# Syllabus

## 1. Data about the program of study

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| 1.1 Institution | Technical University of Cluj-Napoca |
| 1.2 Faculty | Automation and Computer Science |
| 1.3 Departament | 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 Codul disciplinei | 24.00 |

## 2. Data about the subject

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|---|---|---|---|---|---|
| 2.1 Subject name | ***System Theory I*** | | | | |
| 2.2 Course responsible/lecturer | Assist. Prof. Mirela Dobra – mirela.trusca@aut.utcluj.ro | | | | |
| 2.3 Teachers in charge of applications | Assist. Prof. Mirela Dobra – mirela.trusca@aut.utcluj.ro | | | | |
| 2.4 Year of study | 2 | 2.5 Semester | 2 | 2.6 Assessment *(E/C/V)* | E |
| 2.7 Type of subject | *DF – fundamental, DD – in the field, DS – specialty, DC – complementary* | | | | DD |
| | *DI – compulsory, DO – elective, Dfac – optional* | | | | DI |

## 3. Estimated total time

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|---|---|---|---|---|---|---|---|---|---|---|
| 3.1 Number of hours per week | 5 | of which: | Course | 3 | Seminar | 0 | Laboratory | 2 | Project | 0 |
| 3.2 Number of hours per semester | 70 | of which: | course | 42 | Seminar | 0 | Laboratory | 28 | Project | 0 |
| 3.3 Individual study | | | | | | | | | | |
| (a) Manual, lecture material and notes, bibliography | | | | | | | | | | 10 |
| (b) Supplementary study in the library, online and in the field | | | | | | | | | | 6 |
| (c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays | | | | | | | | | | 20 |
| (d) Tutoring | | | | | | | | | | 14 |
| (e) Exams and tests | | | | | | | | | | 5 |
| (f) Other activities: | | | | | | | | | | 0 |

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| 3.4 Total hours of individual study (sum of (3.3(a)…3.3(f))) | 55 |
| 3.5 Total hours per semester (3.2+3.4) | 125 |
| 3.6 Number of credit points | 5 |

## 4. Pre-requisites (where appropriate)

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| 4.1 Curriculum | Mathematical analysis I (Differential calculus); Special mathematics (Complex analysis and transforms); Linear algebra and analytical geometry; |
| 4.2 Competence | Physics, Electrotechnics, Analog and digital circuits; Process modeling. |

## 5. Requirements (where appropriate)

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| 5.1. For the course | N/A |
| 5.2. For the applications | Applications are compulsory |

## 6. Specific competences

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| 6.1 Professional competences | C3.1 Identification of basic concepts of system theory, control engineering, of fundamental principles of modelling and simulation, as well as of process analysis methods in order to explain the basic problems of the field.<br>C3.2 Explaining and interpreting some process automation problems through the application of automatic control fundamentals, of modelling, identification and simulation methods as well as of the computer aided design techniques.<br>C3.3 Solving some types of control problems through: use of modelling methods and principles, development simulation scenarios, application of methods for the identification and analysis of processes (including technological processes) and systems.. |
| 6.2 Cross competences | N/A |

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**7. Course objectives**

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| 7.1 General objective | - modelling Continuous Linear Time Invariant systems;<br>- stability analysis of LTI systems;<br>- time response analysis of LTI systems<br>- negative feedback control systems |
| 7.2 Specific objectives | - work with Matlab/Simulink<br>- Simulation and testing the behavior of dynamic continuous, linear time-invariant systems<br>- use analog components (computers) to test the behavior or LTI systems |

