INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad-500043

CIVIL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**THEORY OF THIN PLATES AND SHELLS**				
Course Code	BSTB03				
Programme	M.Tech				
Semester	I	STE			
Course Type	Elective				
Regulation	**IARE - R18**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	**-**	**3**	**-**	**-**
Chief Coordinator	Mr. Gude Ramakrishna, Associate Professor.				
Course Faculty	Mr. Gude Ramakrishna, Associate Professor.				

COURSE OBJECTIVES:

The course should enable the students to:	
I	Use analytical methods for the solution of thin plates and shells.
II	Use analytical methods for the solution of shells.
III	Apply the numerical techniques and tools for the complex problems in thin plates.
IV	Apply the numerical techniques and tools for the complex problems in shells.

COURSE OUTCOMES (COs):

CO 1	Understand the concept of concepts of space curves, surfaces, shell co-ordinates, boundary conditions.
CO 2	Describe the governing equation for a rectangular plate, Navier solution for simply- supported rectangular plate under various loadings, Levy solution for rectangular plate with other boundary conditions.
CO 3	Analyze under axi- symmetric loading, governing differential equation in polar co-ordinates. Approximate methods of analysis- Rayleigh-Ritz approach for simple cases in rectangular plates.
CO 4	Understand the membrane theory of cylindrical, conical and spherical shells.
CO 5	Understand the cylindrical and conical shells, application to pipes and pressure vessels, thermal stresses in plate/shell.

COURSE LEARNING OUTCOMES (CLO's):

BSTB03.01	Understand the concepts of space curves, surfaces, shell co-ordinates, boundary Conditions.
BSTB03.02	Understand the concept of displacement field approximations, stress resultants.
BSTB03.03	Determination of equation of equilibrium using principle of virtual work.
BSTB03.04	Understand the concept of bending of thin plates and assumptions.
BSTB03.05	Determination of Navier solution for simply- supported rectangular plate under various loadings.
BSTB03.06	Determination of deflection of uniformly loaded simply supported rectangular plate.
BSTB03.07	Solution of Navier and Levy type, large plate loaded at equidistant points by concentrated forces.
BSTB03.08	Understand basic relations in polar coordinates of circular plates.
BSTB03.09	Analyze the use of superposition for the axisymmetric analysis of circular plates.
BSTB03.10	Able to analyze the circular plates on elastic foundation, asymmetric bending of circular plates.
BSTB03.11	Analysis of Rayleigh-Ritz approach for simple cases in rectangular plates.
BSTB03.12	Analysis of membrane theory for cylindrical shells.
BSTB03.13	Understand the general theory in bending of cylindrical shell, simplified method for cylindrical shell.
BSTB03.14	Understand the simplified method for cylindrical shell.
BSTB03.15	Understand the thermal stresses in plate/shell.
BSTB03.16	Analyze shells of revolution under axisymmetric loads.
BSTB03.17	Able to analyze the axisymmetric loaded conical shells.
BSTB03.18	Able to analyze the axisymmetric deformation of toroidal shells.

TUTORIAL QUESTION BANK

UNIT-I

INTRODUCTION

Part – A (Short Answer Questions)

S.No	QUESTIONS	Blooms Taxonomy Level	Course Outcomes (CO's)	Course Learning Outcomes (CLOs)
1	State the relations between bending moments and curvature in pure bending of plates?	Understand	CO 1	BSTB03.01
2	Give a brief account of classifications of plates.	Remember	CO 1	BSTB03.01
3	What are the assumptions in pure bending?	Remember	CO 1	BSTB03.01
4	Derive the differential equations for plate subjected to ylindrical bending.	Understand	CO 1	BSTB03.01
5	Distinguish between thin plate with small deflection and thin plate with large deflection.	Understand	CO 1	BSTB03.02
6	What are the types of forces acting on the body explain with fig.	Remember	CO 1	BSTB03.02
7	Give strain-displacement relation in the case of certain and cylindrical co-ordinate system?	Remember	CO 1	BSTB03.02
8	What are the different kinds of plates, explain the boundary conditions for thin rectangular plate?	Understand	CO 1	BSTB03.02
9	Explain any two types of rigidities in orthotropic plate with figure.	Remember	CO 1	BSTB03.02
10	Give a formula for direction of maximum slope of bent plate.	Remember	CO 1	BSTB03.02
Part - B (Long Answer Questions)				
1	Derive the differential equation governing the plate. Sate various assumptions involved in the derivation.	Understand	CO 1	BSTB03.02

