# OPTIMIZATION METHODS IN ENGINEERING

**Subject Code: 13ME2104**

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**Pre requisites:** Probability and Statistics

**Course Educational Objectives:**

To make the student learn

1. basic mathematical concepts of optimization
2. methods of modelling and formulating optimization problems
3. different methods of solving optimization problems
4. ways of interpreting solution of optimization problems in engineering in general and mechanical engineering problems in particular

**Course Outcomes:**

The student will be able to

1. explain the importance and basic principles of optimization
2. apply the theory to formulate design problems as mathematical optimization problems
3. solve optimization problems using different methods or algorithms
4. learn different methods of solving unconstrained and constrained optimization problems
5. select a suitable technique for a specific engineering problem

## UNIT-I

Introduction: **C**lassification of optimization problems classical optimization techniques: single variable optimization–multivariable with no constraints-multivariable with equality constraints, direct substitution method, method of Lagrange multipliers

One-dimensional unconstrained optimization: unimodal function, methods of single variable optimization -, bisection method, unrestricted, Dichotomous, Fibonacci

## UNIT-II

Non-linear multivariable optimization without constraints: Univariate search, Pattern search methods- Hookes-Jeeves method, Powells method, Steepest descent method

Non-linear multivariable optimization with constraints: Penalty approach- interior and exterior penalty function methods

**UNIT- III**

Geometric programming: solution from differential calculus point of view - solution from arithmetic-geometric inequality point of view - degree of difficulty - optimization of zero degree of difficulty problems with and without constraints- optimization of single degree of difficulty problems without constraints

**UNIT-IV**

Genetic algorithms (GA): Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, drawbacks of GA.

**UNIT-V**

Basic concepts of Stochastic programming, multi-stage optimization, and Multi-objective optimization

Engineering applications: Minimization of weight of a cantilever beam, truss, shaft; optimal design of springs.

**TEXT BOOK:**

1. Singiresu S. Rao, "*Engineering Optimization -Theory and Practice*", Wiley, 4th edition, 2009.

**REFERENCES**:

1. Kalyanmoy Deb, "*Optimization for Engineering Design-Algorithms and Examples*", PHI, 8th reprint, 2005.

2. Ashok D. Belegundu and Tirupathi R. Chandrupatla, "*Optimization concepts and applications in engineering*", PHI, 2nd edition, 2011