INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

CIVIL ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	**THEORY AND ANALYSIS OF PLATES AND SHELLS**
Course Code	:	BST203
Class	:	M. Tech (Structural Engineering) – I semester
Department	:	Civil Engineering
Academic Year	:	2017 – 2018
Course Faculty	:	Gude Ramakrishna Associate professor

COURSE OVERVIEW:

A plate is a structural element which is thin and flat. By "thin," it is meant that the plate's transverse dimension, or thickness, is small compared to the length and width dimensions. A mathematical expression of this idea is: where t represents the plate's thickness and L represents a representative length or width dimension. (See Fig. See Plate and associated (x, y, z) coordinate system...) More exactly, L represents the minimum wave length of deformation, which can be much smaller than the plate minimum lateral dimension for problems of localized loading, dynamics and stability. Plates might be classified as very thin if Ł/t > 100, moderately thin if 20 < Ł/t < 100, thick if 3 < Ł/t < 20, and very thick if Ł/t < 3. The "classical" theory of plates is applicable to very thin and moderately thin plates, while "higher order theories" for thick plates are useful. For the very thick plates, however, it becomes more difficult and less useful to view the structural element as a plate - a description based on the three-dimensional theory of elasticity is required.

COURSE OBJECTIVES:

The course should enable the students to:

I	Formulate and solve the differential equations for bending of thin rectangular and circular plates.
II	Understand and apply the theory of large deflections of plates .
III	Formulate and solve the differential equations for plates on elastic foundations.
IV	Apply the membrane and general theory of bending of thin cylindrical shells
V	Evaluate the buckling criteria in plates by solving the governing equation

COURSE LEARNING OUTCOMES:

Students, who complete the course, will have demonstrated the ability to do the following:

C BST203.01	Understand the concept of bending of thin plates and assumptions.
C BST203.02	Know the governing differential equations in Cartesian coordinate system.
C BST203.03	Concept of analytical solutions for rectangular plates by Navier method for distributed loads
C BST203.04	Concept of analytical solutions for Levy's methods for concentrated loads.
C BST203.05	Concept of analytical solutions for rectangular plates by Navier method off distributed and concentrated loads.

C BST203.06	Know the general governing differential equations in polar coordinate system, annular plate.
C BST203.07	Understand the annular plate, rotationally symmetric loading, eccentric concentrated load, simultaneous bending and stretching of thin plates.
C BST203.08	Understand the large deflection theory of plates.
C BST203.09	Concept of governing differential equation, deflection of uniformly loaded simply supported plate.
C BST203.10	Solution of Navier and Levy type, large plate loaded at equidistant points by concentrated forces.
C BST203.11	Determination governing differential equation for Plates on elastic foundations.
C BST203.12	Determination of deflection of uniformly loaded simply supported rectangular plate.
C BST203.13	Solution of Navier and Levy type, large plate loaded at equidistant points by concentrated forces.
C BST203.14	Understand the geometry and classifications of Shells, stress resultants.
C BST203.15	Understand the membrane theory and its applications to shells of surface of revolutions.
C BST203.16	Analysis of membrane theory for cylindrical shells.
C BST203.17	Understand the general theory in bending of cylindrical shell, simplified method for cylindrical shell.
C BST203.18	Understand the simplified method for cylindrical shell.
C BST203.19	Analysis of governing equation for bending of plate under the combined action of in-plane loading .
C BST203.20	Analysis of governing equation for bending of plate under the action of lateral loads.
C BST203.21	Understand the concept of buckling of rectangular plates by compressive forces acting in one direction only.
C BST203.22	Understand the buckling of rectangular plates by compressive forces acting in one and two directions in the middle plane of plate.

TUTORIAL QUESTION BANK

UNIT – I			
THIN RECTANGULAR PLATES			
Part - A (Short Answer Questions)			
1	State the relations between bending moments and curvature in pure bending of plates?	Remember	CBST001.01
2	Give a brief account of classifications of plates.	Remember	CBST001.01
3	What are the assumptions in pure bending.	Remember	CBST001.01
4	Derive the differential equations for plate subjected to cylindrical bending.	Remember	CBST001.01
5	Distinguish between thin plate with small deflection and thin plate with large deflecti	Remember	CBST001.02
6	What are the types of forces acting on the body explain with fig	Remember	CBST001.02
7	Give strain-displacement relation in the case of certain and cylindrical co-ordinate system?	Remember	CBST001.02
8	What are the different kinds of plates, explain the boundary conditions for thin rectangular plate.	Remember	CBST001.02
9	Explain any two types of rigidities in orthotropic plate with figure.	Remember	CBST001.02
Part - B (Long Answer Questions)			
1	Derive the differential equation governing the plate. Sate various assumptions involved in the derivation.	Apply	CBST001.01
2	Using the Navier solution obtain general equation for a rectangular plate subjected to hydrostatic pressure	Apply	CBST001.01
3	Derive the Navier solution for simply supported rectangular plates and obtain the maximum deflections.	Apply	CBST001.01
4	Derive the differential equations of cylindrical bending of uniformly loaded rectangular plates will simply supported edges	Apply	CBST001.02

