

|                                                           | <p align="center"><b>P.E.S. COLLEGE OF ENGINEERING</b><br/><b>(AN AUTONOMOUS INSTITUTE)</b><br/><b>CHH. SAMBAJINAGAR-431002</b><br/><b>Summer Examination – 2026</b><br/><b>Course: F.Y.M.Tech. Branch : Structural Engineering Semester :II</b><br/><b>Subject Code &amp; Name: MTPESS201T– Theory of Plates and Shells</b><br/><b>Max Marks: 60 Date:29/06/2026 Duration: 3 Hr.</b></p>                                                                                                                                                                                                                                                             |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------------------|-------------------------------------------------|---|-----------------------------------------------------------|---|------------------------------------------------------|---|---------------------------------------------|---|---------------------------------------|---|-------------------------------------------------|-----------|-----------|-----------|
|                                                           | <p><b>Instructions to the Students:</b></p> <ol style="list-style-type: none"><li>1. All the questions are compulsory.</li><li>2. The level of question/expected answer as per OBE or the Course Outcome (CO) on which the question is based is mentioned in ( ) in front of the question.</li><li>3. Use of non-programmable scientific calculators is allowed.</li><li>4. Assume suitable data wherever necessary and mention it clearly.</li></ol>                                                                                                                                                                                                 |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
|                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | (Level/CO) | Marks              |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| <b>Q. 1</b>                                               | <b>Solve Any one of the following.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| <b>A)</b>                                                 | <p>Derive the boundary conditions to be used for</p> <p>1) Simply supported edge 2) a clamped edge 3) a free edge.</p> <p><b>Solution:- Marking Scheme</b></p> <table><tr><th>Content</th><th>Marks Distribution</th></tr><tr><td>Introduction to plate boundary conditions</td><td>1</td></tr><tr><td>Boundary conditions for simply supported edge</td><td>3</td></tr><tr><td>Boundary conditions for clamped edge</td><td>3</td></tr><tr><td>Boundary conditions for free edge</td><td>3</td></tr><tr><td>Neat sketches/physical interpretation</td><td>2</td></tr></table>                                                                        | Content    | Marks Distribution | Introduction to plate boundary conditions       | 1 | Boundary conditions for simply supported edge             | 3 | Boundary conditions for clamped edge                 | 3 | Boundary conditions for free edge           | 3 | Neat sketches/physical interpretation | 2 | <b>K2</b>                                       | <b>12</b> |           |           |
| Content                                                   | Marks Distribution                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| Introduction to plate boundary conditions                 | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| Boundary conditions for simply supported edge             | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| Boundary conditions for clamped edge                      | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| Boundary conditions for free edge                         | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| Neat sketches/physical interpretation                     | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| <b>B)</b>                                                 | <p>Derive the equation of paraboloid of revolution which gives synclastic surface.</p> <p><b>Solution:- Marking Scheme</b></p> <table><tr><th>Content</th><th>Marks Distribution</th></tr><tr><td>Introduction to synclastic surfaces.</td><td>2</td></tr><tr><td>Geometry and characteristics of paraboloid of revolution.</td><td>2</td></tr><tr><td>Assumptions and coordinate system.</td><td>2</td></tr><tr><td>Stepwise derivation of paraboloid equation.</td><td>4</td></tr><tr><td>Final equation with interpretation.</td><td>2</td></tr></table>                                                                                           | Content    | Marks Distribution | Introduction to synclastic surfaces.            | 2 | Geometry and characteristics of paraboloid of revolution. | 2 | Assumptions and coordinate system.                   | 2 | Stepwise derivation of paraboloid equation. | 4 | Final equation with interpretation.   | 2 | <b>K3</b>                                       | <b>12</b> |           |           |
| Content                                                   | Marks Distribution                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| Introduction to synclastic surfaces.                      | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| Geometry and characteristics of paraboloid of revolution. | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| Assumptions and coordinate system.                        | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| Stepwise derivation of paraboloid equation.               | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| Final equation with interpretation.                       | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| <b>Q.2</b>                                                | <b>Solve Any one of the following.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| <b>A)</b>                                                 | <p>Derive the Navier’s solution for simply supported plate carrying Sinusoidal load.</p> <p><b>Solution:- Marking Scheme</b></p> <table><tr><th>Content</th><th>Marks Distribution</th></tr><tr><td>Introduction to Navier’s method and assumptions</td><td>2</td></tr><tr><td>Governing differential equation of plate bending</td><td>2</td></tr><tr><td>Application of simply supported boundary conditions.</td><td>2</td></tr><tr><td>Assumed sinusoidal deflection function.</td><td>2</td></tr><tr><td>Derivation of Navier’s solution.</td><td>3</td></tr><tr><td>Final deflection expression and interpretation.</td><td>1</td></tr></table> | Content    | Marks Distribution | Introduction to Navier’s method and assumptions | 2 | Governing differential equation of plate bending          | 2 | Application of simply supported boundary conditions. | 2 | Assumed sinusoidal deflection function.     | 2 | Derivation of Navier’s solution.      | 3 | Final deflection expression and interpretation. | 1         | <b>K3</b> | <b>12</b> |
