



SE-7473

**B. E. IV (Sem - VII) (Mech.) Examination**  
**May / June - 2011**  
**Mechanical Design Analysis**  
**Eletive - 1 (D)**

Time : Hours]

[Total Marks : 100

**Instructions :**

(1)

नीचे दशांशवैव निशानीवाणी विगतो उत्तरवही पर अवश्य लक्षणी. Fillup strictly the details of signs on your answer book.	Seat No. :
Name of the Examination :	<input type="text"/>
<input type="text" value="B. E. 4 (Sem - 7) (Mech.)"/>	<input type="text"/>
Name of the Subject :	<input type="text"/>
<input type="text" value="Mechanical Design Analysis - Eletive - 1 (D)"/>	<input type="text"/>
Subject Code No. : <input type="text" value="7"/> <input type="text" value="4"/> <input type="text" value="7"/> <input type="text" value="3"/>	Section No. (1, 2,.....): <input type="text" value="1"/> <input type="text" value="2"/>
Student's Signature	

- (2) Attempt all questions.
- (3) Figures to the right indicate marks.
- (4) Assume suitable data if necessary.
- (5) Use of calculator is permissible.

**SECTION - I**

- 1 (a) Answer the following (any five) : 10
- (1) Define stress space and strain space.
  - (2) Explain in brief maximum shear stress theory.
  - (3) Write down strain displacement relationship in Cartesian-coordinates.
  - (4) Explain in brief plain stream condition.
  - (5) Define stress tensor.
  - (6) Define deviatoric plane.
- (b) Derive Lamé's displacement equations of equilibrium. 10

2 Attempt any two :

14

- (a) For the given state of stress, determine the principal stresses and their directions

$$[\tau_{ij}] = \begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix}$$

- (b) With respect to the frame of reference  $oxyz$ , the following state of stress exists. Determine the principal stresses and check on the in variance of  $l_1, l_2, l_3$

$$[\tau_{ij}] = \begin{bmatrix} 1 & 2 & 1 \\ 2 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

- (c) The displacement field in micro units for a body is given by  $u = (x^2 + y)i + (3 + 2)j + (x^2 + 2y)k$ ; determine the principal strains at  $(3, 1, -2)$  and the direction of the minimum principal strain.

3 Attempt any two :

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- (a) Explain energy of distortion theory of failure.  
(b) A cubic element is subjected to following state of stress

$$\sigma_x = 100 \text{ MPa}, \sigma_y = -20 \text{ MPa}, \sigma_z = -40 \text{ MPa} \quad \tau_{xy} = \tau_{yz} = \tau_{zx} = 0$$

Assuming the material to be homogeneous and isotropic, determine the principal shear strains and octahedral shear strain, if  $E = 2 \times 10^5$  and  $\nu = 0.25$

- (c) Prove that the following are the Airy's stress functions and examine the stress distribution represented by them.

(a)  $\phi = Ax^3$  (b)  $\phi = A(x^4 - 3x^2y^2)$

## SECTION - II

- 4 (a) Attempt the following : 10
- (1) What do you mean by thermal stress ?
  - (2) Draw log-log true-stress-strain curve.
  - (3) What is stress relaxation ?
  - (4) Explain Soder-Borg criteria.
  - (5) State effect of irradiation on creep.
- (b) Derive the equation for time to rupture under constant stress. 10

- 5 (a) Derive the general solution of the governing differential equation of a plate : 10

$$w = \frac{qr^4}{\sigma 4D} + c_1 \frac{r^2}{4} (\log r - 1) + c_2 \frac{r^2}{4} + c_3 \log r + c_4$$

OR

- (a) Derive the following equation for a circular disk with a hole of radius 'a'. 10

$$(\sigma_r)_{\max} = \frac{3t\mu}{8} \rho w^2 (b-a)^2$$

$$(\sigma_\theta)_{\max} = \frac{3t\mu}{4} \rho w^2 \left( b^2 + \frac{1-\mu}{3+\mu} a^2 \right)$$

- (b) Write a short-note on cumulative damage in fatigue. 5

- 6 (a) For 3-element rectangular rosette the strain observations are made with gauges mounted on steel specimen are  $\epsilon_A = 400 \times 10^{-6}$ ,  $\epsilon_B = -200 \times 10^{-6}$ ,  $\epsilon_C = 200 \times 10^{-6}$ . Determine principal strains, principal stresses and their directions. 08

Take  $E = 2.1 \times 10^6 \text{ kg/cm}^2$   
 $\nu = 0.29$  for steel

- (b) Write a short note one "Strain gauge rosette". 07
- (c) Derive equation for Goodman criteria. 07