5	Derive the differential equations of cylindrical bending of uniformly loaded rectangular plates with simply supported edges	Apply	CBST001.02
6	Derive the differential equations of small deflections of laterally loaded plates (Lagrange's equations).	Apply	CBST001.02
7	. Derive the differential equations of cylindrical bending of uniformly loaded rectangular plates with built in edges.	Apply	CBST001.02
8	Obtain formulae for slope and curvature of a bent plate.	Apply	CBST001.02
9	Obtain solution for plate problem by Ritz method in case of all round simply supported rectangular plate subjected to UDL?	Apply	CBST001.02
10	Find Levy's solution for simply supported and uniformly loaded rectangular plates.	Apply	CBST001.02
11	cylindrical bending of uniformly loaded rectangular plates with fixed edges	Apply	CBST001.02
12	Find displacement co-ordinates u, v in the case of Cartesian and cylindrical co-ordinate system, for strain displacement relation.	Apply	CBST001.02
13	Derivation of cylindrical bending of uniformly loaded rectangular plate with fixed edges.	Apply	CBST001.02
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 q0. Using levy's method, compute the maximum deflection & bending stress.	Analyze & evaluate	CBST001.01
2	Displacement co-ordinates u, v in the case of Cartesian and cylindrical co-ordinate system, for strain displacement relation	Analyze & evaluate	CBST001.02
3	State and explain about boundary conditions for thin rectangular plate.	Analyze & evaluate	CBST001.02
5	Deflection formulae for partially loaded simply supported rectangular plate, with fig	Analyze & evaluate	CBST001.02
6	Discuss briefly about Levy's solution of finding deflection of a rectangular plate	Analyze & evaluate	CBST001.02
7	Explain and state formulae for maximum and minimum bending stress for plates under sinusoidal load	Analyze & evaluate	CBST001.02
8	Find the transverse deflection w, radial moment Mr, tangential moment MQ and Wmax for the circular plates of the following types. i) A simply supported plate subjected to UDL q	Analyze & evaluate	CBST001.02
9	Show that any point of the middle surface of the bent plate the sum of the curvatu independent of the angle .	Analyze & evaluate	CBST001.02
UNIT – II			
CIRCULAR PLATES			
Part - A (Short Answer Questions)			
1	The maximum deflection at the centre of the plate with uniformly loadedcircular plate.	Remember	CBST001.03
2	Deflection of circular plate with supported edges	Remember	CBST001.03
3	Deflection of circular plate with supported edges	Remember	CBST001.03
4	Briefly explain an expression for maximum deflection at the centre of a simply	Remember	CBST001.04

	supported plate concreted load at the center		
5	Write down slope and deflection of circular plate with clamped edge ,when r=0 and r=a.	Remember	CBST001.04
6	Find maximum deflection at the center of the plate for uniformly loaded circular plate.	Remember	CBST001.05
7	Equation for finding out the moments M_1,M_2 for a circular plate with a circular hole at the center.	Remember	CBST001.06
8	Find deflection and bending moments for circular plate loaded at center.	Remember	CBST001.06
9	Deflection produced by the moment in case of circular plate concentrically loaded.	Remember	CBST001.06
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	Apply	CBST001.03
2	Derive the moment curvature relationship in the case of pure bending of plates.	Apply	CBST001.03
3	Derive the equations of equilibrium for small deflections of laterally loaded plates	Apply	CBST001.04
4	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	Apply	CBST001.04
5	Find Levy's solution for simply supported rectangular plates.	Apply	CBST001.04
6	Find Levy's solution for uniformly loaded rectangular plates.	Apply	CBST001.05
7	Obtain the expression for deflection in case of uniformly loaded circular plates with clamped edges.	Apply	CBST001.06
8	Expression for slope and deflection for circular plate with a circular hole at the centre	Apply	CBST001.06
9	Obtain differential equation for symmetrical bending of laterally loaded circular plate?	Apply	CBST001.07
10	Derive an expression for deflection of simply supported solid circular plate subjected to an end moments	Apply	CBST001.07
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	Analyze & evaluate	CBST001.03
2	Explain correction to the elementary theory of symmetrical bending of circular plates	Analyze & evaluate	CBST001.03
3	Obtain the expression for deflection in case of uniformly loaded circular plates with clamped edges.	Analyze & evaluate	CBST001.04
4	Obtain the expression for deflection in case of uniformly loaded circular plates with clamped edges.	Analyze & evaluate	CBST001.04
5	Determine the deflection and internal moments of simply supported rectangular support plate of size a x b.	Analyze & evaluate	CBST001.04
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.	Analyze & evaluate	CBST001.04
7	Find the deflection equation for a plate subjected to hydro static pressure use Levy's basic equation for calculating deflection.	Analyze & evaluate	CBST001.06
8	Determine the deflection and internal moments of simply supported rectangular support plate of size a x b.	Analyze & evaluate	CBST001.06

