SRM VALLIAMMAI ENGINEERING COLLEGE

(AN AUTONOMOUS INSTITUTION)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF CIVIL ENGINEERING

(M.E- STRUCTURAL ENGINEERING)

QUESTION BANK

II Semester

1917201 - STABILITY OF STRUCTURES

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DEPARTMENT OF CIVIL ENGINEERING

QUESTION BANK

SUBJECT : 1917201- STABILITY OF STRUCTURES

SEM / YEAR: II/I Year

UNIT – I: BUCKLING OF COLUMNS			
States of equilibrium - Classification of buckling problems - concept of equilibrium, energy, imperfection and vibration approaches to stability analysis - Eigen value problem. Governing equation for columns - Analysis for various boundary conditions - using Equilibrium, Energy methods. Approximate methods -Rayleigh Ritz, Galerkins approach - Numerical Techniques - Finite difference method - Effect of shear on buckling.			
PART-A			
Sl.No	Questions	**BT Level**	**Competence**
1.	List the types of structural failure.	BT-1	Remember
2.	What are the approaches to stability analysis?	BT-1	Remember
3.	Draw & label the mode shape of buckling.	BT-3	Application
4.	Outline the assumptions made in the Euler theory of long column?	BT-2	Understand
5.	Outline the difference between the Rayleigh-Ritz method and Galerkins method.	BT-2	Understand
6.	What is meant by elastically restrained column?	BT-1	Remember
7.	Draw& label the load Vs deflection curves of eccentrically loaded columns?	BT-1	Remember
8.	Examine states of Equilibrium.	BT-4	Analyze
9.	The support reactions depends on the relative rigidities of the members. Justify.	BT-5	Evaluate
10.	Construct, why energy approach in structural analysis is considered superior to other methods?	BT-3	Application
11.	Interpret examples for column with one end fixed and the other end hinged.	BT-2	Understand
12.	Construct the implications of columns with geometric imperfections?	BT-3	Application
13.	Compile the differences between Galerkins method and Rayleigh-Ritz method for calculating the buckling load of the member?	BT-6	Create
14.	What do you mean buckling load?	BT-1	Remember
15.	Examine any two applications where the columns are	BT-4	Analyze

	eccentrically loaded.		
16.	Assess how the buckling load of column with variable cross section is obtained?	BT-5	Evaluate
17.	List the types of differential equations for column stability analysis.	BT-1	Remember
18.	Analyse shear on buckling.	BT-4	Analyze
19.	Compose the classification of structural instability.	BT-6	Create
20.	Demonstrate the load deflection curve for initially bent columns.	BT-2	Understand

PART –B

1.	Using higher order differential equation, find the critical load for a column one end fixed and other end is hinged.	BT-1	Remember
2.	Using higher order differential equation, find the critical load for a column one end fixed and other end is free.	BT-1	Remember
3.	Evaluate the critical load for eccentrically loaded column.	BT-5	Evaluate
4.	Compose the principle and applications of Energy methods.	BT-6	Create
5.	Examine the critical load (using energy method) of a hinged-hinged column having uniform varying moment of inertia, $\mathbf{I_0}$.	BT-4	Analyze
6.	Develop the differential equation for maximum deflection and maximum bending moment in case of beam column with central load.	BT-3	Application
7.	Develop Euler's approach in detail.	BT-3	Application
8.	Formulate the differential equation for maximum deflection and end slopes in case of beam column subjected to end couples.	BT-1	Remember
9.	Outline the differential equation for maximum deflection and maximum bending moment in case of beam column with built in ends.	BT-2	Understand
10.	a) Outline the differential equation for beam column. (7) b) Summarize the approximate methods used in the stability analysis and discuss their merits. (6)	BT-2	Understand
11.	Demonstrate the differential equation for maximum deflection and end slopes in case of beam column subjected to clamped/ built in ends.	BT-2	Understand
12.	Determine the critical load of a column which is fixed at one end free at other end using equilibrium approach using fourth order differential equation.	BT-4	Analyze
13.	Determine the critical load of a column which is hinged at both the ends using equilibrium approach using fourth order differential equation.	BT-4	Analyze
14.	Determine the critical load of a column which is fixed at both the ends using equilibrium approach using fourth order differential equation.	BT-1	Remember