**8. Contents**

| 8.1 Lecture | No.hours | Teaching methods | Notes |
|---|---|---|---|
| Systems Theory: preliminaries; Introductory aspects; Systems theory: brief history; Modern control systems examples | 3 | Comprehensive slides<br>Blackboard annotations<br>Oriented discussions on the subject | |
| Mathematical models of physical systems | 3 | | |
| Physical systems determined by ordinary differential equations | 3 | | |
| Laplace Transform; The weighting function and the transfer function | 3 | | |
| Modelling the LTI systems by state space equations; State space analysis | 3 | | |
| Stability of LTI systems. Stability criterions. | 3 | | |
| Response of dynamic LTI systems to standard input signals | 3 | | |
| First order element; Second order element | 3 | | |
| Negative feedback control systems | 3 | | |
| Algebra connection of negative feedback control systems. | 3 | | |
| Sensitivity of negative feedback control systems | 3 | | |
| Negative feedback control structures performances | 3 | | |
| Steady state and transitory response performances | 3 | | |
| The modes of LTI systems | 3 | | |


Bibliography
1. R. C. Dorf, R. Bishop, “Modern Control Systems”, Addison-Wesley, 2004;
2. K. Ogata , “Modern Control Engineering”, Prentice Hall, 1990.
3. Benjamin Kuo, Matlab Tools for Control System Analysis and Design, 1995
4. SKOGESTAD Sigurd, POSTLETHWAITE Ian, Multivariable feedback control : analysis and design, 1997.
5. Golub, G. H., C.F. Van Loan, – Matrix computations, John Hopkins Univ. Press, Baltimore, 1984
6. M. Hanganut, “Teoria sistemelor”, Vol 2., UTCN 1996
7. Ionescu, V. – Teoria Sistemelor , Editura Didactică şi Pedagogică, Bucureşti, 1985.


| 8.2 Aplications (seminar/laboratory/project) | No.hours | Teaching methods | Notes |
|---|---|---|---|
| Modeling dynamic systems using state space equations. | 2 | Solving problems using Matlab | |
| Using Matlab to model the LTI systems. | 2 | | |
| Response of dynamic LTI systems to standard input signals. | 2 | | |
| Minimal form algorithm in Matlab. | 2 | | |
| First and second order element behaviors to standard input signals. | 2 | | |
| Response of dynamic LTI systems using Matlab. | 2 | | |
| Performances and characteristics of first and second order systems. | 2 | | |
| State space analysis. | 2 | | |
| State space analysis: car suspensions model in Simulink. | 2 | | |
| Internal and external stability of dynamic LTI systems. | 2 | | |
| Negative feedback control structures. | 2 | | |
| Root locus analysis. | 2 | | |
| Control system analysis for the car suspension case. | 2 | | |
| Sensitivity analysis using root locus in Matlab. | 2 | | |

Bibliography
1. R. C. Dorf, R. Bishop, “Modern Control Systems”, Addison-Wesley, 2004;
2. K. Ogata , “Modern Control Engineering”, Prentice Hall, 1990.
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7. Ionescu, V. – Teoria Sistemelor , Editura Didactică şi Pedagogică, Bucureşti, 1985.

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

Practical applications by examples

**10. Evaluation**

| Activity type | Assessment criteria | Assessment methods | Weight in the final grade |
|---|---|---|---|
| Course | Solution correctness | Written examination Face-to-face evaluation; on-line evaluation; Course assignments | 80% |
| Seminar | N/A | N/A | 0% |
| Laboratory | Solving problems using Matlab | Colloquium; Face-to-face evaluation; on-line evaluation | 20% |
| Project | N/A | N/A | 0% |
| Minimum standard of performance: Final grade equal or above 5 | | | |

| **Date of filling in:** | | **Title Firstname NAME** | **Signature** |
|---|---|---|---|
| | Course | Assist. Prof.. Mirela Dobra | |
| | Aplications | Assist. Prof.. Mirela Dobra | |
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| Date of approval by the Department Board<br>Automation Department<br>_____ | Head of Departament .....<br>Prof.dr.ing. Honoriu VĂLEAN |
| Date of approval by the Faculty Council ……<br>Computer Science and Automation Faculty<br>_____ | Dean<br>Prof.dr.ing. Liviu Cristian MICLEA |