

# Syllabus

## 1. Data about the program of study

|                                    |  |
|------------------------------------|--|
| 1.1 Institution                    | Technical University of Cluj-Napoca          |
| 1.2 Faculty                        | Automation and Computer Science              |
| 1.3 Department                     | Automation                                   |
| 1.4 Field of study                 | Systems Engineering                          |
| 1.5 Cycle of study                 | Bachelor of Science                          |
| 1.6 Program of study/Qualification | Automation and Applied Informatics (English) |
| 1.7 Form of education              | Full time                                    |
| 1.8 Code                           | 55.10  |

## 2. Data about the subject

|  |  |              |   |                        |    |
|--|--|--------------|---|------------------------|----|
| 2.1 Subject name                       | <b>Optimization</b>  |              |   |                        |    |
| 2.2 Course responsible/lecturer        | Prof.dr.ing. Zsofia Lendek, <a href="mailto:zsofia.lendek@aut.utcluj.ro">zsofia.lendek@aut.utcluj.ro</a> |              |   |                        |    |
| 2.3 Teachers in charge of applications | Prof.dr.ing. Zsofia Lendek, <a href="mailto:zsofia.lendek@aut.utcluj.ro">zsofia.lendek@aut.utcluj.ro</a> |              |   |                        |    |
| 2.4 Year of study                      | 4  | 2.5 Semester | 2 | 2.6 Assessment (E/C/V) | E  |
| 2.7 Type of subject                    | DID – in the field   |              |   |                        | DD |
|  | DOP – elective   |              |   |                        | DO |

## 3. Estimated total time

|  |    |           |        |    |         |   |            |    |         |    |
|--|----|-----------|--------|----|---------|---|------------|----|---------|----|
| 3.1 Number of hours per week   | 4  | of which: | Course | 2  | Seminar | 0 | Laboratory | 2  | Project | 0  |
| 3.2 Number of hours per semester   | 56 | of which: | course | 28 | Seminar | 0 | Laboratory | 28 | Project | 0  |
| 3.3 Individual study   |    |           |        |    |         |   |            |    |         |    |
| (a) Manual, lecture material and notes, bibliography                                 |    |           |        |    |         |   |            |    |         | 20 |
| (b) Supplementary study in the library, online and in the field                      |    |           |        |    |         |   |            |    |         | 10 |
| (c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays |    |           |        |    |         |   |            |    |         | 33 |
| (d) Tutoring   |    |           |        |    |         |   |            |    |         | 3  |
| (e) Exams and tests  |    |           |        |    |         |   |            |    |         | 3  |
| (f) Other activities:  |    |           |        |    |         |   |            |    |         | 0  |
| 3.4 Total hours of individual study (sum of (3.3(a)...3.3(f)))                       |    |           |        |    | 69      |   |            |    |         |    |
| 3.5 Total hours per semester (3.2+3.4)   |    |           |        |    | 125     |   |            |    |         |    |
| 3.6 Number of credit points  |    |           |        |    | 5       |   |            |    |         |    |

## 4. Pre-requisites (where appropriate)

|                |  |
|----------------|--|
| 4.1 Curriculum | Numerical calculus, analysis, linear algebra, differential equations, Matlab |
| 4.2 Competence | Numerical calculus, analysis, linear algebra, differential equations, Matlab |

## 5. Requirements (where appropriate)

|                           |  |
|---------------------------|--|
| 5.1. For the course       | Attending at least 7 lectures is compulsory.                                     |
| 5.2. For the applications | Presence and successfully completing the lab/project applications are compulsory |

## 6. Specific competences

|                              |   |
|------------------------------|---|
| 6.1 Professional competences | <p><b>C1</b><br/>Using knowledge of mathematics, physics, mechanical engineering, chemistry, electrical and electronic engineering in systems engineering</p> <p><b>C3</b><br/>Using basics of control engineering, methods of modeling, simulation, identification and analysis of processes, computer assisted design techniques.</p> |
| 6.2 Cross competences        |   |

## 7. Course objectives

|                         |  |
|-------------------------|--|
| 7.1 General objective   | Mathematical formulation of an optimization problem<br>Optimization methods<br>Global optimization   |
| 7.2 Specific objectives | <ul style="list-style-type: none"> <li>- Solving single variable optimization problems</li> <li>- Implementing optimization methods</li> <li>- Solving multivariable optimization problems</li> <li>- Applying optimization methods</li> <li>- Using genetic algorithms for particular applications</li> </ul> |