| Content                                                   | Marks Distribution                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| Introduction to Navier’s method and assumptions           | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| Governing differential equation of plate bending          | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| Application of simply supported boundary conditions.      | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| Assumed sinusoidal deflection function.                   | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| Derivation of Navier’s solution.                          | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| Final deflection expression and interpretation.           | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                    |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |
| <b>B)</b>                                                 | <p>Derive the Levy’s solution for rectangular plate with at least two opposite edges simply supported carrying a uniformly distributed load, calculate the solution for <math>W_1(x)</math>.</p> <p><b>Solution:- Marking Scheme</b></p>                                                                                                                                                                                                                                                                                                                                                                                                              | <b>K3</b>  | <b>12</b>          |                                                 |   |                                                           |   |                                                      |   |                                             |   |                                       |   |                                                 |           |           |           |

|                                                       | <table><tr><th>Content</th><th>Marks Distribution</th></tr><tr><td>Introduction to Levy's method</td><td>2</td></tr><tr><td>Assumptions and governing plate equation.</td><td>2</td></tr><tr><td>Application of boundary conditions.</td><td>2</td></tr><tr><td>Assumed Levy-type displacement function.</td><td>2</td></tr><tr><td>Derivation of differential equation for (W_1(x))</td><td>3</td></tr><tr><td>  Final expression and interpretation.</td><td>1</td></tr><tr><td></td><td></td></tr></table>                                                                                                                                                                                                                                                                                                                                                             | Content | Marks Distribution | Introduction to Levy's method                         | 2 | Assumptions and governing plate equation.       | 2 | Application of boundary conditions.                  | 2 | Assumed Levy-type displacement function.            | 2 | Derivation of differential equation for (W_1(x)) | 3 | Final expression and interpretation.          | 1 |                                                |    |                                            |   |    |    |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|--------------------|-------------------------------------------------------|---|-------------------------------------------------|---|------------------------------------------------------|---|-----------------------------------------------------|---|--------------------------------------------------|---|-----------------------------------------------|---|------------------------------------------------|----|--------------------------------------------|---|----|----|
| Content                                               | Marks Distribution                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Introduction to Levy's method                         | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Assumptions and governing plate equation.             | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Application of boundary conditions.                   | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Assumed Levy-type displacement function.              | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Derivation of differential equation for (W_1(x))      | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Final expression and interpretation.                  | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
|                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Q. 3                                                  | Solve Any one of the following.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| A)                                                    | <p>Derive the equation of deflection for uniformly loaded circular plate.</p> <p><b>Solution:- Marking Scheme</b></p> <table><tr><th>Content</th><th>Marks Distribution</th></tr><tr><td>Introduction to circular plate bending theory</td><td>1</td></tr><tr><td>Assumptions of thin circular plate theory</td><td>2</td></tr><tr><td>Governing differential equation in polar coordinates</td><td>3</td></tr><tr><td>Application of uniformly distributed load condition</td><td>2</td></tr><tr><td>Derivation of deflection equation.</td><td>3</td></tr><tr><td>Final expression with interpretation.</td><td>1</td></tr><tr><td>Introduction to circular plate bending theory.</td><td>1</td></tr><tr><td>Assumptions of thin circular plate theory.</td><td>2</td></tr></table>                                                                                     | Content | Marks Distribution | Introduction to circular plate bending theory         | 1 | Assumptions of thin circular plate theory       | 2 | Governing differential equation in polar coordinates | 3 | Application of uniformly distributed load condition | 2 | Derivation of deflection equation.               | 3 | Final expression with interpretation.         | 1 | Introduction to circular plate bending theory. | 1  | Assumptions of thin circular plate theory. | 2 | K4 | 12 |
