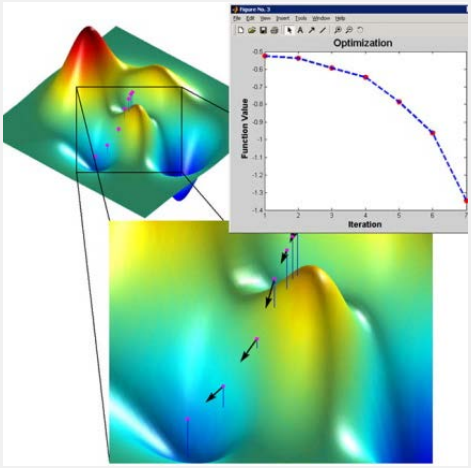
Updated: 03/23/2016

Syllabus for



P60 – Product Design Optimisation

Credits	4 credits
Examiner	Magnus Bengtsson, Chalmers University of Technology
Contact	Magnus Bengtsson magnus.bengtsson@chalmers.se +46 (0) 733 – 16 41 24
Target group	Professionals and doctoral students who want to enhance their skills in product design and expand their engineering expertise with optimization and how to develop optimal solutions. Professionals and doctoral students who want to learn about optimization theory and how it is applied in the context of product and engineering design as well as in research applications.
Fee for industrial members	40 000 SEK
Prerequisites	• Basic calculus (be comfortable with derivatives) • Familiarity with matrix algebra (linear algebra) • Familiarity with multi variable analysis (Calculus: Gradient, Hessian Lagrange) • Familiarity with discrete mathematics (algorithms)

- MATLAB or other coding language experience is highly recommended

For those unfamiliar with MATLAB, you can find some good tutorials here:

http://www.mathworks.se/academia/student_center/tutorials/player/player/content/CoursePlayer.html

It is recommended that you go through these before the class starts. At the very least, you should be familiar with the interface, variables and expressions, and vector analysis and visualization (Units 2-4), but it would also be helpful to complete Units 5, 6, and 13 (you should skip Unit 12, as we will cover some of it during the course). Each unit is approximately 1 hour.

Aim

The course puts the concept of optimal design on a rigorous foundation and demonstrates the intimate relationship between the mathematical model that describes a design and the solution methods that optimize it.

Teachers / tutors

Magnus Bengtsson holds a post-doctoral position in machine elements and systems at the department for Product and Production Development. He received his PhD from Chalmers in 2009. His own research is on aggregate quality in crushing plants. He has a profound experience of research through his previous work at companies such as Skanska AB, Volvo Cars Corporation/Epsilon Embedded (ÅF) and SP Swedish National Research Institute.

Learning outcomes

Upon successful completion of the course, students should be able to:

- Formulate models mechanistic model suitable for opimization
- Understand the basic principles for mechanistic models
- Be able to evaluate the mechanistic model using mathematical analysis
- Understand the basic principles of dimensionless analysis
- Be able to scale mechanistic models
- Formulate appropriate optimization problems
- Analyze optimization formulations
- Be able to run designs of experiments to efficiently sample a design space
- Be able to formulate non mechanistic models using linear regression using measured data
- Understand the basic principles of common optimization algorithms
- Be able to use gradient based optimization algorithms
- Be able to design gradient based optimization algorithms
- Be able to design non gradient based algorithms
- Be able to choose appropriate optimization algorithms for a problem
- Be able to implement and solve optimization problems using algorithms in software
- Be able to evaluate optimization results and provide design

recommendations
- Formulate and solve multi-objective optimization problems
- Formulate and solve optimization problems that account for uncertainty
- Become familiar with advanced optimization methods and software

Contents

The student will be introduced to the concept of design optimization and how to utilize its strength in the context of product and engineering design. An overall goal is to learn the skill on how to design not only products that meet the requirements, but that are also optimal! The course will both handle the theoretical background as well as hands on practice in excel and Matlab. Topics such as e.g. design of experiments, meta-modelling, gradient-based optimization, gradient-free optimization as well as multi-objective optimization will be covered.

As a part of the course ach student will conduct an optimization project, preferably as a part of their research project.

Organisation

The course is structured in two blocks of time, where we will hold a total of five full-day class sessions. These sessions will include lecture-style discussions, in-class problem-solving exercises, and computer-based exercises. The main assignment is a term project, where students will work on their own or in pairs to formulate, analyze, solve, and interpret the results for a design optimization problem of their choosing (preferably related to their research).

Literature

Papalambros, P.Y. and Wilde, D.J. (2000) Principles of Optimal Design, 2nd Edition ISBN: 0521627273

Examination

Grading will be pass/fail, and students must successfully complete the following two tasks:

- A written examination covering the lectured material (supported by complementary readings and exercises), administered at the end of day 5
- Term projects, evaluated based on oral presentations and written reports

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