Course Structure

Course Code : **SM7305**

Course Title : **Operation Research**

Credit Hours : **3**

Course Description

Introduction to Operations Research, The linear programming model, Simplex method, Duality and sensitivity analysis, Integer Programming, The Branch-and-Bound Technique and Its Application to Binary Integer Programming, Nonlinear Programming, Network Optimization Models, Dynamic Programming, Genetic Algorithms, Ant Colony Optimization, Particle Swarm Optimization, real world application.

Course Objectives

- Prepare the students for dealing with complex real world problems, by identifying the main components that can be modeled through formal models from a wide range of techniques that belong to the domain of the Operations Research

Course Topics

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- Introduction to Operations Research (OR). Origins, Nature and Impact of OR. History, strengths and limitations, methodologies
  Modelling in OR. Defining the Problem and Gathering Data. Formulating a Mathematical Model. Deriving Solutions from the Model. Testing solutions from the model.
- The linear programming (LP) model. Assumptions. Examples.
  Graphical solution. The foundations of the simplex method.
- Simplex method. Algebraic approach. Tabular approach.
  Matrix formulation. Insights of the method. The revised simplex method. Two-phase and big-M methods
- Duality and sensitivity analysis. Essence of Duality Theory. Economic Interpretation of Duality.
  Primal–Dual Relationships. Applying Sensitivity Analysis
- Particular cases of LP models: Transportation problems.
  Transshipment, and assignment problems
- Other algorithms for LP. The Dual Simplex Method. Parametric Linear Programming
  The Upper Bound Technique. An Interior-Point Algorithm
- Integer Programming. BIP Applications. Innovative Uses of Binary Variables in Model Formulation.
  Some Formulation Examples. Some Perspectives on Solving Integer Programming Problems.
- The Branch-and-Bound Technique and Its Application to Binary Integer Programming.
  Mix-integer programming. A Branch-and-Bound Algorithm for Mixed Integer Programming. The Branch-and-Cut Approach to Solving BIP Problems. The Incorporation of Constraint Programming.
- Nonlinear Programming. Types of Nonlinear Programming Problems. One-Variable Unconstrained Optimization.
  Multivariable Unconstrained Optimization. Quadratic Programming. Separable

Course Structure

Programming. Convex Programming. Nonconvex Programming (with Spreadsheets)

- Network Optimization Models. The Terminology of Networks. The Shortest-Path Problem.
  The Minimum Spanning Tree Problem. The Maximum Flow Problem. The Minimum Cost Flow Problem. The Network Simplex Method.
- Dynamic Programming. Characteristics of Dynamic Programming Problems. Deterministic Dynamic Programming.
  Probabilistic Dynamic Programming.
- Metaheuristics. The Nature of Metaheuristics. Exploration vs Exploitation. Greedy search.
  Tabu search. Simulated annealing
- Genetic Algorithms for single variable optimization problems.
  Genetic Algorithms for multi variable optimization problems.
- Ant Colony Optimization for single variable optimization problems.
  Ant Colony Optimization for multi variable optimization problems.
- Particle Swarm Optimization for single variable optimization problems.
  Particle Swarm Optimization for multi variable optimization problems.
- Real world applications.

References

- **Introduction to Operations Research (8.th Ed.) :** Hillier, F.S., e G.J. Lieberman 2005 McGraw-Hill
- **Metaheuristics: from design to implementation. El-Ghazali Talbi. Wiley.**
- Essentials of Metaheuristics. Sean Luke.