

Ref. No : EX/PG/CIV/PE/T/123F/2025

M.E. CIVIL ENGINEERING  
FIRST YEAR  
SECOND SEMESTER EXAM 2025

SUBJECT – Theory of Plates and Shells

Part I

Full Marks 60

Time: Three hours

**Answer any 2 questions**

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- 1 A diaphragm supported concrete cylindrical shell is 18 m long along beam direction and 8 m long along arch direction. It has a thickness of 75 mm and rise of the crown is 1.5 m. Deduce the equations of  $N_x$ ,  $N_\theta$  and  $N_{x\theta}$  of this shell under its own dead weight. Plot the variations of these force components along the beam direction along an edge beam . 30
- 2 Draw and define the following shell surfaces – having negative , zero and positive Gaussian curvatures , singly and doubly curved , surfaces of translation and revolution , developable and non- developable , thin and thick . 30
- 3 Consider a spherical dome of radius of curvature R and rise of R/2 . Use membrane theory to deduce the expressions for meridional and circumferential normal forces . Check whether the dome may develop tension under self weight. 30

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Theory of Plates and Shells

Part II (40 marks)

Attempt all questions.

1. Differentiate the assumptions of Kirchhoff and Mindlin plate theories. With neat diagrams derive their strain-displacement relationships.  $5+5+5 = 15$  (CO1)
  
2. Derive the transformation matrix to obtain strains along the off-axes from their on-axis counterparts in case of a lamina assumed to follow the YNS theory. Hence deduce the transformation rule to derive problem-axis stiffness matrix [C] for the m-th lamina in a laminated plate.  $10+5=15$  (CO2)
  
3. Deduce the **elasticity matrix [D]** for a laminated composite plate element following first order shear deformation theory.  $10=10$  (CO3)