Hall Ticket No | | | | | | | | | | | Question Paper Code: BSTB02

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER - I

M.Tech I Semester End Examinations, January- 2020

Regulations: R18

ADVANCED SOLID MECHANICS

(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) Explain the assumption and application of linear elasticity and obtain the compatibility expression for 2 dimensional problem in polar coordinates. **[7M]**

   b) Explain briefly the components of direct stress and shear stress with neat figure. **[7M]**

2. a) Derive the equilibrium equations in polar coordinates system and derive an expression for maximum shearing strain for a state of strain at a point on an element. **[7M]**

   b) Explain Hook’s law giving strain as a function of stress and also stresses in terms of strain in a plane stress case. **[7M]**

UNIT– II

3. a) Write short notes on Polynomial solution of two dimensional problems. What is Biharmonic equation? Solve for Biharmonic equation for the case of symmetrical GUIO stress distribution. **[7M]**

   b) Derive an equation for deflection curve with the use of fourier series. **[7M]**

4. a) Explain St. Venant’s principle and its applications and determine stress induced due bending of curved bar due to load at the end. **[7M]**

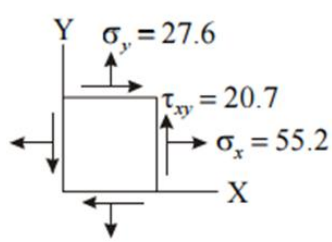
   b) The stress distribution is given by **[7M]**

$$\sigma_x = -kxy^2 + ax^3$$
$$\sigma_y = -1.5bxy^2$$
$$xy = -by^3 - c\,x^2y$$

Determine the constants a, b, c and k if the body forces are zero and k is an unknown force.

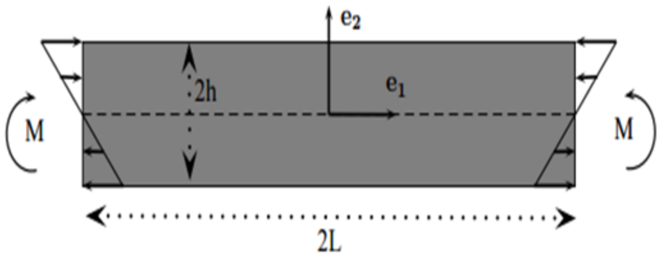
UNIT– III

5 a) At a point in the structural member, the stresses (in MPa) are represented as in Figure, Employ Mohr’s circle to determine: The magnitude and orientation of the principal stresses the magnitude and orientation of the maximum shearing stresses and associated normal stresses. In each case show the results on a properly oriented element.



5. b) Define principal stresses and principal directions. Show that the determination of principal stresses and principal directions reduces to the solution of an Eigen value problem. **[7M]**

6. a) Consider the stress function $\varphi = Ax_2^3$. Show that this stress function corresponds to a state of pure bending of a beam of height 2h and length 2L subject to a bending moment M as shown in the Figure **[7M]**



b) The Stress tensor at a point is given by the following array **[7M]**

$$\begin{pmatrix} 30 & 40 & 20 \\ 20 & 30 & 40 \\ 40 & 20 & 30 \end{pmatrix}$$

Calculate the deviator and spherical stress tensors.

UNIT– IV

7. a) Derive the torque equation of a prismatic bar subjected to thrust T, according to St.Venant's theory. **[7M]**

b) Derive the equation of stresses relating to torsion of elliptical cross- section bar and give the displacement equation relating to torsion of elliptical cross- section bar. **[7M]**

8. a) State the general solution of torsion of bars given by Saint- Venant Principle and derive the torsion for circular shafts. **[7M]**

b) Derive the equilibrium equation and boundary conditions of a bar subjected to a pure torsion as **[7M]**

$$\nabla^2\Psi = 0$$

$$\left(\frac{\partial\Psi}{\partial x} - y\right)l + \left(\frac{\partial\Psi}{\partial y} + x\right)m = 0$$

UNIT– V

9. a) Discuss the yield criteria and the flow rules for perfectly plastic and strain hardening materials. **[7M]**

b) A bolt of 25mm diameter is subjected to an axial force of 50kN. Determine the maximum shear force the bolt can sustain according to various theories of failure. Assume the yield stress of 300MPa and factor of safety = 2. **[7M]**

10. a) Dsicuss briefly on **[7M]**
(i) Tangent Modulus (ii) Plastic Modulus (iii) Assumptions of Plastic theory

b) Explain force/displacement curve for tension test with diagrams. **[7M]**

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COURSE OBJECTIVES:

The course should enable the students to:

I	Solve advanced solid mechanics problems using classical methods
II	Apply commercial software on select, applied solid mechanics problems.