2	Using the Navier solution obtain general equation for a rectangular plate subjected to hydrostatic pressure	Remember	CO 1	BSTB03.02
3	Derive the Navier solution for simply supported rectangular plates and obtain the maximum deflections.	Remember	CO 1	BSTB03.02
4	Derive the differential equations of cylindrical bending of uniformly loaded rectangular plates will simply supported edges	Understand	CO 1	BSTB03.03
5	Derive the differential equations of cylindrical bending of uniformly loaded rectangular plates with simply supported edges	Remember	CO 1	BSTB03.02
6	Derive the differential equations of small deflections of laterally loaded plates (Lagrange's equations).	Understand	CO 1	BSTB03.02
7	. Derive the differential equations of cylindrical bending of uniformly loaded rectangular plates with built in edges.	Remember	CO 1	BSTB03.02
8	Obtain formulae for slope and curvature of a bent plate.	Remember	CO 1	BSTB03.02
9	Obtain solution for plate problem by Ritz method in case of all round simply supported rectangular plate subjected to UDL?	Remember	CO 1	BSTB03.02
10	Find Levy's solution for simply supported and uniformly loaded rectangular plates.	Remember	CO 1	BSTB03.03
11	cylindrical bending of uniformly loaded rectangular plates with fixed edges.	Understand	CO 1	BSTB03.04
12	Find displacement co-ordinates u, v in the case of Cartesian and cylindrical co-ordinate system, for strain displacement relation.	Understand	CO 1	BSTB03.04
13	Derivation of cylindrical bending of uniformly loaded rectangular plate with fixed edges.	Understand	CO 1	BSTB03.04
Part - C (Problem Solving and Critical Thinking Questions)				
1	A square plate with all four edges simply supported, carries a uniformly distributed load of intensity q_0. Using levy's method, compute the maximum deflection & bending stress.	Remember	CO 1	BSTB03.01
2	Displacement co-ordinates u, v in the case of Cartesian and cylindrical co-ordinate system, for strain displacement relation	Understand	CO 1	BSTB03.02
3	State and explain about boundary conditions for thin rectangular plate.	Remember	CO 1	BSTB03.02
4	Deflection formulae for partially loaded simply supported rectangular plate, with fig.	Understand	CO 1	BSTB03.02
5	Discuss briefly about Levy's solution of finding deflection of a rectangular plate.	Remember	CO 1	BSTB03.02
6	Explain and state formulae for maximum and minimum bending stress for plates under sinusoidal load.	Understand	CO 1	BSTB03.02
7	Find the transverse deflection w, radial moment Mr, tangential moment M_Q and corresponding stresses and also find the Wmax for the simply supported circular plate subjected to UDL 'q'.	Remember	CO 1	BSTB03.02
8	Show that any point of the middle surface of the bent plate the sum of the curvature in two perpendicular directions is independent of the angle .	Understand	CO 1	BSTB03.02
9	A square plate with all four edges simply supported, carries a uniformlydistributed load of intensity q0. Using levy's method, compute the maximum deflection & bending stress.	Remember	CO 1	BSTB03.02
UNIT – II				
STATIC ANALYSIS OF PLATES				
Part – A (Short Answer Questions)				

