GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2016-2017

Numerical Optimisation (E004160)

Course size (nominal values; actual values may depend on programme)

Credits 3.0	Study time 90 h	Contact hrs	30.0 h

Course offerings and teaching methods in academic year 2018-2019

A (semester 1)	English	project	5.0 h
		seminar: practical PC room classes	10.0 h
		lecture	15.0 h

Lecturers in academic year 2018-2019

Degroote, Joris	TW03	lecturer-in-charge
Crevecoeur, Guillaume	TW08	co-lecturer

Offered in the following programmes in 2018-2019	crdts	offering
Master of Science in Electromechanical Engineering (main subject Control Engineering and Automation)	3	A
Master of Science in Electromechanical Engineering (main subject Electrical Power Engineering)	3	A
Master of Science in Electromechanical Engineering (main subject Maritime Engineering)	3	A
Master of Science in Electromechanical Engineering (main subject Mechanical Construction)	3	A
Master of Science in Electromechanical Engineering (main subject Mechanical Energy Engineering)	3	A

Teaching languages

English

Keywords

Optimisation, numerical methods, gradient, sensitivity, heuristics, Pareto

Position of the course

This course provides insight into the different numerical techniques that can optimise a design and reduce a cost. The student learns to apply these techniques to practical engineering problems.

Contents

Theory:

1 Formulation: design variables, objectives, constraints
2 Exploring the design space: design of experiments, effects, sensitivity study, visualisation
3 Gradient-based techniques without constraints: existence and uniqueness of the optimum, line search, steepest descent, conjugate gradient, Newton, quasi-Newton
4 Gradient-based techniques with constraints: Karusk-Kuhn-Tucker conditions, simplex, penalty methods
5 Gradient calculation: adjoint, automatic differentiation
6 Stochastic techniques: random search, simulated annealing, genetic algorithms, particle swarm
7 Surrogate-based techniques: Kriging, neural networks, space mapping
8 Multiple objectives: Pareto front, multi-objective evolutionary algorithms

Exercises:

1 Exploring design space for a car heat exchanger
2 Optimisation with and without constraints
3 Optimisation with and without gradient information for an electromagnetic actuator
4 Calculating the gradient for heat conduction in a bar

5 Optimisation with deterministic and stochastic methods for a switched reluctance motor

Initial competences

Introduction to numerical mathematics

Final competences

1 Describe common numerical optimisation techniques.
2 Select appropriate numerical optimisation techniques for an engineering problem.
3 Apply numerical optimisation techniques to an engineering problem.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Lecture, project, seminar: practical PC room classes

Learning materials and price

Capita selecta from English books.

References

[1] Jorge Nocedal, Stephen Wright. Numerical Optimization. Second Edition, Springer, New York, 2006.
[2] Panos Papalambros, Douglass Wilde. Principles of Optimal Design: Modeling and Computation. Cambridge University Press, New York, 2000.
[3] Kaj Madsen, Hans Bruun Nielsen. Introduction to Optimization and Data Fitting. 2008.

Course content-related study coaching

- Minerva
- Possibility of appointments for additional explanation

Evaluation methods

end-of-term evaluation and continuous assessment

Examination methods in case of periodic evaluation during the first examination period

Written examination

Examination methods in case of periodic evaluation during the second examination period

Written examination

Examination methods in case of permanent evaluation

Report

Possibilities of retake in case of permanent evaluation

examination during the second examination period is not possible

Extra information on the examination methods

- Periodic (end-of-term) evaluation: written examination with closed book. Second evaluation: written examination with closed book.
- Permanent evaluation: assessment of project report. Frequency: 1 report.

Calculation of the examination mark

- Periodic (end-of-term) evaluation 50%, permanent evaluation 50%
- Special condition: the student needs a pass for the periodic evaluation as well as for the permanent evaluation to get a pass for the course. If the student fails either the periodic evaluation or the permanent evaluation, the total mark is the lowest of the two. Examination during the second examination period is not possible for the permanent evaluation. The mark of the permanent evaluation is transferred to the second examination period.