PART –C

1.	The yield strength of the material used in a column is 250 MPa. It is desired to obtain an allowable stress equal to 100 MPa. Assuming FoS = 5/3, find the maximum allowable slenderness ration by any suitable method.	BT-1	Remember
2.	From first principles, formulate the expression for buckling load of a column fixed at one end and free at other end.	BT-6	Create
3.	Demonstrate a) Flexural buckling (4) b)Torsional buckling (4) c)Flexural – torsional buckling (4) d)Snap-through buckling. (3)	BT-2	Understand
4.	Explain finite difference method in detail.	BT-5	Evaluate

UNIT – II: BUCKLING OF BEAM-COLUMNS AND FRAMES

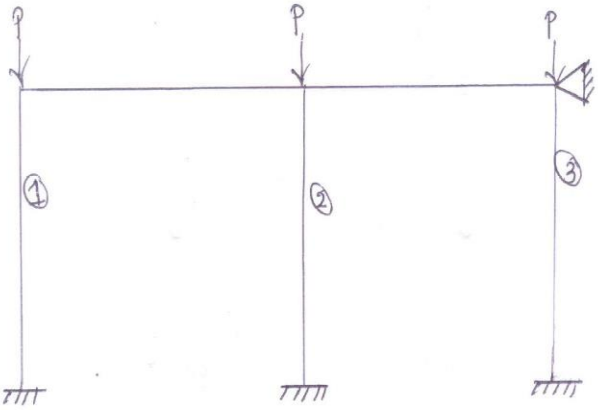
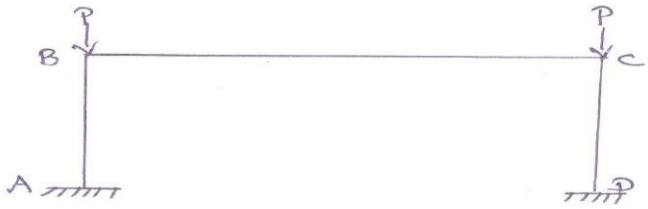
Theory of beam column-Stability analysis of beam column with single and several concentrated loads, distributed load and end couples -Analysis of rigid jointed frames with and without sway-Use of stability function to determine the critical load.

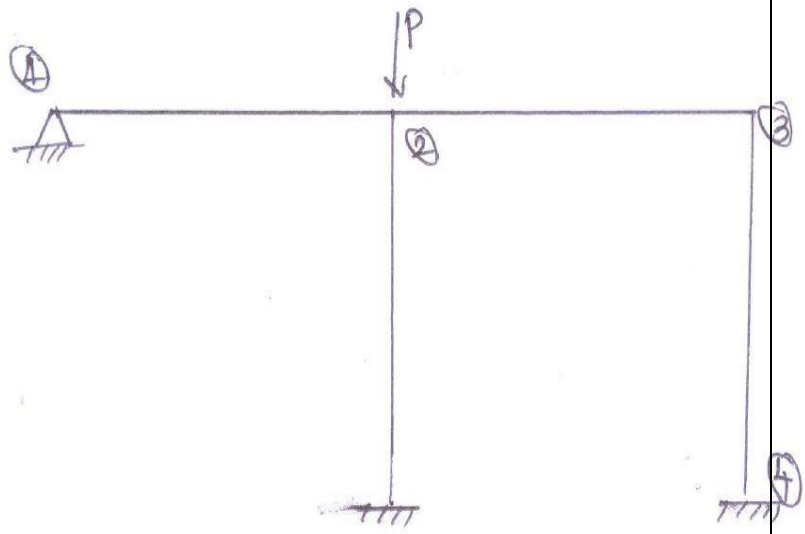
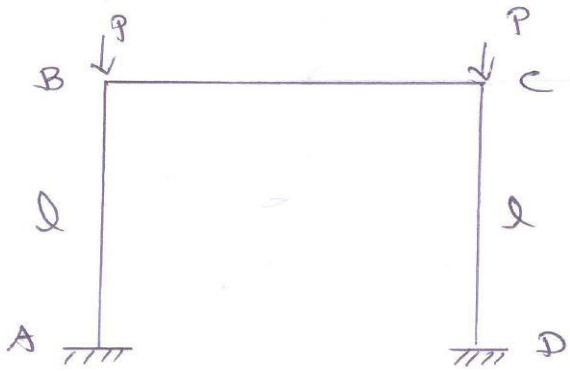
PART – A