1	State the relations between bending moments and curvature in pure bending of plates?	Remember	CO 2	BSTB03.01
2	Give a brief account of classifications of plates.	Remember	CO 2	BSTB03.05
3	What are the assumptions in pure bending?	Remember	CO 2	BSTB03.05
4	Derive the differential equations for plate subjected to cylindrical bending.	Understand	CO 2	BSTB03.05
5	Distinguish between thin plate with small deflection and thin plate with large deflecti	Understand	CO 2	BSTB03.06
6	What are the types of forces acting on the body explain with fig?	Remember	CO 2	BSTB03.06
7	Give strain-displacement relation in the case of certain and cylindrical co-ordinate system?	Understand	CO 2	BSTB03.05
8	What are the different kinds of plates, explain the boundary conditions for thin rectangular plate.	Remember	CO 2	BSTB03.05
9	Explain any two types of rigidities in orthotropic plate with figure.	Remember	CO 2	BSTB03.05
Part - B (Long Answer Questions)				
1	Derive the differential equation governing the plate. Sate various assumptions involved in the derivation.	Understand	CO 2	BSTB03.05
2	Using the Navier solution obtain general equation for a rectangular plate subjected to hydrostatic pressure	Understand	CO 2	BSTB03.05
3	Derive the Navier solution for simply supported rectangular plates and obtain the maximum deflections.	Understand	CO 2	BSTB03.06
4	Derive the differential equations of cylindrical bending of uniformly loaded rectangular plates will simply supported edges	Remember	CO 2	BSTB03.05
5	Derive the differential equations of cylindrical bending of uniformly loaded rectangular plates with simply supported edges	Remember	CO 2	BSTB03.05
6	Derive the differential equations of small deflections of laterally loaded plates (Lagrange's equations).	Understand	CO 2	BSTB03.05
7	. Derive the differential equations of cylindrical bending of uniformly loaded rectangular plates with built in edges.	Remember	CO 2	BSTB03.06
8	Obtain formulae for slope and curvature of a bent plate.	Remember	CO 2	BSTB03.06
9	Obtain solution for plate problem by Ritz method in case of all round simply supported rectangular plate subjected to UDL?	Remember	CO 2	BSTB03.06
10	Find Levy's solution for simply supported and uniformly loaded rectangular plates.		CO 2	BSTB03.06
11	cylindrical bending of uniformly loaded rectangular plates with fixed edges	Remember	CO 2	BSTB0306
12	Find displacement co-ordinates u, v in the case of Cartesian and cylindrical co-ordinate system, for strain displacement relation.	Remember	CO 2	BSTB03.06
13	Derivation of cylindrical bending of uniformly loaded rectangular plate with fixed edges.	Remember	CO 2	BSTB03.06
Part - C (Problem Solving and Critical Thinking Questions)				
1	A square plate with all four edges simply supported, carries a uniformly distributed load of intensity q_0. Using levy's method, compute the maximum deflection & bending stress.	Analyze	CO 2	BSTB03.07
2	Displacement co-ordinates u, v in the case of Cartesian and cylindrical co-ordinate system, for strain displacement relation	Remember	CO 2	BSTB03.07
3	State and explain about boundary conditions for thin rectangular plate.	Remember	CO 2	BSTB03.07
4	Deflection formulae for partially loaded simply supported	Evaluate	CO 2	BSTB03.08

	rectangular plate, with fig.			
5	Discuss briefly about Levy's solution of finding deflection of a rectangular plate	Remember	CO 2	BSTB03.08
6	Explain and state formulae for maximum and minimum bending stress for plates under sinusoidal load	Analyze	CO 2	BSTB03.08
7	Find the transverse deflection w, radial moment Mr,tangential moment M_Q and corresponding stresses and also find the Wmax for the circular plates of the following type. • A simply supported plate subjected to UDL 'q '.	Remember	CO 2	BSTB03.08
8	Show that any point of the middle surface of the bent plate the sum of the curvature in two perpendicular directions is independent of the angle.	Evaluate	CO 2	BSTB03.08
9	A square plate with all four edges simply supported, carries a uniformly distributed load of intensity q0. Using levy's method, compute the maximum deflection & bending stress.	Analyze	CO 2	BSTB03.08
UNIT – III				
CIRCULAR PLATES				
Part - A (Short Answer Questions)				
1	The maximum deflection at the center of the plate with uniformly loaded circular plate.	Remember	CO 3	BSTB03.09
2	Deflection of circular plate with supported edges	Remember	CO 3	BSTB03.09
3	Determine the deflection and internal moments of simply supported rectangular support plate of size a x b.	Understand	CO 3	BSTB03.09
4	Briefly explain an expression for maximum deflection at the centre of a simply supported plate concreted load at the center.	Remember	CO 3	BSTB03.09
5	Write down slope and deflection of circular plate with clamped edge, when r=0 and r=a.	Understand	CO 3	BSTB03.09
6	Find maximum deflection at the center of the plate for uniformly loaded circular plate.	Remember	CO 3	BSTB03.09
7	Find maximum deflection at the center of the plate for uniformly loaded circular plate.	Understand	CO 3	BSTB03.09
8	Find deflection and bending moments for circular plate loaded at center.	Remember	CO 3	BSTB03.09
9	Deflection produced by the moment in case of circular plate concentrically loaded.	Remember	CO 3	BSTB03.09
Part – B (Long Answer Questions)				
1	Derive expressions for deflection, shear force and bending moment for a circular plate with simply supported boundary conditions subjected to uniformly distributed loading.	Remember	CO 3	BSTB03.10
2	Derive the moment curvature relationship in the case of pure bending of plates.	Understand	CO 3	BSTB03.10
3	A simply supported rectangular plate of dimension a x b x h is subjected to load 'P' acting over an area. Derive the expression for deflection. Adopt Navier's approach.	Understand	CO 3	BSTB03.10
4	Derive the equations of equilibrium for small deflections of laterally loaded plates.	Understand	CO 3	BSTB03.10
5	Find Levy's solution for simply supported rectangular plates.	Understand	CO 3	BSTB03.10
6	Obtain the expression for deflection in case of uniformly loaded circular plates with clamped edges.	Remember	CO 3	BSTB03.10
7	Expression for slope and deflection for circular plate with a circular hole at the Centre.	Understand	CO 3	BSTB03.10