| Content                                               | Marks Distribution                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Introduction to circular plate bending theory         | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Assumptions of thin circular plate theory             | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Governing differential equation in polar coordinates  | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Application of uniformly distributed load condition   | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Derivation of deflection equation.                    | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Final expression with interpretation.                 | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Introduction to circular plate bending theory.        | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Assumptions of thin circular plate theory.            | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| B)                                                    | <p>A circular plate of radius R is simply supported boundary and carries a load whose intensity q / unit area is varies according to the relation</p> <p><math>q = q_0 \left(1 - \frac{r}{R}\right)</math> obtain an expression for deflection of plate at the radius R and hence calculate maximum deflection.</p> <p><b>Solution:- Marking Scheme</b></p> <table><tr><th>Content</th><th>Marks Distribution</th></tr><tr><td>Statement of boundary conditions for clamped plate.</td><td>2</td></tr><tr><td>Formulation of governing differential equation.</td><td>2</td></tr><tr><td>Representation of varying load intensity</td><td>2</td></tr><tr><td>Derivation of deflection expression (w(r))</td><td>4</td></tr><tr><td>Calculation of maximum deflection</td><td>1</td></tr><tr><td>Final result with proper interpretation/units</td><td>1</td></tr></table> | Content | Marks Distribution | Statement of boundary conditions for clamped plate.   | 2 | Formulation of governing differential equation. | 2 | Representation of varying load intensity             | 2 | Derivation of deflection expression (w(r))          | 4 | Calculation of maximum deflection                | 1 | Final result with proper interpretation/units | 1 | K4                                             | 12 |                                            |   |    |    |
| Content                                               | Marks Distribution                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Statement of boundary conditions for clamped plate.   | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Formulation of governing differential equation.       | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Representation of varying load intensity              | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Derivation of deflection expression (w(r))            | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Calculation of maximum deflection                     | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Final result with proper interpretation/units         | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Q.4                                                   | Solve Any one of the following.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| A)                                                    | <p>In a thin shell of thickness h, if <math>\sigma_x, \sigma_y, \tau_{xy}, \tau_{xz}</math> and <math>\tau_{yz}</math> are the stresses at point z from midplane, write expressions for stress resultants at the section, interms of these.</p> <p><b>Solution:- Marking Scheme</b></p> <table><tr><th>Content</th><th>Marks Distribution</th></tr><tr><td>Introduction to shell behavior and stress resultants.</td><td>1</td></tr><tr><td>Explation of membrane and bending actions</td><td>2</td></tr><tr><td>Derivation of membrane strain expressions.</td><td>3</td></tr><tr><td>Derivation of bending strain expressions.</td><td>2</td></tr><tr><td>Derivation of stress-strain relationships.</td><td>3</td></tr><tr><td>Final expressions for stress resultants.</td><td>1</td></tr></table>                                                                    | Content | Marks Distribution | Introduction to shell behavior and stress resultants. | 1 | Explation of membrane and bending actions       | 2 | Derivation of membrane strain expressions.           | 3 | Derivation of bending strain expressions.           | 2 | Derivation of stress-strain relationships.       | 3 | Final expressions for stress resultants.      | 1 | K4                                             | 12 |                                            |   |    |    |
| Content                                               | Marks Distribution                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Introduction to shell behavior and stress resultants. | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Explation of membrane and bending actions             | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Derivation of membrane strain expressions.            | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Derivation of bending strain expressions.             | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Derivation of stress-strain relationships.            | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| Final expressions for stress resultants.              | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                    |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |
