

Bachelor of Engineering (Civil Engineering), Fourth Year Second Semester Examination, 2024

THEORY OF STRUCTURES – IV

Full Marks – 100

Time: 3 Hrs.

Answer Question 1 AND ANY FOUR Questions from the rest.

1. Answer All Questions -

8 x 2.5 = 20

- (A) Explain the term “small deflection” in connection to the assumptions of the plate theory.
- (B) How do you differentiate between a “Thin Plate” and a “Thick Plate”? What will you disregard if you analyze a Thick Plate with the theory of a Thin Plate?
- (C) What is the “Flexural Rigidity” (D , Plate Constant) of a Plate? On which factors does it depend? Explain the significance of D to measure the capability of a plate to resist bending moment.
- (D) Which plate theory you will use to find the stress components if the plate is subjected to only a tractive force at the top surface of the plate? Justify your answer.
- (E) What possible measures do you adopt to increase the buckling resistance of a rectangular plate, supported at all four edges, and subjected to a uniform compressive load along one axis?
- (F) State some common examples of Plate Buckling in the field of Structural Engineering.
- (G) Define Hook’s Law. What are the assumptions of the Theory of Elasticity and Hook’s law?
- (H) What are the Plane Stress and Plane Strain problems? Explain with proper examples.
2. A large plate element of length “ a ”, width “ b ”, and thickness “ h ”, simply supported and discontinuous over all the edges, is subjected to a load intensity “ q ” normal to its surface. Take an infinitesimal small Plate Element of size ($dx \times dy \times h$) from that plate, draw the free-body diagram of that small element, and establish the equilibrium equations for the determination of the internal force components. (20)
3. Draw the free-body diagrams of the forces acting on a cylindrical shell having radius “ R ” and thickness “ h ”. Establish the equilibrium equations for the determination of the internal forces using the Membrane Theory. (20)

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4. (A) What are the factors that affect the stability and ultimate strength of a plate? (8)
- (B) A rectangular Steel Plate of size 7.5 m x 2.5 m. x 8 mm., which is simply supported at all four edges, is subjected to a compressive load along the direction of 7.5 m. Calculate the Critical Buckling Load. For Steel, consider the value of Modulus of Elasticity = 210000 MPa and $\mu = 0.3$. Approximately β can be taken as 4.0. (12)
5. A Spherical Dome having radius R is subjected to a vertical load w per unit surface area of the shell. Establish the expressions of the Meridional Stress (N_θ) and Hoop Stress (N_ϕ) from the equilibrium equations. (20)
6. (A) Prove that for two perpendicular sides of a cubic element, the components of shearing stresses perpendicular to the line of intersection of these sides, are equal. (8)
- (B) Establish the relation $G = E/2(1+\nu)$. The symbols have their usual meaning. (12)
7. (A) Define Von-Mises Stress and Tresca Stress.
Describe what they measure and discuss their limitations. (10)
- (B) A material has a Yield Strength of 600 MPa.
Compute the Factor of Safety against failure using Von-Mises Stress Theory for stress values of $\sigma_1 = 420$ MPa, $\sigma_2 = -180$ MPa and $\sigma_3 = 0$ MPa. (10)
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