## 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 |
| 1.8 Subject code | 22. |

### 2. Data about the subject

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|---|---|---|---|---|---|---|
| 2.1 Subject name | ***Systems Theory*** | | | | | |
| 2.2 Course responsible / lecturer | Conf. dr. eng. Raica Paula - Paula.Raica@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. Dora Morar - Dora.Morar@aut.utcluj.ro | | | | | |
| 2.4 Year of study | II | 2.5 Semester | 2 | 2.6 Type of assessment (E - exam, C - colloquium, V - verification) | | E |
| 2.7 Subject category | *DF – fundamentală, DD – în domeniu, DS – de specialitate, DC – complementară* | | | | | DD |
| | *DI – Impusă, DOp – opțională, DFac – facultativă* | | | | | DI |

### 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 | - |

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

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| 7.1 General objective | The general objective of the course is to introduce the fundamental principles of linear system modelling, analysis, and feedback control and to evaluate feedback control systems with desired behaviour. |
| 7.2 Specific objectives | The specific objectives are to acquire the knowledge and techniques related to:<br>- mathematical system modelling (differential equations, input-output representation as transfer functions, block diagrams, state space models) for simple applications<br>- linear system analysis (assessment of stability and performance properties of linear systems) in time and frequency domains<br>- design of feedback controllers such as PID, lead and lag compensators for linear systems using s-domain techniques, state-feedback design<br>- linear sampled-data system representation and analysis |

**8. Contents**

| **8.1 Lectures** | Hours | Teaching methods | Notes |
|---|---|---|---|
| Introduction to systems theory and control engineering. Introduction to system modeling. Linear approximation. | 2 | Lecture, visual presentations, demonstrations | |
| Input/output models. System response. State-space models. | 2 | | |
| Conversion between transfer function and state space. Block diagrams. | 2 | | |
| Linear system analysis. 1st and 2nd order systems. Steady-state error. | 2 | | |
| Higher order systems. Dominant poles. Stability of linear continuous systems. | 2 | | |
| System analysis using root locus. | 2 | | |
| Frequency response. Bode diagrams. | 2 | | |
| Controller design. Lead-lag compensation. | 2 | | |
| System analysis. Applications. Midterm exam. | 2 | | |
| PID – the basic technique for feedback control. | 2 | | |
| Controllability. Observability. State feedback. | 2 | | |
| Sampled-data systems. | 2 | | |
| Digital control systems | 2 | | |
| Controller design – applications. Sampled-data systems – applications. | 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)

| **8.2 Applications - Seminars / Laboratory / Project** | Hours | Teaching methods | Notes |
|---|---|---|---|
| Introduction to Matlab. Simulation of dynamical systems | 4 | Class discussion, Supervised exercise solving using Matlab Individual student reports | |
| Linear approximation of differential equations. Transfer functions. System response. | 4 | | |
| Block diagram models. 1st and 2nd order system analysis. Steady-state error | 4 | | |
| System stability. Root locus | 4 | | |
| Frequency response. Bode diagrams | 4 | | |
| Lead-lag compensation. PID controllers | 4 | | |
| State feedback. 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)

**9. 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.

**10. Evaluation**

| Activity type | Assessment criteria | Assessment methods | Weight in the final grade |
|---|---|---|---|
| Course | Ability to solve exercises related to linear system modeling and analysis<br>Ability to solve exercises related to system design and analysis of sampled-data systems | Midterm exam – written examination<br>Final exam - written examination | 40%<br>60% |
| Laboratory | Answer simple questions from the topic of the lab applications | Lab tests (optional) | 30% (optional, but may contribute to a higher grade) |
| 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: 26.02.2025** | **Responsible** | **Title, First name Last name** | **Signature** |
|---|---|---|---|
| | Course | Assoc. prof. dr. eng. Paula RAICA | |
| | Applications | Conf.dr.eng. 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 |