COURSE SYLLABUS

Multidisciplinary Optimization, 7.5 credits

Multidisciplinär optimering, 7,5 högskolepoäng

Course Code:	TMOR25	**Education Cycle:**	Second-cycle level
Confirmed by:	Dean Oct 15, 2024	**Disciplinary domain:**	Natural sciences
Valid From:	Aug 1, 2025	**Subject group:**	MA1
Version:	1	**Specialised in:**	A1N

Intended Learning Outcomes (ILO)

On completion of the course the student shall:

Knowledge and understanding

- display knowledge of different types of continuous optimization algorithms and their use
- display knowledge in different types of optimization techniques during the design process
- show understanding about how optimization driven design is used in the development of sustainable products

Skills and abilities

- demonstrate the ability to implement different optimization algorithms
- demonstrate the ability to develop methods to solve real-world optimization problems
- demonstrate skills in parameter optimization in product design
- demonstrate the ability to utilize optimization driven product development

Judgement and approach

- demonstrate the ability to critically evaluate suitable optimization methods for a given problem
- demonstrate the ability to critically assess the validity of optimization results.

Contents

The course enables engineering students to apply optimization techniques in the engineering process to optimize product realization aspects. The applications can be broad and multidisciplinary. This is achieved by utilizing both classical optimization algorithms and software for modelling objective functions by using one software as input to another.

The course includes the following elements:

- Introduction to optimization driven design using parameter optimization and structural optimization
- Univariate optimization, direct methods, local descent, line search
- The steepest descent method, Newton's method, Karush-Kuhn-Tucker conditions (KKT),
- Direct methods: Nelder-Mead Simplex method
- Heuristic methods: Population methods (genetic algorithms, differential evolution),

simulated annealing
- Multi-objective non-linear optimization and their industrial applications: Pareto optimality, dominance, NSGA2
- Surrogate modeling using neural networks
- Implementation of optimization algorithms using Julia programming

Type of instruction

Lectures, labs and project work.

The teaching is conducted in English.

Prerequisites

Passed courses of at least 150 credits in the program Industrial Product Realisation, or a bachelor's degree (i.e the equivalent of 180 ECTS credits at an accredited university) with at least 90 credits in Mechanical Engineering, Product Development, Materials Engineering, Manufacturing Engineering, Industrial Engineering, Civil or Construction Engineering, or the equivalent. The bachelor's degree should comprise a minimum of 15 credits in Mathematics. Proof of English proficiency is required.

Examination and grades

The course is graded 5,4,3 or Fail.

The final grade of the course is a weighted grade based on the results from the assignments and written examination and is issued only when all course units have been passed.

Registration of examination:

Name of the Test	Value	Grading
Assignment	4.5 credits	5/4/3/U
Project	3 credits	5/4/3/U

Course literature

The literature list for the course will be provided 8 weeks before the course starts.

Compendium at multidisciplinaryoptimization.ju.se

Reference literature:
Title: Algorithms for Optimization
Author: Kochenderfer M.J., Wheeler T.A
Publisher: MIT Press, 2019
ISBN: 9780262039420