisfied in the absence of body forces. If the stress component does not satisfy the equilibrium conditions, calculate the body forces required to achieve equilibrium.

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

$$\sigma_x = 50\ \text{MPa} \qquad \sigma_y = 0 \qquad \sigma_z = 0$$
$$\tau_{xy} = 30\ \text{MPa} \qquad \tau_{yz} = 20\ \text{MPa} \qquad \tau_{zx} = -30\ \text{MPa}$$

(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 principle stress deviations and octahedral shear stress.

QUESTION NO. 2 (25 Mark)

A) The displacement components in a strained body are:

$$u = 0.01\,x + 0.002\,y^2\ \text{mm} \quad , \quad v = 0.02\,x^2 + 0.02\,z^2\ \text{mm} , \quad w = 0.001\,x + 0.005\ \text{mm}.$$

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

ii) Calculate the strain tensor in the matrix form at the point (2,1,2).

iii) What is the change in distance between two points which, before deformation, have coordinates (3,2,0)mm and (−1,14,5)mm ?

B) The square plate 1m length, Fig 1 is loaded so that the plate is in a state of plane strain. Determine the displacement for the plate given the deformation shown and also strain components for x/ and y/ coordinates axes.
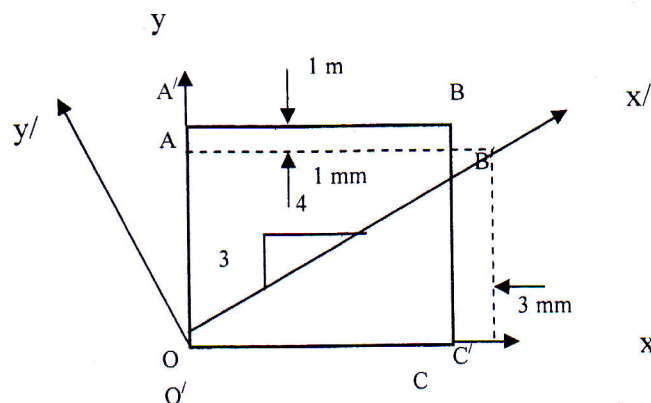

Fig. 1

QUESTION NO. 3 (20 Mark)

The parallepiped in the following Fig.1 is deformed in to the shape indicated by the dashed straight lines. The displacements are give u=c₁xyz, v=c₂xyz, w=c₃xyz, find i) the state of strain at point E in the matrix form when E′ has the coordinates (1.503, 1.001, 1.997), ii) The Dilation at point E.
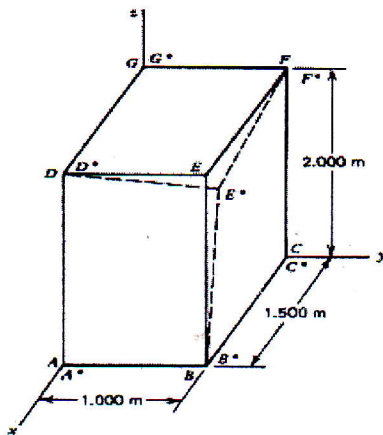
Fig.1

QUESTION NO. 4
<div align="right">(25 Mark)</div>

A) A brass sheet 20 mm x 30 mm x 2 mm is clampled 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 ˙ the sheet. If the element is free in the z–direction, determine the change in sheet thickness. For brass, E=120 GPa, v=0.33, and $\alpha = 16 \times 10^{-6}$ C^{-1}.

B) 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 v=0.3), determine:
- The change in thickness.
 - If the plate thickness were constrained to remain constant, what stress would be applied in the thickness direction?

<div align="center">******** GOOD LUCK**********</div>

Question number	Q1	Q2	Q3	Q4	Q2	Q3	Q4	Q4	Q2	Q3	Q4	Q4
Skills	a-1-1	a-3-1	a-4-1	a-15-1	b-1-1	b-2-1	b-7-1	b-11-1	c-1-1	c-2-1	c-4-1	c-6-1
	Knowledge& understanding skills				Intellectual skills				Professional Skills			

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