9	A uniform loaded solid circular plate with radius ‘’a’’ has its edges simply supported obtain the expressions for the maximum deflection and obtain BM’S	Analyze & evaluate	CBST001.07
UNIT – III			
PLATES ON ELASTIC FOUNDATIONS			
Part - A (Short Answer Questions)			
1	Write short notes on an elastic foundation.	Remember	CBST001.08
2	Write a short notes on Levy’s solution for rectangular plate..	Remember	CBST001.08
3	. Explain relation between elastic properties i.e young’s modulus E_C and, Poission ratio VO	Remember	CBST001.08
4	What are the assumptions made in bending of plates resting on semi infinite elastic solid	Remember	CBST001.09
5	Expression for rigidity of corrugated sheet	Remember	CBST001.09
6	Write down brief notes on bending of plates resting on a Semi-infinite Elastic solid	Remember	CBST001.09
7	Write down assumption made in bending of plates resting on a Semi-infinite Elastic solid	Remember	CBST001.09
8	What are the moments for center of the loaded circular plate of infinitely large plate.	Remember	CBST001.10
9	Bending moment at the center of a circular plate carrying loads at center.	Remember	CBST001.10
Part - B (Long Answer Questions)			
1	Find deflection of rectangular plate on an elastic foundation and bending moment at the centre	Apply	CBST001.08
2	Find deflection ‘w’ of mat foundation resting on an elastic sub grade and carrying equidistant and equal load ’p’.	Apply	CBST001.08
3	Determine the deflection equation for a UDL simply supported rectangular plate on an elastic foundation	Apply	CBST001.08
4	Explain about large plate which rests on elastic foundation is loaded at equidistant points along x-axis by force ‘P’	Apply	CBST001.09
5	Give formula for large plate which rests on elastic foundation is loaded at equidistant points along x-axis by force ‘P’?	Apply	CBST001.09
6	Derive the differential equation for a uniformly loaded simply supported rectangular plate on elastic foundation.	Understand	CBST001.10
7	Derive Levey’s solution for large plate loaded at equidistant points by concentrated force ‘p’	Understand	CBST001.10
8	Write short notes on i)plater on elastic foundation ii)Levy’s solutionfpr rectangular plate. iii)Relation between curvature and B.M. in pure bending.	Understand	CBST001.11
9	Obtain deflection of UDL simply supported rectangular plate on an elastic foundation.	Understand	CBST001.11
Part - C (Problem Solving and Critical Thinking Questions)			
1	Derive Levey’s solution for large plate loaded at equidistant points by concentrated force ‘p’	Analyze & evaluate	CBST001.08
2	Derive deflection ‘w’ of mat foundation resting on an elastic sub grade and carrying equidistant and equal load ’l’.	Analyze & evaluate	CBST001.08
3	Derive the differential equation for a uniformly loaded simply supported rectangular plate on elastic foundation.	Analyze & evaluate	CBST001.09
4	Obtain deflection of UDL simply supported rectangular plate on an elastic foundation.	Analyze & evaluate	CBST001.09
5	Derive Bending moment at the center of a circular plate carrying loads at center.	Analyze & evaluate	CBST001.10

