Gyanmanjari Innovative University

Course Syllabus
Gyanmanjari Institute of Technology
Semester-1

Subject: Advanced Structural Analysis – METSE11501

Type of course: Major Core

Prerequisite: Mechanics of Solids, Structural Analysis and Matrix Algebra

Rationale: In today's computer-driven era, structural theory needs to be reconfigured into an integrated format suitable for all structural types and compatible with digital programming. The matrix method provides a comprehensive approach to analyzing various structural systems and is well-suited for digital computing. Complex structural problems often require mathematical solutions using numerical methods like the finite element method (FEM), which is particularly versatile. The Advanced Structural Analysis course teaches students how to analyze skeletal and continuum structures using matrix methods and software tools, preparing them to handle complex structural analysis effectively.

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	0	2	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	**Application of Virtual Work Principles in Structural Analysis** Students will select different types of structures (continuous beams, plane trusses, or frames) and calculate deflections or internal forces using virtual work methods. They will consider secondary influences like temperature changes or prestrains in their calculations. Students will submit their calculations and analysis on the GMIU Web Portal.	10
2	**Analysis of Structural Non-Linearity and Non-Linear Behavior in Structures**	10

	Students will choose a plane frame or truss and perform a non-linear analysis using software like ANSYS or SAP2000. They will investigate the effects of large deformations and material non-linearities, comparing the results with linear analysis. Students will submit a report detailing their analysis, findings, and design recommendations on the GMIU Web Portal.	
3	**Comparative Study of Flexibility and Stiffness in Different Structural Systems** Students will analyze two different structures (a truss and a frame) subjected to the same loading conditions. They will calculate the flexibility and stiffness matrices and compare the results, discussing which structure is more efficient for specific applications. Students will submit their analysis and conclusions on the GMIU Web Portal.	10
Total		**30**

Course Content:

Sr. No	Course content	Hrs	% Weightage
Stiffness Member Approach			
1	Fundamental principles of virtual work, along with the foundational concepts of flexibility and stiffness.	02	5%
2	Examination of continuous beams, plane trusses, plane frames, and plane grids, encompassing secondary influences like temperature fluctuations, prestrains, and terminal displacements.	16	25
3	An overview of structural non-linearity and the analysis of non-linear behavior in structures.	05	10
Finite Element Method			
4	Fundamentals of discretization, formulation of element stiffness and mass through direct, variational, and weighted residual methods.	06	10
5	Calculations of element characteristics pertaining to bar elements, beam elements, truss elements, as well as constant strain triangle and quadrilateral elements utilizing generalized coordinates.	15	25
6	Calculations of element attributes for bar elements, beam elements, truss elements, and constant strain triangle and quadrilateral elements using intrinsic coordinates; Iso-parametric approach. Axisymmetric solids	16	25
	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	Analyze skeleton structures using stiffness method
CO2	Analyze skeleton structures having secondary effects using stiffness method,
CO3	Derive element properties and analyze structure using finite element method
CO4	Solve realistic engineering problems through computational simulations using finite element code

List of Practical

Tutorial work shall consist of solution of at least five problems from each topic out of which at least half of problems shall be checked by use of standard software.

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] Finite Element Analysis - S. S. Bhavikatti
[2] Finite Element Method in Engineering - S.S. Rao
[3] Finite Elements Methods - C.S. Krishnamurthy
[4] Finite Element Method - Y. M. Desai, T. I. Eltho and A. H. Shah