Sl.No	Questions	BT Level	Competence
1.	Explain Beam- Column.	BT-2	Understand
2.	Illustrate the modes of buckling in frames.	BT-2	Understand
3.	Construct the term of Load-Deflection Characteristics.	BT-3	Application
4.	Outline beam column interaction equation.	BT-2	Understand
5.	Define stability of functions.	BT-1	Remember
6.	Construct the differential equation for a beam column carrying UDL.	BT-3	Application
7.	Develop the differential equation for a beam column carrying non-central concentrated load.	BT-3	Application
8.	Write down the differential equation for a beam column carrying end couples.	BT-1	Remember
9.	What is an euler ideal column?	BT-1	Remember
10.	Explain perfect column.	BT-5	Evaluate
11.	Define euler load.	BT-1	Remember
12.	Define superposition.	BT-1	Remember
13.	Compile stability stiffness influence coefficient.	BT-6	Create
14.	List out application of beam column.	BT-1	Remember
15.	Outline the slope deflection equations of beam.	BT-2	Understand
16.	Examine moment amplification factor.	BT-4	Analyze
17.	Compile the fourth order differential equation of equilibrium of a beam –column.	BT-6	Create
18.	Explain conservative system.	BT-5	Evaluate

19.	Analyze under what conditions superposition is valid for beam- column problem.	BT-4	Analyze
20.	Examine distinct stability functions.	BT-4	Analyze

PART –B

1.	A beam column is subjected to compressive force at the ends in addition to moments at the two ends which produces zero slopes at the two ends which produces zero slopes at the two ends Find the expression for 1)Deflection curve (5) 2)Max Deflection (4) 3)Max Moment. (4)	BT-1	Remember
2.	Demonstrate the effect of shear force on the critical load.	BT-2	Understand
3.	Find the critical load of the frame using Non Sway Mode.  	BT-1	Remember
4.	Find the critical load of the frame using Non Sway Mode.  	BT-1	Remember
5.	Find the critical load of the frame.	BT-1	Remember

			
6.	Examine the critical load of the frame. 	BT-4	Analyze
7.	Develop the differential equation for maximum deflection and maximum bending moment in case of beam column with central load.	BT-3	Application
8.	Construct the differential equation for beam columns with compressive force and distributed lateral load.	BT-3	Application
9.	Examine the differential equation for maximum deflection and end slopes in case of beam column subjected to end couples.	BT-4	Analyze
10.	Compose the differential equation for maximum deflection and maximum bending moment in case of beam column with built in ends.	BT-6	Create
11.	a) Assess differential equation for beam column. (7) b)Defend the approximate methods used in the stability	BT-5	Evaluate

	analysis and discuss their merits? (6)		
12.	Examine the differential equation for maximum deflection and end slopes in case of beam column subjected to clamped/ built in ends.	BT-4	Analyze
13.	Illustrate the maximum bending moment in a beam –column on simply support & when subjected to axial load P and concentrated lateral load Q.	BT-2	Understand
14.	Explain the failure of beam columns.	BT-2	Understand

PART –C

1.	Illustrate matrix approach for frames.	BT-2	Understand
2.	Enumerate beam column action? List out few examples that are subjected to beam column action.	BT-1	Remember
3.	A beam column is subjected to compressive forces at the ends in addition to moments at the two end, Construct the expression for a) Deflection Curve (5) b) Max deflection (5) c) Max Moments (5)	BT-3	Application
4.	Conclude, why superposition of deflection is not valid for a beam column?	BT-5	Evaluate

UNIT – III: TORSIONAL AND LATERAL BUCKLING

Torsional buckling - Combined Torsional and flexural buckling - Local buckling. Buckling of Open Sections- Numerical solutions. Lateral buckling of beams, pure bending of simply supported and cantilever beams.

