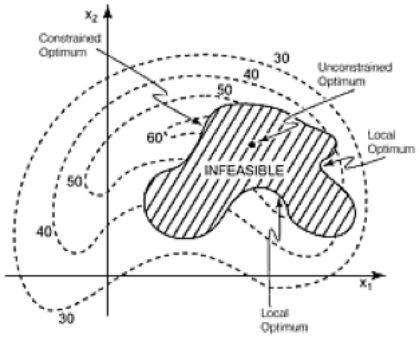
ILLINOIS

Spring 2017 Course Offering: GE 413 — Engineering Design Optimization

Spring 2016, Tu/Th 5-6:20 pm
Instructor: Prof. James Allison (jtalliso@illinois.edu, www.systemdesign.illinois.edu)

Design optimization is an important strategy for rapid development of high-performance engineering systems. This course is an introduction to engineering design optimization, with emphasis on developing the understanding and skills required for solving practical engineering design problems. This course is appropriate for undergraduate and graduate engineering students from across many different disciplines.



This course focuses on the connection between practical engineering design problems and mathematical optimization. Students will learn how to model engineering systems in a way that is appropriate for design optimization, formulate engineering design problems as optimization problems, and how to solve and analyze these optimization problems. Emphasis will be on gradient-based optimization theory and algorithms (nonlinear programming), while gradient-free methods are covered only briefly. Several engineering examples from different engineering domains will be used to demonstrate principles in class and in homework assignments. Students will complete an integrative semester project to help solidify their understanding of how principles learned in class can be used in engineering practice. An optional 'intensive' project can be completed for an additional (fourth) credit hour through independent study credit.

Course Catalog Summary: Application of optimization techniques to engineering design problems. Emphasis on problem formulation, including applications in structural, mechanical, and other design domains. Important theoretical results and numerical optimization methods. MATLAB programming assignments to develop software for solving nonlinear mathematical programming problems.

How is this course different from IE 513? While both IE 513 and GE 413 do cover nonlinear programing theory and algorithms, GE 413 does so in a more applied manner, and focuses in a substantial way on engineering application and practical design optimization. GE 413 does not cover distributed optimization methods (an IE 513 topic), but it does cover surrogate modeling, simulation-based design optimization, optimization numerics, and other topics important to design optimization practice. IE 513 is more research-oriented with emphasis on optimization theory and multidisciplinary design optimization. In summary, while GE 413 and IE 513 have some overlap, they are complementary in several ways and for some graduate students it may make sense to take both. Graduate students who would like to delve deeper into nonlinear programing theory should also consider taking IE 510.

Prerequisites: Multivariate calculus (MATH 241) and linear algebra (MATH 415) are required. Lectures early in the course will build on MATH 241/415 material to provide a mathematical foundation for learning gradient-based optimization. This course involves a significant amount of programming in MATLAB. It is essential that students have either taken at least a first course in programming, or have proficiency in programming. An introduction to MATLAB syntax/programming will be provided early in class, but any students who have not used MATLAB before should devote time before class and early in the semester to gaining proficiency in MATLAB. Experience analyzing at least one type of engineering system (electrical, mechanical, material, etc.) is helpful background for this course. Please contact the instructor with any questions about prerequisites.

Textbook: 1) Optimization in Practice with MATLAB (Messac, 2015, Cambridge University Press), 2) Prof. Allison's course notes.