# SYLLABUS

## 1. Data about the program of study

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| 1.1 Institution | The Technical University of Cluj-Napoca |
| 1.2 Faculty | Faculty of Automation and Computer Science |
| 1.3 Department | Computer Science |
| 1.4 Field of study | Computer Science and Information Technology |
| 1.5 Cycle of study | Bachelor of Science |
| 1.6 Program of study / Qualification | Computer science / Engineer |
| 1.7 Form of education | Full time |

## 2. Data about the subject

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| 2.1 Subject name | ***Systems Theory*** | | | Subject code | **22** |
| 2.2 Course responsible / lecturer | Conf. dr. eng. Raica Paula - Paula.Raica@aut.utcluj.ro<br>Conf. dr. eng. Codrean Alexandru - Alexandru.Codrean@aut.utcluj.ro | | | | |
| 2.3 Teachers in charge of seminars / Laboratory / project | Conf. dr. eng. Raica Paula - Paula.Raica@aut.utcluj.ro<br>Conf. dr. eng. Codrean Alexandru - Alexandru.Codrean@aut.utcluj.ro<br>Sl. dr. eng. Morar Dora - Dora.Morar@aut.utcluj.ro | | | | |
| 2.4 Year of study | II | 2.5 Semester | 4 | 2.6 Type of assessment (E - exam, C - colloquium, V – verification) | E |
| 2.7 Subject category | Formative category: DF – fundamental, DS – specialty, DC – complementary | | | | DF |
| | Optionality: DOB – mandatory, DOP – optional (alternative), DFA – optional (free choice) | | | | DOB |

## 3. Estimated total time

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| 3.1 Number of hours per week | 4 | of which: | Course | 2 | Seminars | - | Laboratory | 2 | Project | - |
| 3.2 Number of hours per semester | 56 | of which: | Course | 28 | Seminars | - | Laboratory | 28 | Project | - |
| 3.3 Individual study: | | | | | | | | | | |
| (a) Manual, lecture material and notes, bibliography | | | | | | | | | | 20 |
| (b) Supplementary study in the library, online and in the field | | | | | | | | | | 1 |
| (c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays | | | | | | | | | | 20 |
| (d) Tutoring | | | | | | | | | | - |
| (e) Exams and tests | | | | | | | | | | 3 |
| (f) Other activities: | | | | | | | | | | - |

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| 3.4 Total hours of individual study (suma (3.3(a)...3.3(f))) | 44 |
| 3.5 Total hours per semester (3.2+3.4) | 100 |
| 3.6 Number of credit points | 4 |

## 4. Pre-requisites (where appropriate)

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| 4.1 Curriculum | Mathematical Analysis II (Integral calculus and differential equations, Linear algebra) |
| 4.2 Competence | Differential equations, complex numbers, Laplace transform, linear algebra |

## 5. Requirements (where appropriate)

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| 5.1. For the course | N/A |
| 5.2. For the applications | Reading and understanding of the lecture notes. |

**6. Specific competence**

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| 6.1 Professional competences | **C1 –** Operating with basic Mathematical, Engineering and Computer Science concepts (4 credits)<br>• **C1.1 –** Recognizing and describing concepts that are specific to the fields of calculability, complexity, programming paradigms, and modeling computational and communication systems<br>• **C1.2 –** Using specific theories and tools (algorithms, schemes, models, protocols, etc.) for explaining the structure and the functioning of hardware, software and communication systems<br>• **C1.3 –** Building models for various components of computing systems<br>• **C1.4 –** Formal evaluation of the functional and non-functional characteristics of computing systems<br>• **C1.5 –** Providing a theoretical background for the characteristics of the designed systems |
| 6.2 Cross competences | N/A |

**7. Expected Learning Outcomes**

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| Knowledge | Describes, identifies and summarizes elementary concepts and methods related to systems in general and linear control systems in particular, namely:<br>▪ Fundamentals of dynamic system modelling: differential equations, transfer functions, block diagrams<br>▪ Properties of 1st and 2nd order linear systems: time response, stability, steady-state error<br>▪ Analysis methods for continuous systems: root locus, frequency response, Bode diagrams<br>▪ Feedback controller design techniques: lead-lag compensators, PID controllers<br>▪ Sampled data and digital control systems. |
| Skills | ▪ Analyses linear continuous and discrete systems using studied theories.<br>▪ Designs and evaluates PID controllers and lead-lag compensators for feedback control systems.<br>▪ Uses specific tools (MATLAB/Simulink) for simulation, analysis and design of control systems.<br>▪ Interprets stability and performance characteristics in time and frequency domains. |
| Responsibilities and autonomy | Carries out project management processes in computer science and information technology, taking on different roles within a team and clearly describing results both verbally and in writing. |

