Gyanmanjari Innovative University

Course Syllabus
Gyanmanjari Institute of Technology
Semester-1

Subject: Analytical and Numerical methods for Structural Engineering – METSE11503

Type of course: Minor Stream

Prerequisite: NIL

Rationale: Reinforced cement concrete is a popular construction material extensively utilized in the field. The continuous advancement of infrastructure development has led to a surge in the construction of specialized structures worldwide, including bunkers, silos, flat slabs, grid floors, shear walls, corbels, deep beams, and water retaining structures. The course on Advanced Concrete Design is specifically designed for aspiring structural engineering students, providing them with comprehensive knowledge and practical skills to analyze and design these unique structures in accordance with the Indian Standard code of practice.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
CI	T	P	C	Theory Marks		Practical Marks		CA	
				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	**Interpolation and Curve Fitting Techniques** Students will be provided with a set of empirical data points and asked to fit the data using different interpolation methods (e.g., linear interpolation, polynomial interpolation) and curve-fitting techniques (e.g., least squares method). They wili compare the accuracy of each method and discuss which method provides the best fit for the given data. Students will submit their analysis, calculations, and graphical representations on the GMIU Web Portal.	10

2	**Applications of Matrix Algebra in Engineering Problems** Students will solve a system of linear equations representing a structural dynamics problem (e.g., mass-spring system) using matrix methods (e.g., Gaussian elimination, LU decomposition). They will also calculate the eigenvalues and eigenvectors for a given matrix to analyze structural stability (buckling analysis). Students will submit their solutions, calculations, and interpretation of results on the GMIU Web Portal.	10
3	**Numerical Differentiation and Integration Techniques** Students will solve a differential equation (e.g., Eulers equation) using numerical methods such as Eulers method, Runge-Kutta methods, and finite difference methods for PDEs (e.g., Laplace equation). They will compare the results with analytical solutions and discuss the advantages and limitations of each numerical method. Students will submit a detailed report with their findings on the GMIU Web Portal.	10
Total		**30**

Course Content:

Sr. No	Course content	Hrs	% Weightage
1	Errors: Error analysis, types of errors, accuracy & precision, stability in numerical analysis	10	15
2	Interpolation and Curve Fitting: Empirical laws for curve fitting, general interpolation formulae.	10	15
3	Solution of Non-linear Algebraic and Transcendental Equations: Solution by graphical method, bisection method, Newton Raphson iterative method, Regula-Falsi method.	14	25
4	Elements of Matrix Algebra: Solution of systems of linear equations, Eigen value problems. Applications to Structural Dynamic problems, stress problems, buckling of columns	14	25
5	Numerical Differentiation & Integration: Solution of Ordinary and Partial Differential Equations, Euler's equation and other methods. Laplace equation - Properties of harmonic functions - Fourier transform methods for Laplace equation. Numerical Integration.	12	20
	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	Solve algebraic equations
CO2	Obtain numerical solution of ordinary and partial differential equations,
CO3	Apply integration method/s for structural analysis, iterative and transformation methods in structural engineering
CO4	Carry out interpolations and curve fitting
CO5	Obtain solution of eigen value problems and Fourier series for structural analysis

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] Numerical methods – B S Grewal

[2] Numerical methods in Engineering - Salvadori & Baron

[3] Numerical Methods in Finite Element Analysis - Bathe & Wilson

[4] Numerical methods for scientific and engineering computations – S R K Iyengar, R K Jain and Mahinder