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

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

M.Tech I Semester End Examinations (Regular) - February, 2018

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 strain at a point within a material is given by: **[7M]**

$$\begin{bmatrix} 200 & 100 & 0 \\ 100 & 300 & 400 \\ 0 & 400 & 0 \end{bmatrix} 10^{-6}$$

For $E = 200GPa$, ascertain the components of stress tensor.

(b) For the following state of strain, determine the principle strains, **[7M]**

$$\begin{bmatrix} 2 & 3 & 2 \\ 3 & -1 & 5 \\ 2 & 5 & -4 \end{bmatrix} 10^{-6}$$

2. (a) The state of stress at a point is given by: $\sigma x = 120MPa$, $\sigma y = 140MPa$, $\sigma z = 120MPa$,$\tau xy = 45MPa$, $\tau yz = 65MPa$, $\tau zx = 25MPa$. Determine the three principal stresses and the directions associated with the three principal stresses. **[7M]**

(b) The state of stress at a point is given by: $\sigma x = 120MPa$, $\sigma y = -55MPa$, $\sigma z = -85MPa$,$\tau xy = -55MPa$, $\tau yz = 33MPa$, $\tau xz = -75MPa$. Determine the three principal stresses and the maximum shearing stress. **[7M]**

UNIT – II

3. (a) Prove that the following are Airy's Stress functions and examine the stress distribution represented by them.

[7M]

i. $\varphi = Ax^2 + By^2$
ii. $\varphi = Bx^3$

(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. **[7M]**

4. (a) A steel gun barrel is subject to an internal pressure of 70MPa.The internal diameter of the barrel is 75mm and external diameter of 225mm. A steel band 25mm thick and internal diameter 0.075mm smaller than the external diameter of the gun barrel is shrunk on the gun barrel. Calculate
   i. The shrinkage pressure on the gun barrel,
   ii. Maximum stress in the steel band, and
   iii. Minimum temperature to which the band must be heated to make the assembly.

   For steel E=200GPa, γ=0.3 and coeffient of thermal expansion $=10 \times 10^{-6}/^{\circ}C$. **[7M]**

   (b) Steel turbine rotor of 750mm outer diameter,150mm inner diameter and 50mm thickness, has 100 blades 150mm, each weighing 4N. it is shrink-fitted on a rigid shaft. Calculate the initial shrinkage allowance on the inner diameter of the rotor so that it just loosens on the shaft at 3000rev/min. Take E=200Gpa,v=0.3. The density of shaft and rotor is 7500kg/m^3. **[7M]**

UNIT – III

5. (a) Prove that the determination of principal stresses and principal directions reduces to solution of eigen value problem. **[7M]**

   (b) Explain Principle of superposition in three dimensional stress strain system. **[7M]**

6. (a) A prismatic bar of $2a * 2b$ cross section is bent by two equal and opposite couples. Determine the equations for the bent shape of prismatic bar **[7M]**

   (b) Explain reciprocal theorem in three dimensional stress strain system **[7M]**

UNIT – IV

7. (a) Prove that the shear flow for a thin walled tube subjected to torsion is constant. **[7M]**

   (b) A 30- cm I beam with flanges and web 1.25 cm thick, is subjected to a torque 4900 Nm as shown in Figure 1. Find the maximum shear stress and the angle of twist per unit length. **[7M]**

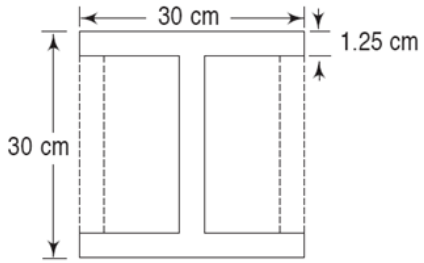

Figure 1

8. (a) Derive a general expression for torsion of thin tubes by membrane analogy. **[7M]**

   (b) A steel girder has the cross-section as shown in Figure 2. The wall thickness is uniformly 1.25 cm. The stress due to twisting should not exceed 350000 kPa.Neglect stress concentrations. Determine the following **[7M]**

   i. maximum allowable torque

   ii. Twist per metre length under that torque

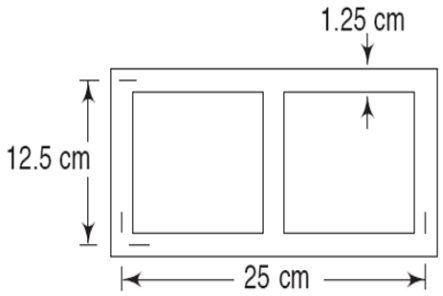

Figure 2

UNIT – V

9. (a) Write a short note on **[7M]**
   i. Tresca's yield criteria.
   ii. Von-mises yield criteria.
   (b) Explain the following theories of strength **[7M]**
   i. Maximum principal stress theory
   ii. Mohr's theory

10. (a) Differentiate between elastic and plastic analysis? **[7M]**
   (b) A bolt of diameter 32mm subjected to axial force 20kN . Find the maximum shear in the bolt according to the least three different theories of failure? Assume yield stress 250MPa and factor of safety 1.5. **[7M]**