OPTIMIZATION METHODS IN ENGINEERING

(Professional Elective - I)

I Semester

Course Code: 19ME2150

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3	0	3

Course Outcomes: At the end of the course, the student will be able to

CO1: Solve optimization problems using classical optimization techniques.

CO2: Solve simple non-linear multivariable optimization problems.

CO3: Solve optimization problems using geometric programming.

CO4: Explain the working of different operators used in genetic algorithms for optimization.

CO5: Explain the basic concepts of stochastic programming; formulate and outline a suitable optimization technique in basic engineering applications.

UNIT-I **(10-Lectures)**

Introduction: Classification of optimization problems- classical optimization techniques: single variable optimization–multivariable optimization without constraints-multivariable optimization with equality constraints: direct substitution method, method of Lagrange multipliers.

One-dimensional unconstrained non-linear optimization: unimodal function, methods of single variable optimization - Exhaustive search, Interval halving method, Fibonacci search, Golden section method, Quadratic search, Newton method and Quasi-Newton method.

Learning outcomes:

1. Classify optimization problems. (L4)
2. Solve optimization problems using classical optimization techniques. (L3)
3. Solve single variable optimization problems using various numerical methods. (L3)

UNIT-II **(10-Lectures)**

Non-linear multivariable optimization without constraints: Univariate search; Pattern search methods- Hookes-Jeeves method, Powells method, Steepest descent (Cauchy's) method, Conjugate gradient (Fletcher-Reeves) method, Newton's method.

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

Learning outcomes:

1. Apply various direct search methods to solve multi variable optimization problems without constraints. (L3)
2. Solve multi variable optimization problems without constraints using various gradient based methods. (L3)

3. Solve multi variable optimization problems with constraints using interior and exterior penalty methods. (L2)

UNIT-III **(10-Lectures)**

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.

Learning outcomes:

1. Define the degree of difficulty of a given posynomial equation. (L1)
2. Describe the geometric programming technique. (L2)
3. Apply geometric programming method to solve multi variable optimization problems. (L3)

UNIT-I V **(10-Lectures)**

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.

Learning outcomes:

1. List various conventional and evolutionary algorithms. (L1)
2. Compare and contrast between conventional and evolutionary algorithms. (L2)
3. Apply genetic algorithms to solve optimization problems. (L3)

UNIT-V **(10-Lectures)**

Basic concepts of Stochastic programming, multi-stage optimization, and multi-objective optimization. Engineering applications: Minimization of weight of a cantilever beam, planar truss, torsionally loaded shaft; optimal design of springs.

Learning outcomes:

1. Describe the basic concepts of sochastic programming. (L2)
2. Formulate various optimization problems in engineering applications. (L3)
3. Formulate and outline a suitable optimization technique in basic engineering applications. (L6)

TEXT BOOK:

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

REFERENCE BOOKS:

1. Kalyanmoy Deb, *Optimization for Engineering Design-Algorithms and Examples*, 2nd Edition, PHI, 2012.

2. Ashok D. Belegundu and Tirupathi R. Chandrupatla, *Optimization Concepts and Applications in Engineering*, 2nd Edition, Cambridge University Press, 2011.