Ref. No.: Ex/CE/5/T/407/2023

Bachelor of Engineering (Civil Engineering), Fourth Year Second Semester Examination, 2023

THEORY OF STRUCTURES – IV

Full Marks – 100 **Time: 3 Hrs.**

Answer Q-1 and ANY FOUR Questions from the rest.

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1. Answer All Questions - **10x2=20**

(A) Two thin square plates, each simply supported at all their four edges, (1) one of size (a x a) subjected to a transverse load $2q_0$ and (b) other of size (2a x 2a) subjected to a transverse load of q_0. In which case the Bending Moment will be higher and at which location? Justify your answer.

(B) Explain the term "small deflection" in connection to the assumptions of the plate theory.

(C) How do you differentiate between a "Thin Plate" and a "Thick Plate"? What will you disregard if you analyse a Thick Plate with the theory of a Thin Plate?

(D) What is the "Flexural Rigidity" (D, Plate Constant) of a Plate? On which factors does it depend?

(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.

(I) What are the major stress components of a Cylindrical Shell?

(J) To cover a large arena, which structure type will you prefer – Plate or Shell? Justify your answer.

2. A small Plate Element of size (dx x dy x h) is subjected to a load intensity q normal to its surface. 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 element and establish the equilibrium equations for the determination of the internal forces using Membrane Theory. **(20)**

4. **(A)** Discuss the effects of plate buckling on the stability and ultimate strength of the plates. **(8)**

   (B) A rectangular Steel Plate of size 6.0 m. x 1.5 m. x 0.02 m, simply supported at all four edges, subjected to a compressive load along the direction of 6 m. Calculate the Critical Buckling Stress of the Plate. For Steel, Modulus of Elasticity = 210000 MPa and $\mu = 0.3$. Approximately take β as 4.0. **(12)**

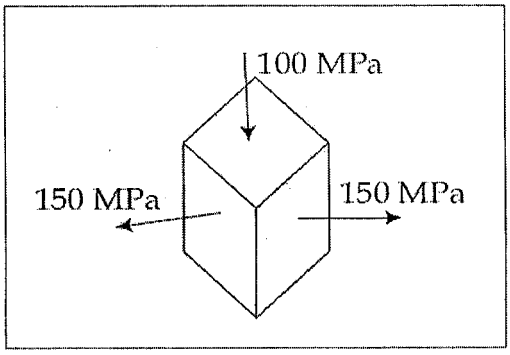
5. A Spherical Dome having radius R is subjected to a vertical load w per unit surface area of the shell. Establish the expressions of the Meridional Stress (N_ϕ) and Hoop Stress (N_Θ) from the equilibrium equations. **(20)**

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. Describe what it measures and its limitations. **(10)**

   (B) A Stressed Element as loaded shown in the figure below – **(10)**



Determine the Von-Mises Stress.
The material has a Yield Strength of 600 MPa.
Calculate the Factor of Safety for the Von-Mises Failure criteria.