8	Obtain differential equation for symmetrical bending of laterally loaded circular plate.	Understand	CO 3	BSTB03.10
9	Derive an expression for deflection of simply supported solid circular plate subjected to an end moments	Understand	CO 3	BSTB03.10
Part - C (Problem Solving and Critical Thinking Questions)				
1	Briefly explain an expression for maximum deflection at the centre of a simply supported plate concreted load at the cente	Understand	CO 3	BSTB03.11
2	Explain correction to the elementary theory of symmetrical bending of circular plates	Understand	CO 3	BSTB03.11
3	Obtain the expression for deflection in case of uniformly loaded circular plates with clamped edges.	Understand	CO 3	BSTB03.11
4	Obtain the expression for deflection in case of uniformly loaded circular plates with clamped edges.	Remember	CO 3	BSTB03.11
5	Determine the deflection and internal moments of simply supported rectangular support plate of size a x b.	Remember	CO 3	BSTB03.11
6	A rectangular plate a x b simply supported at the edges is subjected to sinusoidal loading. Using the Navier solution, obtain the general expressions for deflection and bending moment.	Remember	CO 3	BSTB03.11
7	Find the deflection equation for a plate subjected to hydro static pressure use Levy's basic equation for calculating deflection.	Remember	CO 3	BSTB03.11
8	Determine the deflection and internal moments of simply supported rectangular support plate of size a x b.	Remember	CO 3	BSTB03.11
9	A uniform loaded solid circular plate with radius 'a ' has its edges simply supported obtain the expressions for the maximum deflection and obtain bending moment.	Remember	CO 3	BSTB03.12
UNIT - IV				
STATIC ANALYSIS OF SHELLS: MEMBRANE THEORY OFSHELLS				
Part – A (Short Answer Questions				
1	Differentiate between long shells and short shells.	Remember	CO 4	BSTB03.12
2	Explain the bending and membrane theories for analysis of shells.	Remember	CO 4	BSTB03.12
3	Briefly explain about the classification of shells.	Remember	CO 4	BSTB03.12
4	Explain about the various types of shells with neat sketches.	Remember	CO 4	BSTB03.12
5	Explain about the advantages and disadvantages of the shells.	Remember	CO 4	BSTB03.13
6	Explain about beam analysis.	Remember	CO 4	BSTB03.13
7	Explain the bending and membrane theories for analysis of shells	Remember	CO 4	BSTB03.13
8	Derive the membrane equation for shells.	Remember	CO 4	BSTB03.13
9	Explain about the bending theory of shells	Remember	CO 4	BSTB03.13
10	Explain about the advantages and disadvantages of the shells.	Remember	CO 4	BSTB03.13
Part - B (Long Answer Questions)				
1	Derive Shorer's differential equation	Understand	CO 4	BSTB03.13
2	Write boundary conditions for simply supported cylindrical shells with the edge conditions. i) Single shell without edge beam ii) single shell with edge beam	Understand	CO 4	BSTB03.13
3	Derive the governing differential equation for the membrane analysis of shells of double curvature	Understand	CO 4	BSTB03.13
4	Derive the membrane stress resultants for rectangular hyperbolic paraboloid on straight line generators.	Understand	CO 4	BSTB03.13
5	Derive the equilibrium equation of rectangular shell.	Understand	CO 4	BSTB03.13

