Menofiya University Faculty of Engineering Tim Allowed: 3 hours Second Semester Examination, 2014-2015 Date of Exam: 11/ 6 /2015		**Diploma (500 Level)** **Subject : Stress Analysis** **Code: PRE 508** **Total Mark: 100 Marks** **Production Eng. Dep.**

Answer all the following questions

QUESTION NO. 1

(25 Mark)

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

$\sigma_x = x^2 + y^2$ $\quad \sigma_y = y^2 + z^2$ $\quad \sigma_z = z^2 + x^2$

$\tau_{xy} = x\,y$ $\quad \tau_{yz} = y\,z$ $\quad \tau_{zx} = z\,x$

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.

b) At a point in body, only the stresses $\tau_{xy} = 15$ MPa , $\tau_{yz} = -2$ MPa , $\tau_{xz} = 37$ MPa are known while σ_x , σ_y and σ_z being unknown. If the resultant stress vector at the same point is 140 MPa and acts in a direction making angle 43° , 75° while the x, y axes respectively. Find:

(i) The normal and shear stresses on an oblique plane whose normal makes angle 67° , 30° with x , y axes respectively.

(ii) The stress components σ_x , σ_y and σ_z .

c) The stress at a point with respect to an x, y, z coordinate system, is described by:

$\sigma_x = x^2 + y$, $\sigma_y = x + 6y + z$ and $\sigma_z = y^2 - 5$ & $\tau_{xy} = \tau_{yz} = \tau_{xz} = 0$

(i) Write down the stress tensor at point (3,1,5).

(ii) Determine the traction vector in magnitude and direction on the plane described by the direction cosines $l = 1/\sqrt{2}$, m = $1/\sqrt{2}$ and n is negative.

(iii) Determine the magnitude of normal and shear stress component on this plane.

(iv) Determine the principle stresses and direction cosines of the greatest one.

QUESTION NO. 2

(25 Mark)

a) The displacement components in a strained body are:

$u = 0.01\,x + 0.002\,y^2$ mm , $v = 0.02\,x^2 + 0.02\,z^2$ mm , $w = 0.001\,x + 0.005$ 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) Three strain gauges are symmetrically arranged at 120° on the free surface of a machine. The gauge readings gave strains: $\varepsilon_{\theta 1} = -0.001$, $\varepsilon_{\theta 2} = 0.02$, $\varepsilon_{\theta 3} = 0.003$. The strain normal to the surface is $\varepsilon_z = -0.00156$. Determine the magnitude of principle and volumetric strains

QUESTION NO. 3

(25 Mark)

a) Drive the volumetric infinitesimal strain is the sum of the three normal strains.

b) A 40 x 60 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 and its directions

iii) The mean strain and strain deviations.

(Dim in mm)

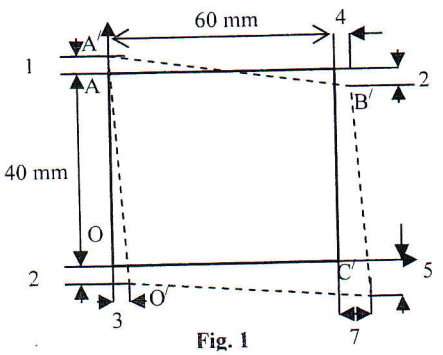

Fig. 1

QUESTION NO. 4

(25 Mark)

a) Drive the total strain energy density for an elastic isotropic solid.

b) 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 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 $\alpha=16\times10^{-6}\ C^{-1}$.

c) A square plate with 800 mm sides parallel to x and y axes has a uniform thickness h = 10 mm and is made of isotropic steel (E = 200 GPa and ν = 0.29). The plate is subjected to a uniform state of stress. If $\sigma_z = \tau_{zx} = \tau_{zy} = 0$ (plane stress), $\sigma_x = \sigma_1 = 500$ MPa and $\epsilon_y = 0$ for the plate. Determine $\sigma_y = \sigma_2$ and the final dimensions of the plate assuming linearly elastic conditions also, find the stored energy in the plate.

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

Question number	Q1	Q2	Q3	Q4	Q2	Q3	Q4	Q4	Q2	Q3	Q4	Q4
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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