INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

THEORY OF PLATES AND SHELLS								
I Semester: ST								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BSTE07	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	0	3	40	60	100
Contact Classes: 45	**Total Tutorials: Nil**	**Total Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: Analysis of Structures								

I. COURSE OVERVIEW:

Plates and shells represent thin-walled structural elements that exhibit two-dimensional action, resulting in lightweight, efficient, and economical structural systems with high strength-to-weight ratios. This course introduces the fundamental theories and governing equations of plate bending in rectangular and circular geometries, solution methods such as Navier's and Levy's approaches, and behavior of plates on elastic foundations under various loading conditions. It also covers the analysis of cylindrical shells and shells of double curvature using membrane and bending theories, with applications to practical engineering forms such as domes, cooling towers, roofs, and shell-type structures. Completion of this course provides essential knowledge for understanding the behavior and design of thin plate and shell structures widely used in modern engineering practice.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The governing differential equations for bending of thin rectangular and circular plates, and apply analytical methods such as Navier's and Levy's solutions to solve practical loading problems.
II. The theory of large deflections in plates, and evaluate the effects of concentrated and distributed loads for efficient and economical structural design.
III. Mathematical formulations to analyze plates resting on elastic foundations under different loading conditions using closed-form solutions and approximation techniques.
IV. The geometry, membrane and bending theories of cylindrical and double-curvature shells, and apply them to the analysis and design of engineering structures such as domes, roofs, and cooling towers.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1 Analyze the bending behavior of thin rectangular plates and solve governing differential equations using Navier's and Levy's methods under distributed and concentrated loads.
CO 2 Formulate and explain the governing differential equations for circular and annular plates in polar coordinates, and evaluate their response under symmetric and eccentric loading.
CO 3 Apply the theory of large deflections in plates to assess bending and stretching effects for efficient and economical structural design.
CO 4 Examine the governing differential equations for plates resting on elastic foundations and solve practical problems using Navier- and Levy-type solutions.
CO 5 Explain the geometry, stress resultants, and bending theory of cylindrical shells, and apply simplified methods for analysis and design.
CO 6 Understand and analyze shells of double curvature and axi-symmetrical shells using membrane theory, with applications to domes, roofs, and cooling towers.

IV. COURSE CONTENT:

MODULE-I: THIN RECTANGULAR PLATES (9)
Bending of thin plates, assumptions, governing differential equations in Cartesian coordinate system, Boundary conditions, analytical solutions for rectangular plates by Navier and Levy's methods, distributed and concentrated loads.

MODULE-II: CIRCULAR PLATES (09)
Circular plates: Governing differential equations in polar coordinate system, annular plate, rotationally symmetric loading, eccentric concentrated load, simultaneous bending and stretching of thin plates, introduction to large deflection theory of plates.

MODULE-III: PLATES ON ELASTIC FOUNDATIONS (9)
Plates on elastic foundations, governing differential equation and deflection of uniformly loaded simply supported rectangular plate.

Navier and Levy type solutions, large plate loaded at equidistant points by concentrated forces.

MODULE-IV: SHELLS (09)
Shells, geometry and classifications, stress resultants, membrane theory and its applications to shells of surface of revolutions, membrane theory for cylindrical shell, general theory in bending of cylindrical shell, simplified method for cylindrical shell.

MODULE-V: INTRODUCTION TO SHELLS OF DOUBLE CURVATURE (10)
Geometry, analysis, and design of elliptic paraboloid, conoid, and hyperbolic paraboloid shapes, including inverted umbrella type.
Axi-Symmetrical Shells:
General equation – Analysis of axi-symmetrical shells by membrane theory – Application to spherical shells and hyperboloid of revolution cooling towers.

V. TEXTBOOKS:

1. Timoshenko S. and Krieger, "*Theory of Plates and Shells*", W. McGraw Hill, 1959.
2. Chandra shekhara. K, "*Theory of Plates*", Universities Press, 2001.
3. Timoshenko, "*Theory of Plates and Shells*", Tata MC Graw Hill, 1959.

VI. REFERENCE BOOKS:

1. UguralAnselC, "*Stresses in Plates and Shells"*, McGraw Hill, 2009.
2. Kraus.H, "*Thin Elastic Shells*", John Wiley and Sons, 1998.
3. Rama swamy. G. S., "*Design and Construction of Concrete Shells*", 2001.

VII. ELECTRONICS RESOURCES:

1. https://pdfs.semanticscholar.org/presentation/ce6d/b61238325d60d3f6dc0f1fbe7af33e3972c1.pdf
2. https://ocw.mit.edu/courses/mechanical-engineering/2-081j-plates-and-shells-spring-2007/readings/lecturenote.pdf.
3. http://community.wvu.edu/~bpbettig/MAE456/Lecture_10_Shell_Elements_b.pdf

VIII. MATERIALS ONLINE:

1. Course Outline Description
2. Tutorial Question Bank
3. Assignments
4. Model Question Paper – I
5. Model Question Paper - II
6. Lecture Notes
7. Early Lecture Readiness Videos
8. Power point presentation