BTU BUSINESS & TECHNOLOGY UNIVERSITY

AI SYLLABUS

# OPERATIONS RESEARCH

# Operations Research

## Course Description:

This course introduces students to Operations Research, a field that involves the application of mathematical models, optimization techniques, simulation, and decision analysis to improve the performance of complex systems. Students will learn to model real-world problems using mathematical techniques, and to use computer software to solve optimization problems. The course covers a range of topics, including linear programming, network optimization, integer programming, decision analysis, and simulation. Through hands-on experience and case studies, students will develop the skills necessary to apply Operations Research techniques to solve complex problems in business, engineering, and other fields.

## Course Goals:

- Understand the fundamentals of Operations Research and its applications
- Learn to formulate and solve optimization problems using mathematical techniques
- Develop proficiency in using software tools to solve optimization problems
- Learn to interpret and communicate results from optimization models
- Understand the limitations and assumptions of Operations Research techniques

## Course Outline:

### Week 1: Introduction to Operations Research

1. Overview of the course and its applications
2. Introduction to mathematical modeling and optimization
3. Applications of Operations Research in industry

### Week 2: Linear Programming

1. Introduction to linear programming
2. Formulating and solving linear programming problems
3. Sensitivity analysis and interpretation of results

### Week 3: Network Optimization

1. Network flow problems and their applications
2. Shortest path and maximum flow algorithms
3. Applications of network optimization in transportation and logistics

### Week 4: Integer Programming

1. Introduction to integer programming
2. Branch-and-bound algorithms
3. Applications of integer programming in scheduling and resource allocation

### Week 5: Decision Analysis

1. Introduction to decision analysis
2. Decision trees and expected value of perfect information
3. Applications of decision analysis in risk management

### Week 6: Simulation

1. Introduction to simulation
2. Monte Carlo simulation and applications
3. Design and analysis of simulation experiments

## Course Assignments:

1. Linear Programming Assignment: Students will solve a linear programming problem using a software tool such as Excel Solver, and will write a report discussing the problem, the solution process, and the interpretation of the results.
2. Network Optimization Case Study: Students will analyze a real-world network optimization problem such as transportation planning or supply chain optimization, and will develop and solve a model to find an optimal solution. Students will present their results and recommendations to the class.
3. Integer Programming Project: Students will work in groups to develop an integer programming model for a scheduling or resource allocation problem, and will solve the model using a software tool such as AMPL or Gurobi. Students will present their results and discuss the limitations and assumptions of the model.
4. Decision Analysis Exercise: Students will work on a decision analysis problem, such as selecting a new investment or choosing between alternative projects. Students will use decision trees and expected value of perfect information to develop a decision analysis model and to evaluate the options.

5. Simulation Experiment: Students will design and run a simulation experiment using a software tool such as Simul8 or Arena. The experiment will simulate a real-world process such as a queuing system or a production line, and will evaluate the performance of the system under different scenarios. Students will present their results and discuss the limitations and assumptions of the simulation model.
6. Grading will be based on the quality of the assignments and presentations, as well as participation in class discussions and group work. The breakdown of grading will be provided in the course syllabus.

## Required Readings:

1. Nonlinear Programming: Theory and Algorithms by Mokhtar S. Bazaraa, Hanif D. Sherali, and C. M. Shetty
2. Linear Programming and Network Flows by Mokhtar S. Bazaraa, John J. Jarvis, and Hanif D. Sherali
3. Stochastic Modeling and Mathematical Statistics by Francisco J. Samaniego
4. Decision Analysis: Introductory Lectures on Choices Under Uncertainty by Howard Raiffa
5. Operations Research: Applications and Algorithms by Wayne L. Winston
6. Optimization Modeling with Spreadsheets by Kenneth R. Baker
7. Introduction to Operations Research by Frederick Hillier and Gerald Lieberman

## Course Resources:

- Operations Research: Applications and Algorithms by Wayne L. Winston
- Optimization Modeling with Spreadsheets by Kenneth R. Baker
- Introduction to Operations Research by Frederick Hillier and Gerald Lieberman
- AMPL modeling language and Gurobi optimization solver (software tools)