| B)                                                    | State the advantages and disadvantages of shell structures compared to plates. Classify thin shell into various types based on shell geometry and curvature.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | K4      | 12                 |                                                       |   |                                                 |   |                                                      |   |                                                     |   |                                                  |   |                                               |   |                                                |    |                                            |   |    |    |

|                                                      | <b>Solution:- Marking Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|--------------------|------------------------------------------------------|---|---------------------------------------|---|------------------------------------------------|---|----------------------------------------|---|------------------------------------|-----------|---------------------------------|-----------|--|--|
|                                                      | <table><tr><th>Content</th><th>Marks Distribution</th></tr><tr><td>Introduction to shell structures.</td><td>1</td></tr><tr><td>Advantages of shell structures.</td><td>3</td></tr><tr><td>Disadvantages/limitations of shell structures.</td><td>3</td></tr><tr><td>Classification based on geometry.</td><td>2</td></tr><tr><td>Classification based on curvature.</td><td>2</td></tr><tr><td>Suitable examples/applications.</td><td>1</td></tr></table>                                                                                                                           | Content | Marks Distribution | Introduction to shell structures.                    | 1 | Advantages of shell structures.       | 3 | Disadvantages/limitations of shell structures. | 3 | Classification based on geometry.      | 2 | Classification based on curvature. | 2         | Suitable examples/applications. | 1         |  |  |
| Content                                              | Marks Distribution                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
| Introduction to shell structures.                    | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
| Advantages of shell structures.                      | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
| Disadvantages/limitations of shell structures.       | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
| Classification based on geometry.                    | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
| Classification based on curvature.                   | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
| Suitable examples/applications.                      | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
| <b>Q. 5</b>                                          | <b>Solve Any one of the following.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
| <b>A)</b>                                            | <p>Derive the equation of equilibrium for cylindrical shells under membrane analysis. State the assumptions and limitations of the theory.</p> <p><b>Solution:- Marking Scheme</b></p> <table><tr><th>Content</th><th>Marks Distribution</th></tr><tr><td>Description of cylindrical shells</td><td>2</td></tr><tr><td>Assumptions used in membrane analysis</td><td>2</td></tr><tr><td>Derivation of equilibrium equation</td><td>6</td></tr><tr><td>Limitations and practical significance</td><td>2</td></tr><tr><td>Description of cylindrical shells</td><td>2</td></tr></table> | Content | Marks Distribution | Description of cylindrical shells                    | 2 | Assumptions used in membrane analysis | 2 | Derivation of equilibrium equation             | 6 | Limitations and practical significance | 2 | Description of cylindrical shells  | 2         | <b>K5</b>                       | <b>12</b> |  |  |
| Content                                              | Marks Distribution                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
| Description of cylindrical shells                    | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
| Assumptions used in membrane analysis                | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
| Derivation of equilibrium equation                   | 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
| Limitations and practical significance               | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
| Description of cylindrical shells                    | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
| <b>B)</b>                                            | <p>Explain membrane analysis of open cylindrical shells with parabolic directrix. Derive the stress resultants and discuss structural behavior.</p> <p><b>Solution:- Marking Scheme</b></p> <table><tr><th>Content</th><th>Marks Distribution</th></tr><tr><td>Introduction to open shells and parabolic directrix.</td><td>2</td></tr><tr><td>Geometry and loading considerations</td><td>2</td></tr><tr><td>Derivation of stress resultants</td><td>5</td></tr><tr><td>Structural behavior and applications</td><td>3</td></tr></table>                                             | Content | Marks Distribution | Introduction to open shells and parabolic directrix. | 2 | Geometry and loading considerations   | 2 | Derivation of stress resultants                | 5 | Structural behavior and applications   | 3 | <b>K5</b>                          | <b>12</b> |                                 |           |  |  |
| Content                                              | Marks Distribution                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
| Introduction to open shells and parabolic directrix. | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
| Geometry and loading considerations                  | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
| Derivation of stress resultants                      | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
| Structural behavior and applications                 | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |
|                                                      | <b>*** End ***</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |         |                    |                                                      |   |                                       |   |                                                |   |                                        |   |                                    |           |                                 |           |  |  |