PART – A

Sl.No	Questions	BT Level	Competence
1.	What are types of torsion?	BT-1	Remember
2.	Define Warping torsion.	BT-1	Remember
3.	Construct any two examples for torsional buckling of Columns.	BT-3	Application
4.	Demonstrate the differential equation for non-uniform torsion.	BT-2	Understand
5.	Outline under what conditions torsional buckling occur?	BT-2	Understand
6.	List the likely modes of buckling in the case of circular tubular column.	BT-1	Remember
7.	Define Shear centre.	BT-1	Remember
8.	Examine lateral buckling.	BT-4	Analyze
9.	Identify the factors affect the lateral buckling strength of beam?	BT-3	Application

10.	Apply, how will you strengthen the beam against lateral buckling?	BT-3	Application
11.	Explain inelastic buckling.	BT-2	Understand
12.	Analyze the factors affect the lateral buckling strength of a beam?	BT-4	Analyze
13.	Discuss warping stiffnesses?	BT-6	Create
14.	What do you mean buckling load?	BT-1	Remember
15.	Defend shear on buckling.	BT-5	Evaluate
16.	Defend Initially bent columns.	BT-5	Evaluate
17.	What is torsional-flexural buckling?	BT-1	Remember
18.	Categorize the sections that has torsional flexural buckling load lesser than the euler load?	BT-4	Analyze
19.	Invent distinct and auxilary stability functions.	BT-6	Create
20.	Explain shear Flow.	BT-2	Understand

PART – B

1.	Compose lateral buckling of simply supported rectangular beam with central concentrated load.	BT-6	Create
2.	Demonstrate the expression for critical moment for lateral buckling of rectangular beam in pure bending?.	BT-2	Understand
3.	Derive the expression for critical moment for lateral buckling of an I section beam in pure bending.	BT-1	Remember
4.	Derive lateral buckling of simply supported rectangular beam with UDL	BT-1	Remember
5.	Determine lateral buckling of cantilever beam with moment at the free end.	BT-5	Evaluate
6.	Explain 'Lateral buckling' in beams and performance of the beam subjected to lateral buckling.	BT-3	Application
7.	Analyze the main difference between torsional and flexural buckling with appropriate examples.	BT-4	Analyze
8.	Explain the critical load for hinged column bases.	BT-2	Understand
9.	Find the critical load of a hinged-hinged column of length 2.5 m.The column is made with a thin walled channel section having flange with of 100 mm, mean deapth of 220mm and uniform thickness of 2mm.The load is applied axially at the centroid.Take modulus of elasticity as 200Gpa and Modulus of rigidity as 80 Gpa.	BT-2	Understand
10.	Explain non uniform torsion of thin walled bars of open cross section with neat sketches.	BT-3	Application
11.	Examine the expression for pure torsion of thin walled bars of open cross section.	BT-4	Analyze
12.	Derive lateral buckling of simply supported beam of narrow	BT-1	Remember

	rectangular section.		
13.	Briefly describe torsional buckling, lateral buckling and inelastic buckling.	BT-1	Remember
14.	Examine the critical load for fixed column bases.	BT-4	Analyze

PART – C

1.	Write a short notes on torsional buckling and also explain pure torsion of thin walled bars of open cross section	BT-6	Create
2.	Investigate torsional-flexural buckling of columns.	BT-5	Evaluate
3.	Derive the critical load of cantilever columns.	BT-3	Application
4.	(i) Explain the Tangent modulus theory. (8) (ii) Explain the Double modulus theory. (7)	BT-2	Understand

UNIT – IV: BUCKLING OF PLATES

Governing differential equation- Buckling of thin plates, various edge conditions- Analysis by equilibrium and energy approach- Finite difference method.

