Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER III (OLD) – • EXAMINATION – SUMMER 2016

Subject Code: 731504 **Date:05/05/2016**

Subject Name: PLATES AND SHELLS

Time:10:30 am to 01:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Use notations for plates from following expressions unless specified otherwise**

$$q_{xy} = \sum_1^\infty \sum_1^\infty A_{mn} \sin(\frac{m\pi}{a}x) \sin(\frac{n\pi}{b}y)$$

$$w_{xy} = \sum_1^\infty \sum_1^\infty B_{mn} \sin(\frac{m\pi}{a}x) \sin(\frac{n\pi}{b}y)$$

4. **Notations for membrane forces in cylindrical shells … N_x – Along generatrix, N_ϕ – Along directrix and $N_{x\phi}$ – Shear in middle surface**
5. **Figures to the right indicate full marks.**

Q.1 **(a)** What do you mean by Kirchoff's equivalent shear? Derive an expression for a plate in x-y plane (middle plane) for the equivalent shear along a free edge y=0 in terms of deflection and its derivatives **07**

(b) Derive D.E. of equilibrium for a cylindrical shell **07**

Q.2 **(a)** Find equation to deflected surface of a clamped circular plate of uniform thickness and radius 'a', carrying an axisymmetric load $q_r = q\,(\frac{r}{a})^2$ **07**

(b) Using finite difference method find necessary equations to be satisfied by deflections of a clamped square plate (a x a) carrying u.d.l. of intensity 'q' per unit area on the entire area of plate. Consider quarter plate only. Take interval $\frac{a}{4}$ in each direction. Take one of the corners of plate as origin for grid system **07**

OR

(b) A simply supported square plate of side 'a', carries a point load 'P' acting vertically downward at $(\frac{a}{4}, \frac{a}{2})$. The plate also carries another point load 'P' acting vertically upward at $(\frac{3a}{4}, \frac{a}{2})$. Use appropriate trial function and find deflection at centre of plate using principle of minimum potential energy **07**

Q.3 **(a)** Find A_{mn} for a simply supported rectangular plate (a x b) carrying load given by **07**

$$q_{xy} = q\frac{xy}{ab} \qquad \text{defined over} \qquad 0 \le x \le \frac{a}{3}, \quad 0 \le y \le \frac{b}{4}$$

(b) Find B_{mn} for plate in Q.3(a) above and hence find deflection at centre of plate considering first 4 terms in the series. **07**

OR

Q.3 **(a)** Derive D.E. of equilibrium for a transversely loaded plate of uniform thickness subject to bending **07**

(b) Classify shells on the basis of geometry **07**

Q.4 **(a)** Derive necessary equations to find the equation to the deflected surface of a rectangular plate (a x b) subject to u.d.l. of intensity ‘q’ on entire area using Levy’s method. Edges x=0, x=a are simply supported and other two edges are fixed **07**

(b) Find the expression for deflection at centre of plate given in Q.4(a) above **07**

OR

Q.4 **(a)** A cylindrical shell of length ‘*l*’ carrying its own weight is supported on diaphragms that are very rigid in their own planes and very fragile in a direction normal to the plane. Sketch the distribution of membrane forces N_x and $N_{x\phi}$ along any arbitrary generator parallel to *x* for following positions of diaphragms **07**

i. At x=0 and $x=l$

ii. At x=0 and $x = \frac{3l}{4}$

iii. At $x = \frac{l}{4}$ and $x = \frac{5l}{6}$

(b) Derive differential equation of equilibrium in ‘r’ direction for a shell of revolution subject to arbitrary loading **07**

Q.5 **(a)** A conical tank of maximum radius ‘a’ and height 1.5 times ‘a’ is filled with water. Find the variation of meridional force N_ϕ using membrane theory **07**

(b) A semicircular barrel roof carries live load ‘*q*’ per unit plan area. Using membrane theory find variation of forces N_x, N_ϕ and $N_{x\phi}$ if the cylindrical shell is fixed at $x=0$ and free at $x=l$ **07**

OR

Q.5 **(a)** A hemispherical dome of radius ‘a’ carries a ring load ‘*q*’ per unit length transferred by an edge beam provided at the edge of an opening at the crown of radius ‘a/6’. Find the forces developed in the dome using membrane theory if the self-weight of the dome is ‘ $\frac{q}{5}$ ’ per unit area of middle surface. The dome rests on level ground. Ignore bending effects **07**

(b) Describe steps you will follow to design a tilted inverted umbrella type hyperbolic shell supported on central column **07**

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