

# Course Descriptions None 2025-2026

| Course Title                                                    | Optimization                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |       |     |     |     |     |     |     |   |          |            |  |  |  |  |  |
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| Course Code                                                     | SCI3003                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |            |       |     |     |     |     |     |     |   |          |            |  |  |  |  |  |
| ECTS Credits                                                    | 5,0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |            |       |     |     |     |     |     |     |   |          |            |  |  |  |  |  |
| Assessment                                                      | Whole/Half Grades                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            |       |     |     |     |     |     |     |   |          |            |  |  |  |  |  |
| Period                                                          | <table><tr><th>Period</th><th>Start</th><th>End</th><th>Mon</th><th>Tue</th><th>Wed</th><th>Thu</th><th>Fri</th></tr><tr><td>1</td><td>1-9-2025</td><td>17-10-2025</td><td></td><td></td><td></td><td></td><td></td></tr></table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Period     | Start | End | Mon | Tue | Wed | Thu | Fri | 1 | 1-9-2025 | 17-10-2025 |  |  |  |  |  |
| Period                                                          | Start                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | End        | Mon   | Tue | Wed | Thu | Fri |     |     |   |          |            |  |  |  |  |  |
| 1                                                               | 1-9-2025                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 17-10-2025 |       |     |     |     |     |     |     |   |          |            |  |  |  |  |  |
| Level                                                           | no level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            |       |     |     |     |     |     |     |   |          |            |  |  |  |  |  |
| Coordinator                                                     | Monica Salvioi For more information:m.salvioi@maastrichtuniversity.nl                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |       |     |     |     |     |     |     |   |          |            |  |  |  |  |  |
| Language of instruction                                         | English                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |            |       |     |     |     |     |     |     |   |          |            |  |  |  |  |  |
| Goals                                                           | <ul style="list-style-type: none"><li>* To become familiar with the basic concepts and methods of optimization.</li><li>* To understand how techniques from calculus and linear algebra are useful for optimization.</li><li>* To become familiar with a diversity of optimization problems and solution techniques.</li><li>* To be able to cast certain real-world problems into the form of optimization problems.</li><li>* To be able to solve certain optimization problems with software (Matlab).</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |            |       |     |     |     |     |     |     |   |          |            |  |  |  |  |  |
| Description                                                     | <p>In everyday life we are surrounded with applications of optimization. A common drive of human activity is to make things better, to enhance performance, and to carry out the best possible actions in given situations. Often the essentials of a situation can be captured by a mathematical description (a model, with or without constraints) and the value of a proposed action by a function (an optimization criterion). Then the goal becomes to optimize the criterion for the given model under the associated constraints (if any). Depending on the nature of the model, the constraints, and the optimization function, many different mathematical techniques are available to characterize and compute optima. In this course we address the most important areas in optimization and we study the most common techniques.</p> <p>First, we consider the optimization of unconstrained continuous functions in several variables. Some notions we will come across are: partial derivatives; the gradient and the Hessian; stationary points; minima, maxima and saddle points; local and global optima. Techniques to compute optima range from analytical and algebraic techniques (i.e., solving systems of equations) to iterative and approximate numerical techniques (e.g., gradient methods and hill climbing, Newton and quasi-Newton methods, and several others). We will focus on a selection of these. An important class of functions to consider is that of least squares criteria. We will consider both linear and nonlinear least squares problems and suitable iterative techniques to solve them. Linear least squares problems are often encountered in the context of fitting a model to measurement data. They also allow one to rephrase the problem of solving a nonlinear system of equations as an optimization problem, while the converse is possible too.</p> <p>Second, we address optimization problems subject to a given set of constraints. A well-known such class consists of linear optimization functions subject to linear equality or inequality constraints: the class of linear programs. The problem of fitting a linear model to measurement data using the criterion of least absolute deviations, can be reformulated as a linear program. Several methods are available to solve such problems, including active set methods and the simplex algorithm, but also interior point methods and primal-dual methods. We discuss the Kuhn-Tucker conditions for optimality. For the optimization of nonlinear functions subject to nonlinear constraints we address the Lagrange multiplier method.</p> <p>To demonstrate the various optimization problems and solution techniques, we will provide many examples and exercises. To demonstrate the wide range of applicability, these are taken from different fields of science and engineering. To become acquainted with optimization techniques, one computer class is organized in which the basics of the software package Matlab are presented.</p> |            |       |     |     |     |     |     |     |   |          |            |  |  |  |  |  |
| Literature                                                      | <p>Hand-outs will be distributed during the course.</p> <p>Recommended literature:</p> <ul style="list-style-type: none"><li>* F.S. Hillier and G.J. Lieberman: Introduction to Operations Research (10th edition). McGraw-Hill, 2015 ISBN 978-0-07-352345-3.</li><li>* A.D. Belegundu and T.R. Chandrupatla: Optimization Concepts and Applications in Engineering (2nd ed.). Cambridge university Press, 2011.</li><li>* Martin T. Hagan et al.: Neural Network Design (2nd edition), available as free ebook.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |            |       |     |     |     |     |     |     |   |          |            |  |  |  |  |  |
| Prerequisites                                                   | You should have passed both Calculus, and Linear Algebra. Even so, you will get an error when trying to register for this course due to a mismatch in course codes for these prerequisite courses. Use Ask SBE to register for this course.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |            |       |     |     |     |     |     |     |   |          |            |  |  |  |  |  |
| Keywords                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |       |     |     |     |     |     |     |   |          |            |  |  |  |  |  |
| Transitional Regulations                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |       |     |     |     |     |     |     |   |          |            |  |  |  |  |  |
| Teaching methods                                                | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |            |       |     |     |     |     |     |     |   |          |            |  |  |  |  |  |
| Assessment methods                                              | Written Exam / Assignment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |            |       |     |     |     |     |     |     |   |          |            |  |  |  |  |  |
| Evaluation in previous academic year                            | For the complete evaluation of this course please click <a href="http://iwio-sbe.maastrichtuniversity.nl/rapporten.asp?referrer=codeUM">http://iwio-sbe.maastrichtuniversity.nl/rapporten.asp?referrer=codeUM</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            |       |     |     |     |     |     |     |   |          |            |  |  |  |  |  |
| This course belongs to the following programme / specialisation |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |       |     |     |     |     |     |     |   |          |            |  |  |  |  |  |