PART – A

Sl.No	Questions	BT Level	Competence
1.	What is lateral buckling?	BT-1	Remember
2.	What is post buckling strength?	BT-4	Analyze
3.	How will you strengthen the beam against lateral buckling?	BT-5	Evaluate
4.	What is inelastic buckling?	BT-1	Remember
5.	What factors affect the lateral buckling strength of a beam?	BT-3	Application
6.	What are the differences between Galerkin's method and Rayleigh-Ritz method for calculating the buckling load of a member?	BT-5	Evaluate
7.	Give any two examples for torsional buckling of columns.	BT-2	Understand
8.	What are the assumptions made in the behaviour of thin plates?	BT-1	Remember
9.	A structure which maintains equilibrium may not remain stable- why?	BT-3	Application
10.	Why energy approach in structural analysis is considered superior to other methods?	BT-6	Create
11.	What are thick plates?	BT-6	Create
12.	What are thin plates?	BT-4	Analyze
13.	What are the implications of columns with geometric imperfections?	BT-1	Remember
14.	Draw the typical buckling mode for a rectangular plate size " a × 3a" When it is simply supported along all edges and uni-axially compressed along the shorter edges.	BT-3	Application
15.	Outline the idealizations made in the analysis of thin plates.	BT-2	Understand
16.	Define finite Difference operators.	BT-4	Analyze
17.	Explain the stress distribution in post buckling	BT-2	Understand
18.	Explain the stress distribution in pre buckling	BT-1	Remember
19.	Draw Load Deflection curve for post buckling region.	BT-1	Remember

20.	Define Inelastic buckling of plates.	BT-2	Understand

PART B

1.	Derive the expression for critical load of a plate uniformly compressed in one direction. The plate is simply supported with sides a,b and loaded with compressive force N_x.	BT-1	Remember
2.	Derive the expression for strain energy of bending in a plate?	BT-1	Remember
3.	Derive the expression for critical moment due to lateral buckling of an I- section beam in pure bending?	BT-3	Application
4.	A Prismatic member is simply supported and subjected to combined axial force P and a transverse load of W at the mid-span. Derive the equation which defines its failures criteria. The member is adequately laterally supported against lateral/weak axis buckling?	BT-4	Analyze
5.	A beam column member is subjected to an axial compressive load of P. Find the maximum permissible lateral load that the beam can carry without causing elastic buckling?	BT-2	Understand
6.	Determine the lateral buckling moment of resistance of a beam of I-section subjected to pure bending.	BT-3	Application
7.	Derive the ultimate strength of axially compressed plates	BT-4	Analyze
8.	Briefly describe torsional buckling, lateral buckling and inelastic buckling.	BT-2	Understand
9.	Discuss the stability of plates under in plane and transverse loading.	BT-1	Remember
10.	Derive the critical value of the compressive force for buckling of simply supported rectangular plates uniformly compressed in one direction.	BT-5	Evaluate
11.	Derive the critical value of the compressive force for buckling of simply supported rectangular plates uniformly compressed in two directions.	BT-4	Analyze
12.	Compose plate buckling by finite elements.	BT-6	Create
13.	Using energy method determine the critical load of a square plate of size "a × a" Whose edges are fixed and compressed by a uniformly distributed force " N" along the entire boundary.	BT-2	Understand
14.	Using finite difference method determine the critical load of a square plate of size "a × a" Whose edges are simply supported and compressed by a uniformly distributed force " N" along the entire boundary. Assume the plate is divided into 16 elements.	BT-1	Remember

PART –C

1.	Explain post buckling behaviour of thin plates.	BT-3	Application
2.	Illustrate the design provisions for local buckling of plates.	BT-6	Create
3.	Compose the plate-buckling coefficients for various cases.	BT-5	Evaluate
4.	Determine the critical loading for a simply supported ,square plate loaded in two perpendicular directions by uniformly distributed load. Obtain an exact solution by solving the	BT-2	Understand

	governing differential equation.		

