INDUSTRIAL ENGINEERING DEPARTMENT

IE 203
Operations Research II
Fall 2022

Type:	Required
Credits/ECTS:	4 Credits / 7 ECTS MMWThTh 34834
Class/Laboratory/PS schedule:	Tuesday 11:00-13:00 – Lecture Wednesday 16:00-17:00 (Online) – Problem Session Thursday 11:00-13:00 (Online) – Lecture
Instructor:	Necati Aras Office Hours: Anytime with prior notification
Prerequisite(s):	IE 202 (Operations Research I) and IE 255 (Probability for Industrial Engineers) or equivalents.

Course Description:

This is an introductory level course focusing on integer programming, mixed-integer programming, nonlinear programming, deterministic dynamic programming and some stohacastic models such as Markov chains, the Poisson process and queueing theory. The first part of the course deals with integer programming and covers the branch-and-bound method, cutting plane algorithm, linearization, processing and node/variable selection in branch-and-bound tree. The second part of the course starts with deterministic dynamic programming and continues with formulating unconstrained and constrained nonlinear programming models. The final and third part focuses on discrete-time Markov chains, explains the Poisson process and its relationship to the exponential distribution, and examines queuing problems that are solved using analytical formulas.

Textbook(s) / other required material:
There is no required textbook, but the following books can be used as a reference.
- Hillier F.S., and Lieberman, G.J., Introduction to Operations Research, Eleventh Edition, McGraw Hill, 2021.
- Winston, W., Operations Research: Applications and Algorithms, Fourth Edition, Thomson-Brooks/Cole, 2004.

Course objectives (and program outcomes):
This course aims to provide students the skills and methods to solve a set of problems encountered during the design of production and service facilities. By the completion of the course, the students will be able to;

- formulate integer and mixed-integer programming models
- apply branch-and-bound method and cutting plane method

- formulate nonlinear programming models
- solve constrained and uncosntrained nonlinear programming models
- apply Karush-Kuhn-Tucker optimality conditions to find candidate solutions to a constrained nonlinear optimization problem
- formulate a deterministic dynamic programming problem
- use Markov chains to analyze a decision process
- have a basic knowledge on basic stochastic processes such as Poisson process
- mention the relationship between Poisson process and exponential distribution
- identify different types of queueing models and use balance equations to analyze these queues

Considering these objectives, this course mainly addresses the following student outcomes of the industrial engineering undergraduate program;

- *Student Outcome (1):* an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- *Student Outcome (2):* an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

Topics covered:

1. Formulation of integer programming (ILP) and mixed-integer programming (MILP) models
2. Solving ILPs and MILPs using branch-and-bound method and cutting plane method
3. Formulation of nonlinear programming models
4. Convexity
5. Solving constrained and unconstrained nonlinear programming models
6. Karush-Kuhn-Tucker optimality conditions
7. Deterministic dynamic programming
8. Markov Chains
9. Poisson Process and Exponential Distribution
10. Queuing Theory

Grading:

Assignments:	20% (2 Assignement 10% each)
Quizzes:	20% (2 Quizzes 10% each)
Midterm:	30%
Final:	30%

Prepared by, and date of preparation: Necati Aras, September 2022