## 8. Contents

| 8.1 Lecture  | No.hours | Teaching methods   | Notes  |
|--|----------|--|--|
| Introduction. Stating an optimization problem.   | 2        | Exposition<br>Questions<br>Discussions with students<br>Proofs | Possibly online on Teams platform  |
| Unconstrained optimization. Sufficient conditions. Constrained optimization.   | 2        |  |  |
| Optimization of single variable functions.   | 2        |  |  |
| Newton and gradient methods.   | 2        |  |  |
| Conjugate gradient and quasi-Newton methods.   | 2        |  |  |
| Algorithms for minimization without derivatives.   | 2        |  |  |
| Linear programming. Formulation.   | 2        |  |  |
| The simplex method.  | 2        |  |  |
| Quadratic programming.   | 2        |  |  |
| Active set methods.  | 2        |  |  |
| Genetic algorithms for numerical optimization  | 2        |  |  |
| Genetic algorithms for numerical optimization  | 2        |  |  |
| Applications.  | 2        |  |  |
| Applications.  | 2        |  |  |
| Bibliography   |          |  |  |
| 1. Optimal, predictive, and adaptive control, Edoardo Mosca, Englewood Cliffs, New Jersey, 195                         |          |  |  |
| 2. Modern control design : with MATLAB and SIMULINK, Ashish Tewari, Wiley, 2002  |          |  |  |
| 3. Tehnici de optimizare, vol. 2, T. Colosi, P.Bikfalvi, D.Isoc, Cluj-Napoca : Institutul Politehnic Cluj-Napoca, 1989 |          |  |  |
| 4. Optimal control with engineering applications, Geering, H, Springer, 2007   |          |  |  |
| 5. Optimization, P. Raica, UTPress, 2010   |          |  |  |
| 6. Lecture notes available online at lendek.net/teaching   |          |  |  |
| 8.2 Applications (seminar/laboratory/project)  | No.hours | Teaching methods   | Notes  |
| Numerical methods in optimization.   | 2        | Tutorials and application                                      | Attendance mandatory. Matlab will be used. Possibly online on Teams platform |
| Unconstrained optimization. Applications   | 2        |  |  |
| Optimization of single variable functions.   | 2        |  |  |
| Optimization of single variable functions.   | 2        |  |  |
| Newton and gradient methods. Applications.   | 2        |  |  |
| Newton and gradient methods. Applications.   | 2        |  |  |
| Nelder-Mead and Rosenbrock methods. Applications.  | 2        |  |  |
| Nelder-Mead and Rosenbrock methods. Applications.  | 2        |  |  |
| Simplex method. Applications.  | 2        |  |  |
| Simplex method. Applications.  | 2        |  |  |
| Active set method. Applications.   | 2        |  |  |
| Active set method. Applications.   | 2        |  |  |
| Genetic algorithms. Applications.  | 2        |  |  |
| Genetic algorithms. Applications.  | 2        |  |  |
| Bibliography   |          |  |  |
| 1. Optimal, predictive, and adaptive control, Edoardo Mosca, Englewood Cliffs, New Jersey, 195                         |          |  |  |
| 2. Modern control design : with MATLAB and SIMULINK, Ashish Tewari, Wiley, 2002  |          |  |  |
| 3. Tehnici de optimizare, vol. 2, T. Colosi, P.Bikfalvi, D.Isoc, Cluj-Napoca : Institutul Politehnic Cluj-Napoca, 1989 |          |  |  |
| 4. Optimal control with engineering applications. Geering, H. Springer. 2007   |          |  |  |

5. Optimization, P. Raica, UTPress, 2010
6. Lecture notes available online at [lendek.net/teaching](http://lendek.net/teaching)

### 9. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

The methods taught at this course represent the basis in optimization. Thus, the students will be capable to formulate mathematically an optimization problem, to analyze the problem, determine the methods that can be used to solve it and interpret the results. By doing the project, the students will be familiarized with the latest results in this domain and have the possibility to do research.

The knowledge acquired can be applied both in the academic community (research in optimization and optimal control) and in industry (optimal control, optimal design, improving/optimization of industrial processes)

### 10. Evaluation

| Activity type  | Assessment criteria                          | Assessment methods | Weight in the final grade |
|--|--|--------------------|---------------------------|
| Course   | Level of understanding of the material       | Exam               | 0.4                       |
| Seminar  |  |                    |                           |
| Laboratory   | Implementation, analysis, report, discussion | Partial exam       | 0.6                       |
| Project  |  |                    |                           |
| Minimum standard of performance:<br>Attendance of at least 7 lectures, all lab exercises completed, and final grade $\geq 5$ |  |                    |                           |

|   |              |  |                  |
|---|--------------|--|------------------|
| <b>Date of filling in:</b><br>3.02.2025           |              | <b>Title Firstname NAME</b>                        | <b>Signature</b> |
|   | Course       | Prof.dr.ing. Zsofia Lendek                         |                  |
|   | Applications | Prof.dr.ing. Zsofia Lendek                         |                  |
| Date of approval by the Department Board<br>_____ |              | Head of Departament<br>Prof.dr.ing. Honoriu VĂLEAN |                  |
| Date of approval by the Faculty Council<br>_____  |              | Dean<br>Prof.dr.ing. Vlad MURESAN                  |                  |