Gyanmanjari Innovative University

Course Syllabus
Gyanmanjari Institute of Technology
Semester-1

Subject: Structural Optimization – METSE11508

Type of course: Minor Stream

Prerequisite: NIL

Rationale: The fundamental objective of structural design is to achieve both safety and economy. Safety is ensured by adhering to the standards set by the relevant codes of practice. While there may be numerous design solutions that satisfy these code provisions, only a few of them are truly cost-effective. To achieve the best possible outcome with the available resources, optimization techniques come into play. These techniques enable the identification of optimal designs that may involve minimum cost, minimum weight, maximum performance, or a combination of these factors. As a result, optimization techniques play a crucial role in enhancing the efficiency and effectiveness of structural design.

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	**Linear Programming** Students will solve linear programming problems using graphical and algebraic methods, and then apply the simplex method to more complex problems. They will be provided with different linear programming scenarios to work on and will submit their solutions, including graphical representations and simplex method calculations, in a report on the GMIU Web Portal.	10

2	**Structural Applications of Optimization** Students will perform optimization in structural design by applying the plastic theory and matrix methods to design planar structures. They will work on problems where they need to optimize structural elements based on given constraints and loading conditions. The analysis should include optimization strategies and results, with a focus on practical application. Students will prepare a report detailing their design process and optimization results, to be submitted on the GMIU Web Portal.	10
3	**Introduction to Specialized Optimization Techniques** Students will study and apply various specialized optimization techniques to specific problems. They will work on integer programming, dynamic programming, geometric programming, and genetic algorithms, solving problems relevant to these methods. Each student will document their methods, solutions, and any challenges encountered, and submit their findings in a comprehensive report on the GMIU Web Portal.	10
	Total	**30**

Course Content:

Sr. No	Course content	Hrs	% Weightage
1	**Introduction** Basic theory and elements of optimization Terminology and definitions. Basic principles and procedure of optimization. Classical Methods of optimization: Trial and error method, Lagrangian Multiplier method and Kuhn-Tucker method with illustrative examples.	10	15
2	**Linear Programing** Introduction, terminology, standard form of linear programming problem, geometrical interpretation, canonical form of equation graphical and algebraic methods of solving L.P. problems, Simplex method, illustrative examples.	10	15
3	**Non Linear programming** Unconstrained methods of optimization on Direct search methods, Univariate search method, Hooke and Jeeves' method, Powell's method, Steepest Descent Methods, Davidon – Fletcher-Powell (DFP) method, illustrative examples.	14	25
4	**Structural Applications** Optimum design using the plastic theory, Optimum design of planner structures using matrix force method and matrix displacement method.	16	30
5	**Introduction to Specialized Optimization techniques** Integer programming, Dynamic programming, Geometric programming and Genetic Algorithms.	10	15
	Total	**60**	**100**

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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	Understand optimization techniques
CO2	Classify the optimization problems,
CO3	Derive response quantities corresponding to design variable,
CO4	Apply optimization techniques to trusses, beams and frames.

List of Practical

Tutorial work shall consist of presentations / problems / preparation of learning material based on above topics. Apart from above assignments a group of students has to undertake one open ended design problem based on engineering application of Thin plates & shells.

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.

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Reference Books:

[1] Engineering Optimization – Theory and Practice, Rao S. S., New Age International.
[2] Optimum Design of Structures, Majid K I, - NEWNES – BUTTERWORTHS, London
[3] Optimization for Engineering Design – Algorithms and examples, Deb, K., Prentice Hall.
[4] Optimum Structural Design, Kirsch U., McGraw Hill.
[5] Introduction to Optimum Design, Arora J S. McGraw Hill

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