UNIT – V: INELASTIC BUCKLING

Double modulus theory- Tangent modulus theory- Shanley's model- Eccentrically loaded inelastic column- Inelastic buckling of plates- Post buckling behaviour of plates.

PART – A

Sl.No	Questions	BT Level	Competence
1.	Demonstrate the basic difference between elastic and inelastic buckling.	BT-2	Understand
2.	What are the assumptions made in Tangent modulus theory?	BT-1	Remember
3.	What are the assumptions made in Double modulus theory?	BT-4	Analyze
4.	How it is possible that a plate can carry load even after buckling?	BT-2	Understand
5.	Draw the stress distribution of double modulus for a rectangular section.	BT-1	Remember
6.	Draw the strain distribution of double modulus for a rectangular section.	BT-3	Application
7.	Define Inelastic buckling of plates.	BT-5	Evaluate
8.	Where double modulus theory is applied.	BT-1	Remember
9.	A structure which maintains equilibrium may not remain stable- why?	BT-2	Understand
10.	Why energy approach in structural analysis is considered superior to other methods?	BT-5	Evaluate
11.	Load deflection curve for post buckling region	BT-6	Create
12.	Give the equation of inelastic critical stress for plates.	BT-3	Application
13.	What are the assumptions made in Shanley theory of inelastic buckling?	BT-6	Create
14.	Define inelastic buckling of columns	BT-4	Analyze
15.	Demonstrate Rayleigh-Ritz method.	BT-1	Remember
16.	What is the strain energy of bending in a plate?	BT-1	Remember
17.	Outline types of differential equations for column stability analysis	BT-3	Application
18.	Define shear on buckling?	BT-4	Analyze
19.	Give the equation of plasticity reduction factor.	BT-2	Understand
20.	Outline the Galerkin's equation.	BT-1	Remember

PART-B

1.	Explain the Tangent Modulus and Double Modulus theories.	BT-2	Understand
2.	Explain the various assumptions made in the double modulus theory.	BT-3	Application
3.	Explain the inelastic buckling of a column with built-in ends subjected to axial load	BT-5	Evaluate

4.	Explain the orthogonal relation of buckling problems	BT-4	Analyze
5.	Explain the following: a . Inelastic buckling of columns. (5) b . Mathematical treatment of stability problems (4) c . Effect of shear on critical load of columns (4)	BT-1	Remember
6.	Explain 'Inelastic buckling' and its importance	BT-3	Application
7.	Derive expression for Reduced Modulus of I Section.	BT-1	Remember
8.	Derive the expression for inelastic buckling of a column which is rectangular in cross section with both ends hinged using Double modulus theory.	BT-4	Analyze
9.	Illustrate Shanley's theory of inelastic buckling.	BT-2	Understand
10.	Derive the expression for inelastic buckling of a column which is rectangular in cross section with both ends fixed using Double modulus theory.	BT-2	Understand
11.	Detail the difference between elastic and inelastic buckling theories.	BT-1	Remember
12.	Derive the expression for inelastic buckling of a column which is rectangular in cross section with one end is hinged other end fixed using Double modulus theory.	BT-1	Remember
13.	Outline the strain reversal concept.	BT-4	Analyze
14.	Formulate the differential equation for plate buckling.	BT-6	Create

PART –C

1.	Demonstate the finite difference method for plate stabilty	BT-2	Understand
2.	Derive the critical load for the square plate a x a simply supported on all edges subjected to inplane compressive force.	BT-6	Create
3.	Explain the orthogonal relation of buckling problems	BT-3	Application
4.	Using matrix method ,obtain critical load for a fixed –fixed column.	BT-1	Remember