HSOE4002 OPTIMIZATION ENGINEERING (3-0-0)

Course Objectives: The course aims to enable students to:

1. Understand the mathematical foundations of engineering optimization.
2. Formulate engineering design and decision-making problems as optimization models.
3. Apply linear programming techniques to engineering applications.
4. Solve unconstrained and constrained nonlinear programming problems.
5. Understand numerical optimization algorithms and their convergence properties.

Module I: Introduction to Engineering Optimization, Linear Programming (10 Hours)
Introduction to optimization, Engineering design process, Mathematical formulation of optimization problems, Objective function, Design variables, Constraints, Equality and inequality constraints, Feasible and infeasible regions, Local and global optimum, Convex and non-convex optimization, Classification of optimization problems, Applications in engineering.

Fundamentals of Linear Programming (LP), Standard form of LP, Graphical solution method, Basic feasible solution, Simplex method, Big-M method, Two-phase simplex method, Duality theory, Economic interpretation of duality, Sensitivity analysis, Degeneracy, Unbounded and infeasible problems.

Module II: Transportation, Assignment and Integer Programming (7 Hours)
Transportation model, Initial basic feasible solutions, MODI method, Assignment problem, Hungarian algorithm, Integer programming, Branch and Bound method
Applications in manufacturing and logistics.

Module III: Unconstrained Nonlinear Programming (10 Hours)
Characteristics of nonlinear optimization problems, One-dimensional search methods : Bounding phase method, Golden section search, Fibonacci search.
Multivariable optimization, Gradient vector, Hessian matrix, Necessary and sufficient conditions, Steepest descent method, Newton's method, Conjugate gradient method, Convergence criteria

Module IV: Constrained Nonlinear Programming (8 Hours)
Equality constraints, Inequality constraints, Lagrange multiplier method, Kuhn-Tucker (KKT) optimality conditions, Penalty function methods, Barrier methods, Sequential Quadratic Programming (Introduction)

Module V: Introduction to Modern Optimization Techniques (5 Hours)
Need for heuristic optimization, Genetic Algorithm, Particle Swarm Optimization, Simulated Annealing, Multi-objective optimization, Pareto optimality, Engineering applications

Course Outcomes (COs)
At the end of the course, students will be able to:

CO1 Formulate engineering problems as optimization models.
CO2 Solve linear programming problems using graphical and simplex methods.
CO3 Apply unconstrained nonlinear optimization techniques.
CO4 Solve constrained nonlinear optimization problems using optimality conditions.
CO5 Implement optimization algorithms using computational tools.

Text Books

1. Operations Research, H.A. Taha, A,M, Natarajan. P. Balasubramanie. A Tamilarasi Person Education, Eight Edition
2. Introduction to Operations Research, F.S. Hillier, G.J. Liberman,Bodhibrata Nag,Preetam Basu Tata McGraw Hill, 12th Edition

Reference Books

1. Kalyanmoy Deb, Optimization for Engineering Design, PHI Learning Pvt. Ltd.
2. A Ravindran, D.T. Philips, J, Solberg, Introduction to Operations Research – Principle & Practices, 12th Edition, Wiley India Pvt. Ltd.