Sabanci University
Faculty of Engineering and Natural Sciences

Multidisciplinary Design Optimization

Instructor: Güllü Kızıltaş Şendur **Office:** 1075 **Tel:** 9584
Class Hours and Place: M: 15:40-17:30 T:13:40-16:30 ONLINE- To be changed if possible
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Textbook:
No single textbook. Readings will be assigned at the end of a lecture. Selected research articles will be handed out and/or posted electronically throughout the semester.

References:
Papalambros, Panos Y., and Douglass J. Wilde. *Principles of Optimal Design – Modeling and Computation.* 2nd ed. Cambridge, UK: Cambridge University Press, 2000. ISBN: 0521627273. (Paperback)

Vanderplaats, Garret N. *Numerical Optimization Techniques for Engineering Design.* 3rd ed. Colorado Springs: Vanderplaats Research & Development Inc., 2001. ISBN: 0944956017.

Haftka R. T., and Gurdal, Z. *Elements of Structural Optimization* 3rd ed., Kluwer Academic Publishers, 1992

Steuer, R. E. *Multiple Criteria Optimization: Theory, Computation and Application*. New York: Wiley, 1986. ISBN: 047188846X.

Alexandrov, N. M., and M. Y. Hussaini, eds. *Multidisciplinary Design Optimization: State of the Art.* Proceedings in Applied Mathematics Series, No. 80. Soc for Industrial & Applied Math, 1997. ISBN: 0898713595.

Statnikov, Roman B., and Joseph B. Matusov. *Multicriteria Optimization and Engineering*. New York: Chapman and Hall, 1995. ISBN: 0412992310.

David E. Goldberg, "Genetic Algorithms – in Search, Optimization & Machine Learning", Addison –Wesley, ISBN 0 201 15767-5, 1989

Course Objectives:
At the end of this course students will

- learn how MDO can support the product development process of complex, multidisciplinary engineered systems
- learn how to rationalize and quantify a system architecture or product design problem by selecting appropriate objective functions, design parameters and constraints
- subdivide a complex system into smaller disciplinary models, manage their interfaces and reintegrate them into an overall system model

- be able to use gradient-based numerical optimization algorithms, e.g. sequential quadratic programming (SQP) and various modern heuristic optimization techniques such as simulated annealing (SA) or genetic algorithms (GA) and select the ones most suitable to the problem at hand
- perform a critical evaluation and interpretation of analysis and optimization results, including sensitivity analysis and exploration of performance, cost and risk tradeoffs
- sharpen their presentation skills, acquire critical reasoning with respect to the validity and fidelity of their MDO models

Course Contents:

This course addresses the design of complex multidisciplinary systems using optimization. This is not a traditional optimization course. Rather, focus is on how optimization can be used in the design of multidisciplinary systems. Each of the three concepts will be emphasized: multidisciplinary systems, design and optimization. The course content will be applicable to system architecture and design of a broad range of engineering systems.

Course Work:

There are three main parts in the course work: (i) A set of homework assignments (ii) a term project where a design problem chosen by students is formulated, analyzed and solved, and (iii) 2 Midterm Exams. The term project will be based on the application of theory to a topic from a project related to student's research. Within the project, there will be three major deliverables towards the end of the term:

1. Project Proposal (ca 10 minutes), 2nd week of semester
2. Project Presentation (ca. 30 minutes including Q&A), end of semester
3. Final Report preferably in the format of a scientific conference article, end of semester

A typical grade distribution is:

Homework	***25%***
Term project presentation	***5%***
Term project report	***30%***
Midterm	***40%***

Syllabus Overview:

An approximate allocation of topics throughout the semester is as follows.

Weeks 1–2	Introduction to MDO and system characterization
Week 3-4	Problem formulation and setup
Week 5	Subsystem model development
Week 6-8	Optimization and search techniques
Week 9	Sensitivity analysis and approximations
Week 10-11	Multiobjective optimization and stochastic challenges
Week 12-13	System assessment and extensions
Week 14-15	Implementation issues and real world applications