Hall Ticket No | | | | | | | | | | | Question Paper Code: BST001

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

M.Tech I Semester End Examinations (Regular) - February, 2017

Regulation: IARE–R16

Theory of Elasticity and Plasticity

(STRUCTURAL ENGINEERING)

Time: 3 Hours **Max Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. (a) The state of stress at a point with respect to the xyz system is

$$\begin{bmatrix} 3 & 2 & -2 \\ 2 & 0 & -1 \\ -2 & -1 & 2 \end{bmatrix} kN/m^2$$

Determine the stress tensor relative to the x'y'z' coordinate system obtained by a rotation through 30° about the z - axis. [7 M]

(b) The state of stress at a particular point relative to the xyz coordinate system is given by the stress matrix

$$\begin{bmatrix} 15 & 10 & -10 \\ 10 & 10 & 0 \\ -10 & 0 & 40 \end{bmatrix} MPa$$

Determine the normal stress and the magnitude and direction of the shear stress on a surface intersecting the point and parallel to the plane given by the equation 2x-y+3z = 9 [7 M]

2. (a) For the stress tensor given below, determine the principal stresses and the direction cosines associated with the normal to the surface of each principal stress. [7 M]

$$\begin{bmatrix} 3000 & 1000 & 1000 \\ 1000 & 0 & 2000 \\ 1000 & 2000 & 0 \end{bmatrix} N/m^2$$

(b) The state of stress components at a point are given by the following array;

$$\begin{bmatrix} 10 & 5 & 6 \\ 5 & 8 & 10 \\ 6 & 10 & 6 \end{bmatrix} MPa$$

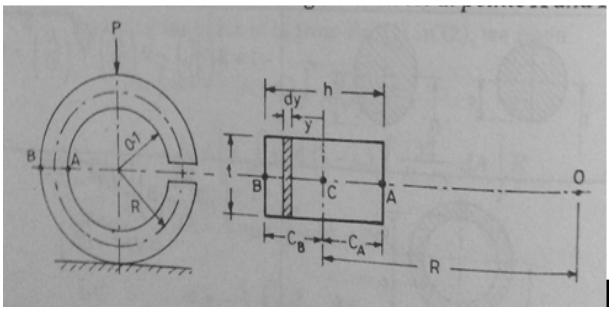
Calculate the principal stresses and principal planes. [7 M]

UNIT – II

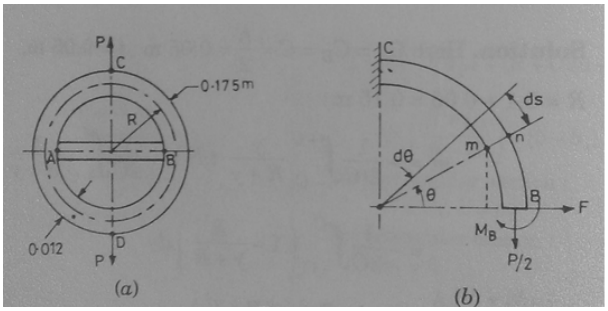
3. (a) Prove that the following are Airy's Stress functions and examine the stress distribution represented by them;
   i. $\varphi = Ax^2 + By^2$
   ii. $\varphi = Bx^3$
   iii. $\varphi = A(x^4 - 3x^2y^2)$

   (b) Show that the Airy's stress function $\phi = \left(xy^3 - \frac{3}{4}xyh^2\right)$ represents stress distribution in a cantilever beam loaded at the free end with load P. Find the value of A if $\tau_{xy} = 0$ at $y = \pm\frac{h}{2}$ where b and h are width and depth respectively of the cantilever. [7 M]

4. (a) A load P = 70 kN is applied to the circular steel frame shown in fig below. The rectangular cross section is 0.1 m wide and 0.05m thick. Determine the Tangential stress at points A and B. [7 M]



   (b) A Steel ring of 0.35 m mean diameter and of uniform rectangular section 0.06m wide and 0.012m thick is shown in fig below. A rigid bar is fitted across diameter AB, and a tensile force P applied to the ring as shown. Assuming an allowable stress of 140 MPa, determine the maximum tensile force that can be carried by the ring. [7 M]



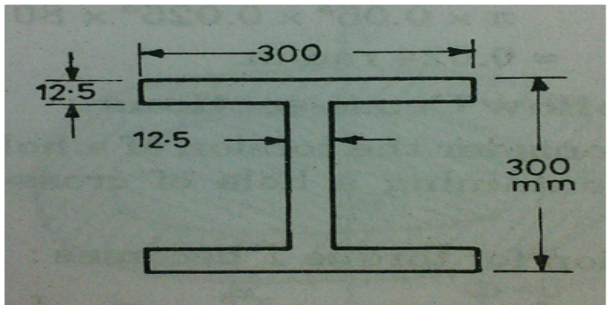
UNIT – III

5. (a) Derive the conditions of compatibility in three dimensional stress strain system. [7 M]
   (b) Explain Principle of superposition in three dimensional stress strain system. [7 M]

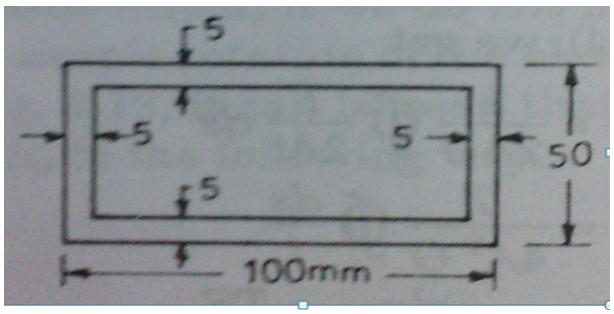
6. (a) Show that if the rotation is zero throughout the body then the displacement vector is the gradient of a scalar potential function. Give an example for each irrotational deformation. [8 M]
   (b) Explain reciprocal theorem for three dimensional stress strain system. [6 M]

UNIT – IV

7. (a) A Square shaft rotating at 250 rpm, transmits torque to a crane which is designed to lift maximum load of 150 kN at a speed of 10 m / min. If the efficiency of crane gearing is 65 %, estimate the size of the shaft for the maximum permissible shear stress of 35 MPa. Also calculate the angle of twist of the shaft for a length of 3m. Take G = 100 GPa. [7 M]
   (b) A 300 mm steel I-beam shown in fig below flanges and web 12.5 mm thick is subjected to a torque of 4 kN.M find the maximum shear stress and angle of twist per unit length G = 100 GPa. [7 M]



8. (a) An elliptical shaft of semi axes a = 0.05 m , b = 0.0025 m, and G = 80 GPa is subjected to a twisting moment of 1200π N.m. Determine the maximum shearing stress and the angle of twist per unit length. [7 M]
   (b) A hollow aluminium section is designed as shown in fig below for a maximum shear stress of 35 MPa. Find maximum permissible twisting moment for this section and the angle of twist under this moment per meter length G = 28 GPa. [7 M]



UNIT – V

9. (a) Explain the mechanism of plastic deformation. [7 M]
   (b) Explain the yield criteria and flow rules for perfectly plastic and strain hardening materials. [7 M]

10. (a) Explain St. Venant's Theory of plastic flow. [7 M]
    (b) Discuss the mathematical formulation of plastic potential. [7 M]