COURSE CONTENT

OPTIMIZATION TECHNIQUES								
I Semester: ST								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BSTE05	**Elective**	3	0	0	3	40	60	100
Contact Classes: 45	**Total Tutorials: Nil**	**Total Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: Linear Algebra and Calculus								

I. COURSE OVERVIEW:

Optimization Techniques is an advanced course designed to equip students with the theoretical foundations, computational methods, and practical applications of optimization in structural engineering. The course emphasizes the systematic development of efficient, safe, and sustainable structural systems by integrating engineering principles with optimization algorithms. Students will be introduced to classical optimization methods, modern metaheuristic approaches, and computational tools widely applied in solving structural design problems. The course covers both deterministic and stochastic optimization methods, focusing on real-world applications in civil structures

II. COURSE OBJECTIVES:

The student will try to learn:

I. The principles of structural optimization and be able to solve them analytically.
II. Structural optimization problems in the framework of calculus of variations as well as finite-variable optimization.
III. Contemporary literature on structural optimization in general and topology optimization in particular.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1 Formulate structural engineering problems into optimization models by identifying design variables, objective functions, and constraints.
CO 2 Apply classical optimization methods (linear, nonlinear, and integer programming) to solve structural design problems.
CO 3 Analyze structural optimization problems using gradient-based and numerical approaches.
CO 4 Implement metaheuristic algorithms such as Genetic Algorithms, Particle Swarm Optimization, and Ant Colony Optimization for complex structural systems.
CO 5 Evaluate alternative structural designs based on weight, cost, safety, and sustainability criteria.
CO 6 Develop and validate computational optimization models using MATLAB, Python, or specialized structural analysis/optimization software.

IV. COURSE CONTENT:

MODULE - I: INTRODUCTION (09)
Definition, Variables, Objective Function, Constraints, Simultaneous Failure Mode and Design, Classical External Problems

MODULE - II: CALCULUS OF VARIATION (09)
Differential calculus, Optimality criteria, Vibrational Principles with Constraints, Single variable optimization Multivariable optimization

MODULE – III: LINEAR PROGRAMMING (10)
Integer Programming, Nonlinear Programming, Dynamic Programming, Geometric Programming and Stochastic Programming.

Problem formulation, Graphical solution, Analytical method, Standard form, Slack, surplus and artificial variables

MODULE - IV: APPLICATIONS (9)
Structural Steel and Concrete Members, Trusses and Frames, Methods for optimal design of structural elements, continuous beams and single storied frames using plastic theory

MODULE - V: DESIGN (9)
Frequency Constraint, Design of Layouts, Minimum weight design for truss members, Fully stressed design-Optimization principles to design of R.C. structures such as multi-storey buildings.

V. TEXT BOOKS:
1. Spillers, William R, Keith M. MacBain, "*Structural Optimization*", Springer, 2009.
2. M. P. Bendsoe, O. Signmund,"*Topology Optimization: Theory, methods and Applications*" Springer, 2003

VI. REFERENCE BOOKS:
1. Haftka, Raphael T., Gürdal, Zafer, "*Elements of Structural Optimization*", Third Revised and Expanded Edition, kluver academic publishers, 2012.
2. Andrej Cherkaev, "*Variational methods for Structural Optimization*", Springer, 2012.

VII. ELECTRONICS RESOURCES:
1. http://nptel.ac.in/courses/112108211/25
2. http://nptel.ac.in/courses/112108211/25

VIII. MATERIALS ONLINE:
1. Course Outline Description
2. Tutorial Question Bank
3. Assignments
4. Model Question Paper – I
5. Model Question Paper - II
6. Lecture Notes
7. Early Lecture Readiness Videos
8. Power point presentation