**8. Discipline objective (as results from the *key competences gained*)**

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| 8.1 General objective | The general objective of the course is to develop students' ability to describe, identify and apply the fundamental principles of linear system modelling, analysis, and feedback control design, enabling them to assess and evaluate feedback control systems with desired behavior in both continuous and discrete domains. |
| 8.2 Specific objectives | The specific objectives are for students to acquire the knowledge and techniques related to:<br>▪ mathematical system modelling: deriving transfer function representations, constructing block diagram models - applied to simple engineering applications;<br>▪ linear system analysis: identifying and assessing stability and performance properties of linear systems in both time and frequency domains;<br>▪ feedback controller design: designing PID controllers, lead and lag compensators for linear systems using s-domain techniques;<br>▪ sampled data and digital systems: describing and analyzing linear discrete-time system representations. |

**9. Contents**

| **9.1 Lectures** | Hours | Teaching methods | Notes |
|---|---|---|---|
| Introduction to systems theory and control engineering. Introduction to system modelling. | 2 | | |
| Input/output models. System response. Block diagram models. | 2 | | |

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| Linear system analysis. 1st and 2nd order systems. | 2 | Lectures with visual presentations, examples and demonstrations. Problem-solving sessions with guided discussion. | |
| Stability of linear continuous systems. | 2 | | |
| Higher order systems. DC gain. Dominant poles. | 2 | | |
| Steady-state error. Static error constants. Applications. | 2 | | |
| System analysis using root locus. | 2 | | |
| Frequency response - 1. Bode diagrams. | 2 | | |
| Frequency response - 2. Applications. | 2 | | |
| System analysis. Midterm exam | 2 | | |
| Controller design. Lead-lag compensation. | 2 | | |
| PID – the basic technique for feedback control. | 2 | | |
| Sampled data systems. | 2 | | |
| Digital control systems. | 2 | | |

Bibliography:

1. R. C. Dorf, R. Bishop, "Modern Control Systems", Addison-Wesley, 2004;
2. K. Ogata, "Modern Control Engineering", Prentice Hall, 1990.
3. K. Dutton, S. Thompson, B. Barraclough, "The Art of Control Engineering", Addison-Wesley, 1997
4. William S. Levine (editor), "The Control Handbook", CRC Press and IEEE Press, 1996
5. Lecture notes available on on the course class at: http://moodle.cs. utcluj.ro or Teams/Files (Systems Theory team)

| **9.2 Applications - Seminars / Laboratory / Project** | Hours | Teaching methods | Notes |
|---|---|---|---|
| Introduction to MATLAB. Simulation of dynamical systems | 4 | Supervised hands-on exercises using MATLAB/Simulink. Individual problem solving with instructor feedback. | |
| Transfer functions. System response. Block diagram models. | 4 | | |
| 1st and 2nd order system analysis. System stability. | 4 | | |
| Steady-state error. Root locus | 4 | | |
| Frequency response. Bode diagrams | 4 | | |
| Lead-lag compensation. PID controllers | 4 | | |
| Sampled data systems. | 4 | | |

Bibliography:

1. Alexandru Codrean, Paula Raica, "Control Engineering Handbook", UTPress, 2024
2. Lecture notes and exercises available on the course class in Teams/Files (Systems Theory team)

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

The course content combines theoretical knowledge with applications and focuses on the formulation and solution of specific problems that may occur in various engineering fields. Application of the control theory concepts are specific to most of the engineering disciplines. The course level is introductory, and the intent is to motivate and prepare students for further study in related areas and to conduct projects in real-life applications.

**11. Evaluation**

| Activity type | Assessment criteria | Assessment methods | Weight in the final grade |
|---|---|---|---|
| Course | Ability to identify, describe and apply methods for modelling and analysis of linear continuous systems (transfer functions, stability, frequency response, root locus). Ability to design and evaluate feedback controllers (PID, lead-lag) and to analyze sampled-data and digital control systems. | Midterm exam – written examination<br>Final exam - written examination | 40%<br>60% |
| Laboratory | Ability to utilize MATLAB/Simulink tools for simulation and analysis of dynamical systems; ability to interpret results and | Lab tests (optional) | 30% (optional, but may contribute to a higher grade) |

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| | connect experimental observations to theoretical concepts. | | |
| In case of online teaching, the evaluation will be organized as a quiz and exercises to be solved on paper and sent as files. The platform used: Moodle. | | | |
| Minimum standard of performance:<br>Solution of simple exercises applying the knowledge and techniques presented in the course.<br>40% Midterm grade + 60% Final grade + 30%Lab grade > 5 | | | |

| **Date of filling in:** 30.04.2026 | **Responsible** | **Title, First name Last name** | **Signature** |
|---|---|---|---|
| | Course | Conf.dr.ing. Paula RAICA<br>Conf.dr.ing. Alexandru CODREAN | |
| | Applications | Conf.dr.ing. Paula RAICA<br>Conf.dr.ing. Alexandru CODREAN | |
| | | Sl.dr.eng. Dora MORAR | |

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| Date of approval in the department | Head of department,<br>Prof.dr.eng. Rodica Potolea |
| Date of approval in the Faculty Council | Dean,<br>Prof.dr.eng. Vlad Mureșan |