COURSE OUTCOMES (COs):

CO 1	Understand the theory of elasticity including strain/displacement and Hooke's law relationships
CO 2	Analyse solid mechanics problems using classical methods and energy methods
CO 3	Solve for stresses and deflections of two-dimensional under unsymmetrical loading
CO 4	Obtain stresses and deflections of torsion of beams on elastic foundations
CO 5	Apply various failure criteria for general stress states at points

COURSE LEARNING OUTCOMES (CLOs):

BSTB02.01	Understand the Displacement, Strain and Stress Fields
BSTB02.02	Understand the Constitutive Relations, Cartesian Tensors
BSTB02.03	Solve the problems on Equations of Elasticity
BSTB02.04	Know the Elementary Concept of Strain
BSTB02.05	Understand the Strain at a Point
BSTB02.06	Know concept of Principal Strains and Principal Axes
BSTB02.07	Understand the concept of Compatibility Conditions
BSTB02.08	Understand the concept of Stress at a Point
BSTB02.09	Develop the Stress Components on an Arbitrary Plane
BSTB02.10	Understand the concepts on differential Equations of Equilibrium
BSTB02.11	Know the Hydrostatic and Deviatoric Components.
BSTB02.12	Understand the Equations of Equilibrium, Strain Displacement and Compatibility Relations
BSTB02.13	Understand the formulation of Stress- Strain relations
BSTB02.14	Concept of Strain Displacement
BSTB02.15	Understand the solutions for boundary value problems
BSTB02.16	Know the co-axiality of the Principal Directions
BSTB02.17	Understand the Plane Stress and Plane Strain Problems
BSTB02.18	Know the Two-Dimensional Problems in Polar Coordinates
BSTB02.19	Understand the Saint Venant's Method, Prandtl's Membrane Analogy
BSTB02.20	Formulation of Torsion of Rectangular Bar and thin plates
BSTB02.21	Understand the concept of Plastic Stress-Strain Relations
BSTB02.22	Solution of Principle of Normality and Plastic Potential, Isotropic Hardening

MAPPING OF SEMESTER END EXAMINATION - COURSE OUTCOMES

SEE Question No		Course Learning Outcomes		Course Outcomes	Blooms Taxonomy Level
1	a	BSTB02.02	Understand the Constitutive Relations, Cartesian Tensors	CO 1	Understand
	b	BSTB02.03	Solve the problems on Equations of Elasticity	CO 1	Analyze
2	a	BSTB02.02	Understand the Constitutive Relations, Cartesian Tensors	CO 1	Understand
	b	BSTB02.04	Know the Elementary Concept of Strain	CO 1	Analyze
3	a	BSTB02.05	Understand the Strain at a Point	CO 2	Understand
	b	BSTB02.06	Know concept of Principal Strains and Principal Axes	CO 2	Analyze
4	a	BSTB02.07	Understand the concept of Compatibility Conditions	CO 2	Understand
	b	BSTB02.05	Understand the Strain at a Point	CO 2	Analyze
5	a	BSTB02.12	Understand the Equations of Equilibrium, Strain Displacement and Compatibility Relations	CO 3	Understand
	b	BSTB02.13	Understand the formulation of Stress- Strain relations	CO 3	Analyze
6	a	BSTB02.17	Understand the Plane Stress and Plane Strain Problems	CO 3	Understand
	b	BSTB02.18	Know the Two-Dimensional Problems in Polar Coordinates	CO 3	Analyze
7	a	BSTB02.19	Understand the Saint Venant's Method, Prandtl's Membrane Analogy	CO 4	Understand
	b	BSTB02.20	Formulation of Torsion of Rectangular Bar and thin plates	CO 4	Remember
8	a	BSTB02.19	Understand the Saint Venant's Method, Prandtl's Membrane Analogy	CO 4	Understand
	b	BSTB02.20	Formulation of Torsion of Rectangular Bar and thin plates	CO 4	Remember
9	a	BSTB02.21	Understand the concept of Plastic Stress-Strain Relations	CO 5	Understand
	b	BSTB02.22	Solution of Principle of Normality and Plastic Potential, Isotropic Hardening	CO 5	Analyze
10	a	BSTB02.21	Understand the concept of Plastic Stress-Strain Relations	CO 5	Understand
	b	BSTB02.22	Solution of Principle of Normality and Plastic Potential, Isotropic Hardening	CO 5	Analyze

Signature of Course Coordinator **HOD, CE**