Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – III • EXAMINATION – WINTER • 2013

Subject code: 731504 Date: 28-11-2013

Subject Name: Plates and Shells

Time: 10.30 am – 01.00 pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Show that the sum of bending curvatures in any two mutually perpendicular directions, n and t, at any point of the middle surface, is a constant, i.e., $\chi_x + \chi_y = \chi_n + \chi_t$ **07**

(b) Derive the basic fourth order partial differential equation for a plate. Also write down the equation for shear and corner forces. **07**

Q.2 **(a)** Show that for a flat circular steel plate subjected to a uniform pressure on one surface, the maximum stress when periphery is simply supported is 1.65 times that when the periphery is clamped. Take poisson's ratio,$\nu = 0.3$. **07**

(b) Find the maximum deflection in a circular plate subjected to a concentrated load 'P' at the centre. The plate is fixed all around the edges. Take radius = 2m, t = 60 mm, $\nu = 0.3$, E = 208 GPa. P = 30 kN. Also find the deflection when the plate is simply supported all around the edges. **07**

OR

(b) Give merits and demerits of Navier's solution and Levy's solution **07**

Q.3 **(a)** Distinguish between "membrane theory" and "exact theory" of small deflection of plate. Explain stress resultants in both theories with sketches. **04**

(b) A square plate of side a ($0 \le x \le a$; $0 \le y \le a$) with two opposite sides x = 0 and x = a simply supported and the remaining edges clamped is subjected to a uniformly distributed load P_0. If the plate is discretized into four identical rectangular finite elements, compute the maximum deflection. Take a = 4m; h = 30mm; P_0 = 50MPa; E = 210 GPa; and ν = 0:3. Analyze only one quarter-plate by the FEM. **10**

OR

Q.3 **(a)** Using membrane theory derive the condition of equilibrium for doubly curved surfaces. **04**

(b) Derive an equation of w-expression of a rectangular plate (a x b) derived from Navier solution for following cases subjected to uniformly distributed load: **10**

(i) Plate without resting on soil

(ii) Plate with resting on soil

Having foundation modulus 'k'.

Write the equations for concentrated load.

Q.4 **(a)** Find N_θ and N_Φ for conical dome due to self weight and live load uniformly distributed. **07**

(b) A spherical roof dome is subjected to its own weight and snow load of 1 kN/m^2 . Determine the required cross-sectional area of the thrust ring. Take R = 40m; φ1 = 50° and h_s = 12 cm (thickness of the dome). Assume that the dome and the thrust ring are constructed of concrete with ν = 0.15. **07**

OR

Q.4 **(a)** Derive equations of equilibrium for general bending theory of uniformly loaded cylindrical shell. Mark important internal stress resultants. **07**

Q.4 **(b)** Find displacement 'w' of the crown and at the edge for a circular dome for the following data: Φ = 60°, q = 2500 N/m^2, r = 30 m, t = 50 mm, ν = 0.2, E = 1.15 x 105 N/mm^2. Also plot for 'w' at the edge and Φ = 15°, 30°, 45° & 60°. **07**

Q.5 **(a)** Give the classification of shell based on shell curvature with neat sketches. **07**

(b) A simply supported at (x = 0 and x = L) semicircular cylindrical shell is subjected to a snow load 'q' which is uniformly distributed over its plan area. Given the radius of the shell is 'a', thickness is 'h', modulus of elasticity and Poisson's ratio are E and ν respectively, determine the membrane stresses in the shell. **07**

OR

Q.5 **(a)** Develop basic equation of membrane analysis of a paraboloid of revolution. Give stress function Φ, Z & R if 2a = 16m, 2b = 22m, rise = 2.5m and thickness = 80 mm. **07**

(b) A planetarium dome may be approximated as an edge-supported truncated cone. It is subjected to a snow load with a maximum accumulation over the dome q = 2.8 kPa. Assume that the dome is constructed of 12.5 cm thick concrete having the radii of the parallel circles equal to 45 m at the base and 20 m at the top, respectively. Determine the membrane stresses in the dome. **07**

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