BOĞAZİÇİ UNIVERSITY

DEPARTMENT OF INDUSTRIAL ENGINEERING

FALL 2021 – 2022

IE 440 NONLINEAR MODELS IN OPERATIONS RESEARCH

Day and Time	: M 12:00 – 13:00	W 13:00 – 15:00
Classroom	: Online	Online
Instructor	: İ. Kuban Altınel	
Office/Phone	: M4034, Ext. 6407	
Office Hours	: M 13:00 – 15:00	W 11:00 – 13:00
Teaching Assistant	: A. Buğra Çınar	
Office	: M4040	
Office Hours	: TBA	

Grading

- Quizzes : 10% per quiz (2 midterm-like quizzes), Close book.
- Programs : 10% (6 programs. The lowest grade will be dropped)
- Midterm : 30%, Open book.
  - Eligibility : Any registered student may take the midterm exam.
  - Makeup : NO MAKEUP. ABSENCE WILL BE GIVEN 0 WHATEVER THE REASON IS!
- Final : 40%, Open book.
  - Eligibility : Only registered students with a 70 overall weighted average or above, if they were given full grade at the final exam, e.g. 100, may enter.
  - Makeup : Only registered students who are eligible to take the final will be given a makeup exam if he/she fails the course or he/she is absent at the final exam with an officially accepted excuse.

Textbook: There is no textbook.

References:
1. Practical Methods of Optimization, R. Fletcher
2. Linear and Nonlinear Programming, 2nd edition, D. Luenberger
3. Introduction to the theory of neural computation, J. Hertz, A. Krogh, R. G. Palmer
4. Neural Networks in optimization, Z-S Zhang
5. Past IE 303 and IE 485 exams and their solutions

THEY ARE ALL AVAILABLE **ON RESERVE** AT THE LIBRARY.

IE 440 TENTATIVE PLAN

1. NONLINEAR OPTIMIZATION IN ONE DIRECTION
   Analytical optimization, Iterative optimization, Convergence, Speed of convergence, Search methods, Approximation methods.

2. CONVEXITY
   Convex sets, Convex functions, Gradient, Hessian, Eigenvalues and eigenvectors, Positive definiteness.

3. NONLINEAR UNCONTRAINED OPTIMIZATION IN MANY DIRECTIONS
   Necessary and sufficient conditions, Search methods (coordinate search, pattern search, simplex search), Descent directions and steepest descent method, Newton's method, Davidon-Fletcher-Powell and Broyden-Fletcher-Goldfarb-Shanno methods.

4. CONSTRAINED NONLINEAR OPTIMIZATION
   Necessary and sufficient conditions, Saddle point problem and its relation with convex programs, Reduced gradient and generalized reduced gradient methods.

5. NEURAL NETWORKS
   Supervised learning and back propagation algorithm, Unsupervised learning and self-organizing maps.

6. MACHINE LEARNING
   Learning as an optimization problem, Discriminant design, Support vector machines.

IE 440 TENTATIVE PROGRAM

WEEK	MONTH	DAY	TENTATIVE DAILY OUTLINE
1	October	06W	Nonlinear model examples
2		11M	Nonlinear optimization in one variable
		13W	"
3		18M	Convexity
		20W	"
4		25M	Unconstrained nonlinear optimization in many variables
		27W	"
5	November	01M	"
		03W	"
6		08M (Q1)	Constrained nonlinear optimization in many variables
		10W	"
7		15M	"
		17W	"
8		22M	"
		24W (MT)	Neural Networks – Simple Perceptrons
9		29M	"
	December	01W	Neural Networks – Multi-layer Perceptrons
10		06M	"
		08W	Neural Networks – Self-organizing Maps
11	January	13M	"
		15W	"
12		20M (Q2)	Machine Learning
		22W	"
13		27M	"
		29W	"
14		03M	"