6	Derive the membrane differential equation for the elliptic paraboloid	Understand	CO 4	BSTB03.13
7	Derive the membrane differential equation for the rotational paraboloid	Understand	CO 4	BSTB03.13
8	Explain about membrane theory of anticlastic shells	Understand	CO 4	BSTB03.14
Part - C (Problem Solving and Critical Thinking Questions)				
1	Derive the equilibrium equation of rectangular shell.	Remember	CO 4	BSTB03.14
2	Derive the general equations for axisymmetric shells of revolution.	Remember	CO 4	BSTB03.14
3	Define the membrane state of stress in shells. Derive equations of equilibrium, using membrane theory for cylindrical shell and obtain Mx, Mq&Mxq.	Remember	CO 4	BSTB03.14
4	Explain the following a) Membrane behavior b) Membrane equation	Remember	CO 4	BSTB03.14
5	Explain about membrane theory of anticlastic shells.	Remember	CO 4	BSTB03.14
6	Find the equations of equilibrium in case of shells in the form of a surface of revolution and loaded symmetrically with respect to their axis.	Understand	CO 4	BSTB03.14
7	(a) Differentiate between long shells and short shells. (b) Explain about the advantages and disadvantages of the shells.	Understand	CO 4	BSTB03.15
8	Write a short note on a) Anti-symmetric shells b) Singly curved shells c) ISI classification of shells	Understand	CO 4	BSTB03.15
9	a) How do you classify shells into long and short shells as per various theories b) Write boundary conditions for simply supported cylindrical shells with the edge conditions. i) Single shell without edge beam ii) single shell with edge beam	Understand	CO 4	BSTB03.15
10	Define the membrane state of stress in shells. Derive equations of equilibrium, using membrane theory for cylindrical shell.	Understand	CO 4	BSTB03.15
UNIT – V				
SHELLS OF REVOLUTION: WITH BENDING RESISTANCE				
Part - A (Short Answer Questions)				
1	Derive geometrical relations for shells of double curvature.	Remember	CO 5	BSTB03.15
2	Explain about Anti-symmetric shells	Remember	CO 5	BSTB03.15
3	Derive the equilibrium equation of rectangular shell.	Remember	CO 5	BSTB03.16
4	Briefly explain about the types of shells.	Remember	CO 5	BSTB03.16
5	Briefly explain about the classification of shells.	Remember	CO 5	BSTB03.16
6	Explain about the bending theory of shells	Remember	CO 5	BSTB03.16
7	Differentiate between long shells and short shells.	Remember	CO 5	BSTB03.16
8	Explain about membrane theory of anticlastic shells	Remember	CO 5	BSTB03.16
Part - B (Long Answer Questions)				
1	Write a short note on a) Anti-symmetric shells b) Singly curved shells	Understand	CO 5	BCSB28.16
2	Explain about the bending theory of shells.	Understand	CO 5	BSTB03.16
3	Derive the general equations for axisymmetric shells of revolution.	Understand	CO 5	BSTB03.16
4	Derive the membrane stress resultants for rectangular hyperbolic paraboloid on straight line generators.	Understand	CO 5	BSTB03.17
5	Explain about membrane theory of anticlastic shells	Understand	CO 5	BSTB03.17

6	Derive the general equations for axisymmetric shells of revolution.	Understand	CO 5	BSTB03.17
7	Explain about membrane theory of anticlastic shells	Understand	CO 5	BSTB03.17
8	Explain about cylindrical bending of uniformly loaded rectangular plates with fixed edges	Understand	CO 5	BSTB03.17
9	Write assumptions made in general theory of thin elastic shells.	Understand	CO 5	BSTB03.17
Part - C (Problem Solving and Critical Thinking Questions)				
1	Derive the membrane differential equation for the rotational paraboloid	Understand	CO 5	BSTB03.17
2	Derive geometrical relations for shells of double curvature	Understand	CO 5	BSTB03.18
3	Derive the governing differential equation for the membrane analysis of shells of double curvature.	Understand	CO 5	BSTB03.18
4	Derive the membrane stress resultants for rectangular hyperbolic paraboloid on straight line generators.	Understand	CO 5	BSTB03.18
5	Derive the membrane differential equation for the rotational paraboloid.	Remember	CO 5	BSTB03.18
6	Write a short note on a) Anti-symmetric shells b) Singly curved shells c) ISI classification of shells	Remember	CO 5	BSTB03.18
7	Derive the moment curvature in the case of pure bending of plates	Remember	CO 5	BSTB03.18
8	State the assumptions in shorer's theory of cylindrical shells and drive the shorer's differential equation.	Remember	CO 5	BSTB03.18
9	Classify thin shell into various types based on shell geometry & curvature.	Remember	CO 5	BSTB03.18

Prepared by:

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