

M.E. DEGREE EXAMINATIONS: DECEMBER 2008

First Semester

STRUCTURAL ENGINEERING

P07SE101 Theory of Elasticity and Plasticity

Time: Three Hours

Maximum Marks: 100

Answer ALL Questions:-

PART A (20 x 1 = 20 Marks)

1. Pick the incorrect statement based on the assumptions of Linear Elasticity, The elastic constants are
 - a. independent of the magnitude of stress and strain
 - b. independent of the location in the body
 - c. independent of orientation of the co-ordinate axis
 - d. dependent on the orientation of the co-ordinate axis
2. Gravitational force is
 - a. Surface force
 - b. Body force
 - c. Octahedral stress
 - d. Shear stress
3. Stress invariants are
 - a. variable
 - b. exchangeable
 - c. constant
 - d. continuous functions.
4. Strain rosettes always measure
 - a. stress
 - b. linear strain
 - c. tangential strain
 - d. principal strain
5. The equations obtained by imposing certain restrictions on the strain components to ensure single valued, continuous solution for the displacement components are called
 - a. equilibrium equations
 - b. compatibility equations
 - c. transformation equations
 - d. constitutive equations
6. For two systems of forces statically equivalent, the stress distribution is
 - a. not altered near the regions of load applications
 - b. altered near the regions of load applications
 - c. altered at locations distant from load application
 - d. altered at every point
7. A tunnel is an example of
 - a. plane stress
 - b. complimentary stress
 - c. plane strain
 - d. principal strain
8. Airy's stress function
 - a. does not involve any elastic constants
 - b. does not obey equilibrium condition
 - c. does not obey compatibility condition
 - d. does not obey hookes law

9. For solids of revolution subjected to axially symmetric loading, the stress components are
- dependent on angular coordinate
 - independent of angular coordinate
 - all zero
 - independent of Cartesian coordinate
10. At the edge of a hole in a stressed plate,
- there is no stress
 - there is high stress concentration
 - stresses are the same as in other parts of the plate
 - stresses are less than in other parts of the plate
11. The value of σ_θ in a thick cylinder submitted to uniform pressure on the inner and outer surface can
- never be reduced below internal pressure
 - be reduced below internal pressure
 - zero
 - be compressive.
12. In the case of pure bending, the discrepancy between the elementary solution and the exact solution comes from the fact
- σ_θ is neglected in the elementary solution
 - both σ_r and σ_θ are neglected in the elementary solution
 - σ_r is neglected in the elementary solution
 - longitudinal fibres are not subjected to any stress
13. Distorsion of elements on the surface of a rectangular bar subjected to torsion are
- zero at the middle of the sides
 - lowest at the middle of the sides
 - greatest at farthest point on the surface in the sides
 - greatest at the middle of the sides
14. In membrane theory, the contour lines of the membrane represent
- the lines of shearing stress for the cross-section of the twisted bar.
 - The torque for the cross-section of the twisted bar.
 - Twist of the bar
 - Shear strain energy of the twisted bar
15. In the torsion of rolled profile sections, at the reentrant corners
- considerable stress concentration occurs
 - stress is zero
 - only axial stress occurs
 - stresses are the same as in the cross-section

16. A beam bends without rotating when a transverse force is applied passing through
- center of section
 - shear center
 - the extreme point in the cross-section
 - midpoint of the side
17. The ratio of plastic bending moment to the elastic bending moment is called
- Load factor
 - section modulus
 - shape factor
 - elastic modulus
18. The infinitely large increase in curvature of a beam on application of an infinitely small increase in applied bending moment indicates
- final collapse
 - plastic hinge
 - elastic moment
 - load factor
19. When the state of stress is partially plastic, the neutral axis and the geometric axis
- coincide
 - do not coincide
 - coincide with the side of the beam
 - do not exist.
20. The process of plastic flow is
- irreversible
 - reversible
 - elastic
 - non traceable

PART B (5 x 16 = 80 Marks)

- 21.a)i) Derive the equations of equilibrium and compatibility conditions for 3D problems in Cartesian coordinates. (10)
- ii) A body is subjected to three dimensional forces and the state of stress at a point in it is represented as follows. Determine the resultant stress on the octahedral plane. (6)

$$\begin{bmatrix} 200 & 200 & 200 \\ 200 & -100 & 200 \\ 200 & 200 & -100 \end{bmatrix} \text{ Mpa.}$$

(OR)

- 21.b)i) The components of strain at a point in a body are as follows:

$$\epsilon_x = 0.1; \epsilon_y = -0.05; \epsilon_z = 0.05; \gamma_{xy} = 0.3; \gamma_{yz} = 0.1; \gamma_{zx} = -0.08.$$

Determine the principal strains. (6)

- ii) The components of strain at a point in a body are as follows:

$$\epsilon_x = c_1 z(x^2 + y^2); \epsilon_y = x^2 z; \gamma_{xy} = 2 c_2 x y z \text{ where } c_1 \text{ and } c_2 \text{ are constants.}$$

Check whether the strain field is compatible one? (6)

22.a.i) Investigate what problem of plane stress is satisfied by the stress function

$$\phi = \frac{3F}{4h}(xy - \frac{xy^3}{3h^2}) + \frac{P}{2}y^2$$

applied to the region included in $y=0$, $y=h$, $x=0$ on the side x positive. (10)

ii) Define plane stress and plane strain. Give practical examples. (6)

(OR)

22.b.i) A rectangular beam 80mm wide and 00 mm thick is of 600 mm in length. It carries a uniformly distributed load of intensity 10 N/mm throughout its length. Plot the variation of stresses in the beam at mid-span. Compare the results with results from elementary strength of materials. (10)

ii) Outline the computer algorithm for solving a 2D problem for bending of a cantilever of narrow rectangular cross-section under the action of couples. (6)

23.a.i) Derive the expression for radial and tangential stress in a thick cylinder subjected to internal and external fluid pressure. (10)

ii) Explain axisymmetric problems with examples. (6)

(OR)

23.b.i) Derive expressions for stress components in a plate subjected to a uniform tension in the x direction with a small hole in the middle of the plate. (10)

ii) Discuss the state of stresses in a circular disc subjected to diametrically opposite concentrated loads. (6)

24.a.i) Derive the expressions for stresses in a prismatic bar subjected to pure torsion. (10)

ii) Compare the torsion of a closed tubular section and the torsion of a tube of the same radius and thickness but with a longitudinal slit and find the ratio between their torsional rigidities. (6)

(OR)

24.b.i) A two cell tube as shown in the **figure1** is subjected to a torque of 10 kNm. Determine the shear stress in each part and angle of twist per metre length. Modulus of rigidity of the material as 83 kN/sq.mm. (10)

ii) Explain the application of Prandtl's membrane analogy for torsion problems bringing out the analogous quantities. (6)

25.a)i) Explain any two yield criteria used in plastic theory. Obtain an expression for one of these and construct the yield surface using a principal stress coordinate space frame. (10)

ii) Write a note on plastic potential and its significance. (6)

(OR)

25.b.i) What is meant by plastic analysis? Explain the various empirical stress-strain models and discuss their applications to different materials. (10)

ii) Describe the flow rule and strain hardening. (6)

Figure 1 for Qn. No. 24.b.i.


