ME 441 – Engineering Optimization for Product Design and Manufacturing

Course Description: The course is designed to provide engineering students a view of optimization as a tool for engineering decision making. Students will be given a fundamental introduction to the optimization techniques and an opportunity to learn how to model product design and manufacturing problems and solve them using computer-based (numerical) optimization techniques. Students will be encouraged to relate the course material to their research.

Instructor: Dr. Wei Chen, A216, 491-7019, weichen@northwestern.edu
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Required Textbook:
Introduction to Optimum Design, Arora, J.S., 2017, Elsevier Academic Press, 4th edition.

Reference Materials:

Engineering Optimization: Methods and Applications, Reklaitis, R.R., 2002.
Optimization Concepts and Applications in Engineering, Belegundu, A.D., 1999.
Quality Engineering using Robust Design, Phadke, M.S., 1989.

Prerequisite: Graduate standing or senior undergraduate

Topics:
- Introduction to engineering optimization
- Formulation of optimization models
- Linear models and solution techniques
- Unconstrained nonlinear models and solution algorithms
- Constrained nonlinear optimization
- Discrete and mixed integer models and techniques
- Shape and topology optimization
- Computer experiments and metamodeling
- Optimization under uncertainty
- Multiobjective & Multidisciplinary optimization

Grading: Homework (35%), Quiz (30%), Term project (25%written + 5% presentation), Class participation (5%)

Class Schedule:

DATE	TOPIC	Reading Assignment
Week#1 T: 9/22	Introduction	Chapter 1

Th: 9/24	Optimum Design Formulation	Chapters 2
Week#2 T: 9/29	Graphical Optimization & Using Matlab	Chapters 3, 7
Th: 10/1	Optimality Conditions	Chapter 4,5
Week#3 T: 10/6	Optimality Conditions	
Th:10/8	Linear Models and Solution Techniques	Chapters 8, 9
Week#4 T: 10/13	Numerical Methods for Optimization	Chapters 10-13
Th: 10/15	Numerical Methods for Optimization	
Week#5 T:10/20	Computer Lab 1- iSight	
Th: 10/22	Quiz 1	
Week#6 T: 10/27	Numerical Methods for Optimization	
Th: 10/29	Mixed variable problems	Chapters 15, 16, 18
Week#7 T: 11/3	Topology & Shape Optimization	Handout
Th: 11/5	Computer Experiments and Metamodeling	Chapter 20, Handout
Week#8 T: 11/10	Computer Lab 2 – Hyperworks	
Th: 11/12	Computer Experiments and Metamodeling	
Week#9 T: 11/17	Quiz 2	
Th: 11/19	Optimization under Uncertainty	Chapter 20
Week#10 T: 11/24	Computer Lab 3-iSight	
Th: 11/26	No Class – Thanksgiving holiday	
Week#11 T: 12/1	Multi-objective & Multidisciplinary Optimization	Chapter 17
Th: 12/3	No Class (preparation for project)	
Week#12 Friday 12/11	Project Presentation 12-2 pm	

Project: Students can work either as an individual or in a small group (with no more than 2 members) on a computational design project. Ideally, the topic of the project should be tightly related to a student's discipline or the graduate research. The focus of the project is to demonstrate the use of modern computational design techniques for improving engineering design, manufacturing, and other engineering decisions throughout the product life cycle. Students may also choose to work on implementing numerical algorithms and developing computer codes if no suitable application can be found.