



Birla Institute of Technology & Science, Pilani

Hyderabad Campus

SECOND SEMESTER 2022 – 2023

Course Handout Part II

16-01-2023

In addition to part-I (General Handout for all courses appended to the timetable) this portion gives further specific details regarding the course.

Course No. : CE G514
Course Title : **Structural Optimization**
Instructor-in-Charge : A. VASAN
Chamber No. : D-117

Course Description: Introduction, Engineering Optimization Problems, Optimal problem formulation, Single-variable optimization algorithms, Bracketing methods, Region Elimination methods, Gradient-based methods, Multivariable optimization algorithms, Evolutionary optimization methods, Simplex Search method, Hooke-Jeeves pattern search method, Powell's conjugate direction method, Cauchy's method, Newton's method, Conjugate Gradient method, Constrained Optimization algorithms, Kuhn-Tucker conditions, Transformation methods, Direct search for constrained minimization, Feasible Direction Method, Specialized algorithms, Integer Programming, Geometric Programming, Nontraditional optimization Algorithms, Genetic algorithms, Simulated Annealing, Structural Optimization, Methods of optimal design of structural elements, minimum weight design of truss members, optimum reinforced design of R.C. C. Slabs and beams, Optimization to the design of structures such as multi-storey buildings, water tank, shell roofs, folded plates.

1. Scope and Objective of the Course:

This objective of this course is to present the techniques and applications of engineering optimization in a simple manner. The ever-increasing demand on engineers to lower production costs to withstand competition has promoted engineers to look for rigorous methods of decision making, such as optimization methods, to design and produce both economically and efficiently. Optimization techniques, having reached a degree of maturity over the past several years, are being used in a wide spectrum.

Course Outcomes: After successful completion of this course, the student will be able to:

- CO1. Formulate engineering design problems as mathematical optimization model
- CO2. Choose the best suited optimization technique as well as software tool for solving the formulated optimization mathematical model
- CO3. Solve real world application problems using nontraditional optimization algorithms
- CO4. Develop a report that describes the formulated optimization model and the solving technique, analyze the results and propose recommendations in language understandable to the decision-making process

Student Learning Outcomes (SLOs) assessed in this course – (a), (b), (c), (d), (e), (f), (h), (j), and (k).

2 (a) Textbook

- T1. Singiresu S. Rao, "Engineering Optimization: Theory and Practice", New Age International Publishers, Fourth Edition, 2013.

(b) Reference books

- R1. Deb K, "Optimization for Engineering Design: Algorithms and Examples", Prentice Hall, New Delhi, 1995.
- R2. Deb K, "Multiobjective Optimization Using Evolutionary Algorithms", John Wiley & Sons Limited, 2010.

3. Course Plan:

Lecture No.	Topics to be covered	Learning objectives	Reference	SLO
1-3	Statement of an Optimization Problem, Classification, Applications, Optimization Literature	To understand optimization and formulate mathematical optimization model	T1	a, c, e, j
4-8	Single Variable Optimization, Multivariable Optimization with and without constraints, Kuhn-Tucker Conditions (KKT)	To develop single and multivariable optimization models and solve using KKT conditions	T1	a, c, e
9-16	Graphical Method, Analytical Method, Two Phase Simplex Method, Z_j - C_j Method, Primal Dual Algorithm, Big M Method, Special Cases	To solve LP models using various methods	T1	a, c, e
17-21	Unimodal Function, Elimination Methods, Interpolation Methods, Direct Search Methods, Indirect Search Methods	To solve simple nonlinear functions using various techniques	T1	a, c, e
22-27	Unconstrained Minimization Problem, Constrained Minimization, Primal Dual Relationships	To solve simple optimization model functions using various techniques	T1, R1	a, c, e
28-34	Bellman's principle of optimality, multistage decisions processes, concept of sub optimization, conversion of final value problem to initial value problem	To understand multistage decisions processes using dynamic programming	T1	a, c, e
35-38	Multiobjective Optimization, Introduction to Nontraditional Optimization Algorithms such as Genetic Algorithms, Particle Swarm Optimization, Cuckoo Search Optimization etc	To introduce Multiobjective optimization and nontraditional optimization and understand their working	T1, R2	a, b, c, e, k

39-42	Methods of Optimum Structural elements, minimum weight design of truss members, optimum reinforced design of RCC slabs and beams, principles of optimization of design of multi-storey structures etc	To apply various optimization techniques to solve various practical structural engineering problems	T1, Journal Papers	a, b, c, d, e, f, h, j, k
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Student Learning Outcomes (SLOs):

SLOs are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.

- (a) an ability to apply knowledge of mathematics, science and engineering
- (b) an ability to design and conduct experiments, as well as to analyze and interpret data
- (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- (d) an ability to function on multidisciplinary teams
- (e) an ability to identify, formulate, and solve engineering problems
- (f) an understanding of professional and ethical responsibility
- (g) an ability to communicate effectively
- (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- (i) a recognition of the need for, and an ability to engage in life-long learning
- (j) a knowledge of contemporary issues
- (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

4. Evaluation Scheme

S. No.	Evaluation Component	Duration (min)	Weightage (%)	Date & Time	Remarks
1	Midsem Test	90	25	15/03 11.30 am – 01.00 pm	OB
2	Seminar (2 nos)	-	15	-	OB
3	Project (3 reviews)	-	25	-	OB
4	Compre Exam	120	35	12/05 AN	OB

5. Chamber Consultation Hour: Thursday 04.30 PM – 05.00 PM

6. Notices: Notices concerning this course will be displayed on Google Classroom Course page.

7. Make-up Policy: Prior permission for all make ups are a must. For medical emergencies, requests have to be forwarded by the Chief Warden to the satisfaction of IC.

8. Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

INSTRUCTOR-IN-CHARGE