6	Obtain the deflection equation for a UDL simply supported rectangular plate on an elastic foundation	Apply	CBST001.10
UNIT – IV			
SHELLS			
Part - A (Short Answer Questions)			
1	Differentiate between long shells and short shells.	Remember	CBST001.13
2	Explain the bending and membrane theories for analysis of shells.	Remember	CBST001.13
3	Briefly explain about the classification of shells.	Remember	CBST001.14
4	Explain about the various types of shells with neat sketches.	Remember	CBST001.14
5	Explain about the advantages and disadvantages of the shells.	Remember	CBST001.15
6	Explain about beam analysis.	Remember	CBST001.16
7	Explain the bending and membrane theories for analysis of shells	Remember	CBST001.17
8	Derive the membrane equation for shells.	Remember	CBST001.18
9	Explain about the bending theory of shells	Remember	CBST001.19
10	Explain about the advantages and disadvantages of the shells.	Remember	CBST001.20
Part - B (Long Answer Questions)			
1	Derive Shorer's differential equation	Understand	CBST001.13
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	CBST001.13
3	Derive the governing differential equation for the membrane analysis of shells of double curvature	Understand	CBST001.14
4	Derive the membrane stress resultants for rectangular hyperbolic paraboloid on straight line generators.	Understand	CBST001.14
5	Derive the equilibrium equation of rectangular shell.	Understand	CBST001.15
6	Derive the membrane differential equation for the elliptic paraboloid.	Understand	CBST001.16
7	Derive the membrane differential equation for the rotational paraboloid	Understand	CBST001.17
8	Explain about membrane theory of anticlastic shells	Understand	CBST001.18
9	Write a short note on a) Anti-symmetric shells b) Singly curved shells c) ISI classification of shells	Understand	CBST001.20
Part - C (Problem Solving and Critical Thinking Questions)			
1	Derive the equilibrium equation of rectangular shell.	Apply	CBST001.14
2	Derive the general equations for axisymmetric shells of revolution	Apply	CBST001.14
3	Define the membrane state of stress in shells. Derive equations of equilibrium, using membrane theory for cylindrical Shell and obtain Mx, MQ & MxQ	Apply	CBST001.15
4	10. Explain the following a) Membrane behavior b) Membrane equation	Apply	CBST001.15
5	Explain about membrane theory of anticlastic shells.	Apply	CBST001.15
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.	Apply	CBST001.16

7	(a) Differentiate between long shells and short shells. (b) Explain about the advantages and disadvantages of the shells.	Apply	CBST001.17
8	Write a short note on a) Anti-symmetric shells b) Singly curved shells c) ISI classification of shells	Apply	CBST001.18
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	Apply	CBST001.19
UNIT – V			
BUCKLING OF THIN PLATES			
Part - A (Short Answer Questions)			
1	Write brief notes on buckling of plates .	Remember	CBST001.22
2	Explain about buckling of rectangular plates by compressive force acting in one direction in the middle plane of plate.	Remember	CBST001.22
3	Buckling of rectangular plates by compressive force acting in two directions in the middle plane of plate.	Remember	CBST001.21
4	What are the boundary conditions of fixed and clamped edges in finite difference method.	Remember	CBST001.21
5	Application of the theory to the calculation of grid work.	Remember	CBST001.21
6	Drive an differential equation of an isotropic plate.	Remember	CBST001.21
7	Explain any two types of rigidities in orthotropic plate .	Remember	CBST001.21
8	Explain about differential equations for plate subjected to cylindrical bending.	Remember	CBST001.22
Part - B (Long Answer Questions)			
1	Derive governing equation for bending of plate under the action of in plan loading .	Understand	CBST001.22
2	Derive governing equation for bending of plate under the action of lateral loads.	Understand	CBST001.22
3	Derive the equation for strain energy in pure bending of plates.	Understand	CBST001.21
4	Derive an expression for all round simply supported rectangular plate by Navier solution.	Understand	CBST001.21
5	Find maximum and minimum deflection of simply supported rectangular plate.	Understand	CBST001.21
6	Explain and state maximum and minimum bending stress for plates under sinusoidal load..	Understand	CBST001.21
7	Explain an expression for maximum deflection at the centre of a simply supported plate concreted load at the center	Understand	CBST001.21
8	Explain about cylindrical bending of uniformly loaded rectangular plates with fixed edges	Understand	CBST001.22
Part - C (Problem Solving and Critical Thinking Questions)			
1	Derive expression for deflection of plate concentrated load on simlysupported rectangular plate with fog.	Apply	CBST001.21
2	Write down the expression for all round simply supported rectangular plate by Navier solution.	Apply	CBST001.21
3	Write notes about thermal stresses in simply supported rectangular plates.	Apply	CBST001.21
4	Derive Levy's solution of finding deflection of a rectangular plate	Apply	CBST001.22
5	cylindrical bending of uniformly loaded rectangular plates with fixed edges	Apply	CBST001.22
6	Derive an equation for cylindrical bending of uniformly loaded rectangular	Apply	CBST001.22

	plates with fixed edges		
7	Derive the differential equations of cylindrical bending of uniformly loaded rectangular plates with different edge conditions.	Apply	CBST001.22
8	Find maximum deflection at the center of the plate for uniformly loaded circular plate.	Apply	CBST001.22
9	Derive formulae for maximum and minimum bending stress for plates under sinusoidal load	Apply	CBST001.22

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HEAD
DEPARTMENT OF CIVIL ENGINEERING