Gyanmanjari Innovative University

Course Syllabus
Gyanmanjari Institute of Technology
Semester-1

Subject: Theory of structural stability – METSE11505

Type of course: Minor Stream

Prerequisite: Theory of Structures & Structural Analysis

Rationale: Structures are subjected to a multitude of loads, making it crucial to comprehend their behavior under these conditions. Stability holds paramount importance in the design of any structure, necessitating a comprehensive study of various design criteria. The failure of structures can often be attributed to the instability of individual members, making it essential to investigate instability arising from different structural actions. Additionally, the stability of frames as a whole must be analyzed to ensure their overall structural integrity.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
				Theory Marks		Practical Marks		CA	
CI	T	P	C	ESE	MSE	V	P	ALA	
4	1	0	5	60	30	10	20	30	150

Legends: CI-Class Room Instructions; T – Tutorial; P - Practical; C – Credit; ESE - End Semester Examination; MSE- Mid Semester Examination; V – Viva; CA - Continuous Assessment; ALA- Active Learning Activities.

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
1	**Stability of Columns: Governing Equations and Buckling Analysis** Students will derive the governing differential equation for column stability and solve it to obtain Euler's formulas for different column boundary conditions. They will perform a buckling analysis on a column using eigenvalue problems to determine buckling modes and critical loads. Students will consider scenarios involving axial and flexural buckling, lateral bracing, and combined axial, flexural, and torsion buckling. They will document their analysis process, including equations, calculations, and conclusions, and submit the detailed report on the GMIU Web Portal.	10

2	**Stability of Frames: Beam-Columns and Global Buckling** Students will examine the stability of a single-storey frame with sway and no-sway conditions using the stiffness method. They will study standard cases of beam-columns with elastic restraints and analyze the slenderness ratio of frame members. Additionally, students will investigate the effects of initial curvature and other geometric imperfections on the buckling behavior of beam-columns. The analysis will be performed using a combination of theoretical calculations and structural analysis software. A report summarizing their findings and design considerations will be submitted on the GMIU Web Portal.	10
3	**Introduction to Inelastic Buckling and Dynamic Stability** Students will research and present the differences between elastic and inelastic buckling, focusing on materials; yielding and post-buckling behavior. They will perform an inelastic buckling analysis for a steel column under compression and compare the results with an elastic buckling analysis. Additionally, they will study the dynamic stability of a simple structure under dynamic loading (e.g., harmonic excitation) using analytical and numerical methods. A report highlighting their findings and comparisons between different buckling types and stability criteria will be submitted on the GMIU Web Portal.	10
Total		**30**

Course Content:

Sr. No	Course content	Hrs	% Weightage
1	**Fundamental Concepts & Criteria for Design of Structures** Concept of stability - Stability, Strength, and Stiffness, Classical Concept of Stability of Discrete and Continuous Systems, instability and bifurcation, different forms of structural instability, approaches of stability analysis, Linear and nonlinear behavior	10	15
2	**Stability of Columns** Governing differential equation- Euler formulas for column – Eigenvalue problem; buckling modes and critical load; elastically restrained column, column with geometric imperfections, eccentrically loaded column, and large deflection analysis. Axial and Flexural Buckling, Lateral Bracing of Columns, Combined Axial, Flexural and Torsion Buckling	13	20
3	**Stability of Beams** Introduction lateral buckling of beams in pure bending; torsional buckling; combined flexural-torsional buckling	10	15
4	**Stability of Frames: Beam columns** Standard cases of beam columns, beam-columns with elastic restraints; effect of initial curvature Member Buckling versus Global Buckling, Slenderness Ratio of Frame Members,	13	20

	Buckling analysis of single-storey frames with sway and no sway condition using stiffness method		
5	**Stability of Plates** Differential equation of plate buckling and boundary conditions, rectangular plates under uniaxial and biaxial compression; axial- flexural buckling; shear-flexural buckling, application of energy methods for calculation of buckling loads and modes. **Introduction to Inelastic Buckling and Dynamic Stability.**	14	30
	Total	**60**	**100**

Suggested Specification table with Marks (Theory):60

Distribution of Theory Marks **(Revised Bloom's Taxonomy)**						
Level	Remembrance (R)	Understanding (U)	Application (A)	Analyze (N)	Evaluate (E)	Create (C)
Weightage	NA	NA	NA	NA	NA	NA

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcome:

After learning the course, the students should be able to:	
CO1	Determine stability of columns and frames
CO2	Determine stability of beams and plates
CO3	Use stability criteria and concepts for analyzing discrete and continuous systems

List of Practical

Sr. No	Descriptions	Unit No	Hrs
1	Study of effective length of columns with different end condition& determine buckling load	2	2
2	Study of Axial, Flexural & Torsional buckling in columns	2	2
3	Study of lateral torsional buckling of beams	3	2
4	Study of Structural stability of Beams, trusses & Frames	4	2
Total			**8**

Instructional Method:

The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of the tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

From the content 10% topics are suggested for flipped mode instruction.
Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses, Virtual Laboratory

The internal evaluation will be done on the basis of Active Learning Assignment

Practical/Viva examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

Reference Books:

[1] Theory of elastic stability, Timoshenko and Gere, Tata Mc Graw Hill,1981
[2] Principles of Structural Stability Theory, Alexander Chajes, Prentice Hall, New Jersey.
[3] Structural Stability of columns and plates, Iyengar, N. G. R., Eastern west press Pvt. Ltd.
[4] Structural Stability, Chen, W.F. & Lui, E.M.: Elsevier (1987).
[5] Stability Analysis and Design of Structures, Gambhir, M.L.: Springer- Verlag (2004)
[6] Strength of Metal Structures, Bleich F. Bucking, Tata McGraw Hill, New York.