KUMARAGURU college of technology
character is life

Register Number:……..

M.E DEGREE EXAMINATIONS: NOV/DEC 2023

(Regulation 2018)

First Semester

STRUCTURAL ENGINEERING

P18SET1001: Advanced Solid Mechanics

COURSE OUTCOMES

CO1: Formulate equilibrium and compatibility equations for 3D problems.

CO2: Formulation of boundary value problems in linearized elasticity and solution of 2D problems using Airy's stress functions.

CO3: Solution to boundary value problems corresponding to end torsion of prismatic beams .

CO4: Analyse using plastic theories .

CO5: Analyse using fracture mechanics .

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Shear strain energy theory for the failure of a material at elastic limit, is due to CO4 [K_2]

   a) St. Venant's b) Von Mises

   c) Guest or Trescas d) Haigh

2. Pick the Wrong statement out. CO2 [K_2]

   1) The slope of the curvature is equal to the flexural rotation

   2) The slope of the bending moment diagram is equal the shear stress

   3) The slope of shear force diagram is equal to the load intensity

   4) The second derivative of the deflection is equal to the curvature

   a) 1 b) 1,3,4

   c) 2,3,1 d) 1,2

3. Consider the following statements. CO2 [K_2]

   Assertion(A): Two dimensional problems may be either formulated as plane stress or plane strain problems.

   Reason(R): The solutions of these problems may be obtained by Airy's stress or complex potentials methods. Now Select your answer according to the coding scheme given below

   a) Both (A) and (R) are true and (R) is the the correct explanation of (A)

   b) Both (A) and (R) are true and (R) is not the correct explanation of (A)

c) (A) is True, but (R) is false
d) Both (A) and (R) are false

4. The strain energy will be higher in which shaft under the same torque CO3 [K_2]
   a) Solid shaft
   b) Hollow shaft
   c) Same in Solid as well as hollow shaft
   d) Circular shaft

5. The components of strain tensor at a point in the plane strain case can be obtained by measuring longitudinal strain in following directions. CO1 [K_1]
   a) Along any two arbitrary directions
   b) Along any three arbitrary directions
   c) Along two mutually orthogonal directions
   d) Along any arbitrary direction

6. A power transmitting ductile material shaft under P, T and M will fail under CO3 [K_2]
   a) Tensile considerations only
   b) Shear considerations only
   c) Compressive considerations only
   d) Bending stress considerations only

7. Consider the following statements and select your answer according to the coding scheme given below. CO1 [K_2]

   Assertion (A): A beam is said to be of uniform strength if bending stress is same at every section along its longitudinal axis.

   Reason(R): In a uniform beam Shear stress is same throughout the beam.

   a) Both (A) and (R) are true and (R) is the the correct explanation of (A)
   b) Both (A) and (R) are true and (R) is not the correct explanation of (A)
   c) (A) is True, but (R) is false
   d) Both (A) and (R) are false

8. Fracture toughness, K_{IC}, decreases with CO5 [K_1]
   a) increasing strain rate
   b) increasing temperature
   c) increase in yield strength
   d) increase in grain size

9. In the theory of plastic bending of beams, the ratio of plastic moment to yield moment is called CO4 [K_2]
   a) Shape factor
   b) Modulus of resilience
   c) Plastic section modulus
   d) Rigidity modulus

10. If a material is subjected to two incremental true strains namely ε_1 and ε_2, then the total true strain is CO5 [K_1]
   a) $\varepsilon_2 \times \varepsilon_2$
   b) $\varepsilon_1 - \varepsilon_2$
   c) $\varepsilon_1 + \varepsilon_2$
   d) $\varepsilon_1 / \varepsilon_2$

PART B (10 x 2 = 20 Marks)

11.	Outline the applications of linear elasticity?	CO1	[K_2]
12.	Write the equilibrium equations in 3D Cartesian coordinates	CO1	[K_2]
13.	Write down polynomial of the second degree.	CO2	[K_2]
14.	Express the stress components in terms of an Airys Stress function	CO2	[K_2]
15.	Write the assumptions made in theory of simple torsion	CO3	[K_2]
16.	Explain Sand heap analogy	CO3	[K_2]
17.	Summarize Von-Mise's criterion theory	CO4	[K_2]
18.	Infer Plastic flow shortly	CO4	[K_2]
19.	Define the terms stress intensity factor and fracture toughness	CO5	[K_2]
20.	Infer Linear elastic fracture mechanics	CO5	[K_2]

PART C (6 x 5 = 30 Marks)

21.	Develop the equations of equilibrium for 3D Problems in Cartesian coordinates	CO1	[K_3]
22.	Derive biharmonic equation for plane stress and plane strain problems in Cartesian coordinates system	CO2	[K_3]
23.	Develop the expression for radial and tangential stresses in a thick cylinder subjected to internal and external uniform pressure.	CO2	[K_3]
24.	Differentiate Von mises yield criterion and Tresca yield criterion	CO4	[K_2]
25.	Explain membrane analogy and Prandtl's theory on torsion	CO3	[K_2]
26.	Determine the shear stress components for the Airy's Stress function.	CO2	[K_3]

$$\phi = -\frac{P}{d^3} xy^2 (3d - 2y)$$

Answer any FOUR Questions
PART D (4 x 10 = 40 Marks)

27.	Develop the Compatibility conditions for 3-D Cartesian system.	CO1	[K_3]
28.	Discuss the Kirsch effect of circular hole on stress distribution in a thin rectangular plate subjected to uniaxial tension	CO2	[K_3]

29.	Construct the expression for the angle of twist and shear stress at any point and hence maximum shear stress in a bar of elliptical cross section due to a torque T. Use St. Venant's warping function approach	CO3	[K_3]
30.	Assuming proper stress functions and derive expressions for stresses in a Cantilever beam of narrow rectangular section with moment at the free end	CO2	[K_3]
31.	Explain the various modes of failure criteria and failure pattern in fracture mechanics	CO5	[K_2]

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