INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

ENGINEERING OPTIMIZATION TECHNIQUES								
VIII Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AAED60	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Mathematics, Numerical Methods								

I.COURSE OVERVIEW:

The major emphasis of this course is to apply the concept of mathematical principles to obtain the required performance of systems. Various techniques in optimizations which include simplex methods and classical methods are discussed. Constrained and Un constrained techniques which are the part of engineering problems are addressed.

II.COURSE OBJECTIVES:

The students will try to learn:

I. The concepts of optimization and various methods for obtaining best performance of systems.
II. The concept of classical methods and its applications for better design.
III. The methods involved in nonlinear programming and simplex methods for efficient programming.
IV. The concepts linear and nonlinear programming for obtaining better solutions under constraints and unconstraint conditions.

III.COURSE OUTCOMES:

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

CO 1 Demonstrate a comprehensive understanding of various optimization methods employed in engineering.
CO 2 Analyze and evaluate the performance of optimization algorithms in different engineering applications.
CO 3 Develop proficiency in utilizing optimization software tools for problem-solving and decision-making.
CO 4 Acquire skills in modeling and representing complex engineering systems for optimization.
CO 5 Collaborate effectively in a team to tackle optimization challenges and present solutions.
CO 6 Communicate optimization results and findings clearly through written reports and oral presentations.

IV. COURSE CONTENT:

MODULE-I: INTRODUCTION TO OPTIMIZATION (10)

Introduction, Historical Development , Engineering Applications of Optimization, Statement of an Optimization Problem, Design Vector, Design Constraints, Constraint Surface, Objective Function, Objective Function Surfaces, Classification of Optimization Problems, Classification Based on the Existence of Constraints, Classification Based on the Nature of the Design Variables, Classification Based on the Physical Structure of the Problem, Classification Based on the Nature of the Equations Involved, Classification Based on the Permissible Values of the Design Variables, Classification Based on the Deterministic Nature of the Variables, Classification Based on the Separability of the Functions, Classification Based on the Number of Objective Functions, Optimization Techniques.

MODULE –II: CLASSICAL OPTIMIZATION TECHNIQUES (10)

Introduction, Single-Variable Optimization, Multivariable Optimization with No Constraints, semi definite Case, Saddle Point, Multivariable Optimization with Equality Constraints, Solution by Direct Substitution, Solution by the Method of Constrained Variation, Solution by the Method of Lagrange Multipliers, Multivariable Optimization with Inequality Constraints, Kuhn–Tucker Conditions, Constraint Qualification, Convex Programming Problem.

MODULE –III: LINEAR PROGRAMMING: SIMPLEX METHOD (10)

Introduction, Applications of Linear Programming, Standard Form of a Linear Programming Problem, Geometry of Linear Programming Problems. Pivotal Reduction of a General System of Equations

Motivation of the Simplex Method, Simplex Algorithm, Identifying an Optimal Point, Improving a non-optimal Basic Feasible Solution, Two Phases of the Simplex Method.

MODULE–IV: NONLINEAR PROGRAMMING:ONE-DIMENSIONAL MINIMIZATION METHODS (09)

Introduction, Unimodal Function, Elimination methods, Unrestricted Search, Search with Fixed Step Size, Search with Accelerated Step Size, Exhaustive Search, Dichotomous Search, Interval Halving Method, Fibonacci Method, Golden Section Method, Comparison of Elimination Methods.

MODULE–V: NONLINEAR PROGRAMMING II: UNCONSTRAINED OPTIMIZATION TECHNIQUES (09)

Introduction, Classification of Unconstrained Minimization Methods, General Approach, Rate of Convergence, Scaling of Design Variables, DIRECT SEARCH METHODS -Random Search Methods, Random Jumping Method, Random Walk Method, Random Walk Method with Direction Exploitation, Advantages of Random Search Methods, Grid Search Method, Univariate Method, Pattern Directions, Powell's Method, Conjugate Directions, Algorithm, Simplex Method, Reflection, Expansion, Contraction.

V. TEXT BOOKS:

1. Singiresu S. Rao, "Engineering Optimization Theory and Practice", John Wiley Sons, 4th Edition, 2009.
2. Kalyanmoy Deb, "Optimization for Engineering Design", PHI Learning private limited, 2nd Edition, 2012.

VI. REFERENCE BOOKS:

1. Kaushik Kumar, Supriyo Roy, J. Paulo Davim "Soft Computing Techniques for Engineering Optimization", CRC Press, 1st Edition, 2021.
2. Xin-She Yang "Optimization Techniques and Applications with Examples" John Wiley & Sons, 2018.

VII. ELECTRONICS RESOURCES

1. https://archive.nptel.ac.in/content/storage2/courses/105108127/pdf/Module_1/M1L1_LN.pdf

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Tech talk topics
4. Open end experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper - II
9. Lecture notes
10. E-learning readiness videos (ELRV)
11. Power point presentation