Ref. No.: Ex/CE/5/T/407/2025

**Bachelor of Engineering (Civil Engineering), Fourth Year Second Semester Examination, 2025**

**THEORY OF STRUCTURES – IV**

**Full Marks – 100** **Time: 3 Hrs.**

**Answer Question 1 AND ANY FOUR Questions from the rest.**

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**1. Answer All Questions -** **10 x 2 = 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 analyse a Thick Plate with the theory of a Thin Plate?

**(C)** 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.

**(D)** 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.

**(E)** 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.

**(F)** 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?

**(G)** State some common examples of Plate Buckling in the field of Structural Engineering.

**(H)** Define Hook's Law. What are the assumptions of the Theory of Elasticity and Hook's law?

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

**(J)** What are the Plane Stress and Plane Strain problems? Explain with proper examples.

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**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 x dy x 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)**

**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 $\beta$ 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 ($N_\phi$) and Hoop Stress ($N_\theta$) 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 $\sigma1 = 420$ MPa, $\sigma2 = -180$ MPa and $\sigma3 = 200$ MPa. **(10)**

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