

## SYLLABUS

### 1. Data about the program of study

|                                    |   |
|------------------------------------|---|
| 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                   | 2.  |

### 2. Data about the subject

|  |  |              |   |   |    |
|--|--|--------------|---|---|----|
| 2.1 Subject name   | <b>Linear Algebra</b>  |              |   |   |    |
| 2.2 Course responsible/lecturer                            | Prof. dr. Ioan Radu Peter <a href="mailto:ioan.radu.peter@math.utcluj.ro">ioan.radu.peter@math.utcluj.ro</a> |              |   |   |    |
| 2.3 Teachers in charge of seminars/<br>laboratory/ project | Conf. dr. Dalia Cimpean <a href="mailto:Dalia.Cimpean@math.utcluj.ro">Dalia.Cimpean@math.utcluj.ro</a>       |              |   |   |    |
| 2.4 Year of study  | I  | 2.5 Semester | 1 | 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                                 |              |   |   | DF |
|  | DI – Impusă, DOp – opțională, DFac – facultativă   |              |   |   | DD |

### 3. Estimated total time

|  |    |           |        |    |          |    |            |  |         |    |
|--|----|-----------|--------|----|----------|----|------------|--|---------|----|
| 3.1 Number of hours per week   | 4  | of which: | Course | 2  | Seminars | 2  | Laboratory |  | Project |    |
| 3.2 Number of hours per semester   | 56 | of which: | Course | 28 | Seminars | 28 | Laboratory |  | Project |    |
| 3.3 Individual study:  |    |           |        |    |          |    |            |  |         |    |
| (a) Manual, lecture material and notes, bibliography                                 |    |           |        |    |          |    |            |  |         | 20 |
| (b) Supplementary study in the library, online and in the field                      |    |           |        |    |          |    |            |  |         | 4  |
| (c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays |    |           |        |    |          |    |            |  |         | 17 |
| (d) Tutoring   |    |           |        |    |          |    |            |  |         |    |
| (e) Exams and tests  |    |           |        |    |          |    |            |  |         | 3  |
| (f) Other activities:  |    |           |        |    |          |    |            |  |         | 0  |
| 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)

|                |  |
|----------------|--|
| 4.1 Curriculum | Basic knowledge of Linear Algebra and Analytic Geometry  |
| 4.2 Competence | Competences in elementary Linear Algebra and Analytic Geometry: matrices, determinants, linear systems, vectors and lines in plane |

### 5. Requirements (where appropriate)

|                           |                            |
|---------------------------|----------------------------|
| 5.1. For the course       | Blackboard, videoprojector |
| 5.2. For the applications | Blackboard, videoprojector |

### 6. Specific competence

|                              |   |
|------------------------------|---|
| 6.1 Professional competences | <p><b>C1</b> – Operating with basic Mathematical, Engineering and Computer Science concepts</p> <p><b>C1.1</b> - Recognizing and describing specific concepts to calculability, complexity, programming paradigms and modeling of computing and communication systems</p> <p><b>C1.2</b> - Using specific theories and tools (algorithms, schemes, models, protocols, etc.) for explaining the structure and the functioning of hardware,</p> |
|------------------------------|---|

|                       |  |
|-----------------------|--|
|                       | software and communication systems<br><b>C1.3</b> - Building models for various components of computing systems<br><b>C1.4</b> - Formal evaluation of the functional and non-functional characteristics of computing systems<br><b>C1.5</b> - Providing 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*)

|                         |  |
|-------------------------|--|
| 7.1 General objective   | A presentation of the concepts, notions, methods and fundamental techniques used in linear algebra and analytic geometry.  |
| 7.2 Specific objectives | Use of the matricial calculus (in the general context of linear algebra) in order to solve problems in engineering.<br>Use of the vectorial calculus (in the general context of analytic geometry) in modelling and solving practical problems concerning spatial forms. |

### 8. Contents

| 8.1 Lectures  | Hours | Teaching methods  | Notes |
|---|-------|---|-------|
| Linear spaces. Definition. Linear subspaces. Examples.  | 2     | Explanation<br>Demonstration<br>Collaboration<br>Interactive activities |       |
| Linear independence. Basis. Dimension. Change of basis.   | 2     |   |       |
| Inner - product spaces. Definition, properties, Schwarz' inequality. Examples                                     | 2     |   |       |
| Linear transformations. Definition, elementary properties, Kernel and Image.                                      | 2     |   |       |
| The matrix associated to a linear transformation. The standard construction. Expressions in terms of coordinates. | 2     |   |       |
| Eigenvalues and eigenvectors. Definitions, invariant subspaces, characteristic polynomials.                       | 2     |   |       |
| The diagonal form. Canonical forms, diagonalizability.  | 2     |   |       |
| The Jordan canonical form. Construction of a Jordan basis and a Jordan matrix.                                    | 2     |   |       |
| Functions of a matrix. The n-th power of a matrix. Elementary functions of a matrix.                              | 2     |   |       |
| The adjoint operator. Definition, properties, examples.   | 2     |   |       |
| Self-adjoint operators, unitary operators, properties of the eigenvalues and eigenvectors.                        | 2     |   |       |
| Bilinear forms, quadratic forms. The associated matrix.   | 2     |   |       |
| The canonical form. Reduction to a canonical form. The method of eigenvalues and Jacobi's method.                 | 2     |   |       |
| Conics and quadrics. Reduction to a canonical form. Geometric properties.   | 2     |   |       |
| Bibliography  |       |   |       |
| 1. D. Cimpean, D. Inoan, I. Rasa, An invitation to Linear Algebra and Analytic Geometry, Ed. Mediamira, 2012      |       |   |       |
| 2. V. Pop, I. Rasa, Linear Algebra with Applications to Markov Chains, Ed. Mediamira, 2005                        |       |   |       |
| 8.2 Applications – Seminars/Laboratory/Project  | Hours | Teaching methods  | Notes |
| Determinants, matrices, geometric vectors   | 2     | Explanation   |       |
| Linear spaces, bases, dimension   | 2     |   |       |
| Inner-product spaces  | 2     |   |       |
| Linear transformations. Examples  | 2     |   |       |
| Linear transformations characterized in terms of matrices   | 2     | Demonstration   |       |
| Invariant subspaces, eigenvalues, eigenvectors  | 2     | Collaboration   |       |
| Diagonalizable linear transformations   | 2     |   |       |
| Jordan bases, Jordan canonical forms  | 2     | Interactive activities  |       |
| Elementary functions of a matrix, examples  | 2     |   |       |
| The adjoint operator  | 2     |   |       |
| Special classes of operators  | 2     |   |       |

|  |   |  |  |
|--|---|--|--|
| Bilinear forms, quadratic forms                    | 2 |  |  |
| Reduction to a canonical form                      | 2 |  |  |
| Conics and quadrics, reduction to a canonical form | 2 |  |  |

#### Bibliography

1. D. Cimpean, D. Inoan, I. Rasa, An invitation to Linear Algebra and Analytic Geometry, Ed. Mediamira, 2012
2. V. Pop, I. Corovei, Algebra pentru ingineri. Culegere de probleme, Ed. Mediamira, 2003.

\*Se vor preciza, după caz: tematica seminariilor, lucrările de laborator, tematica și etapele proiectului.

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

Collaboration with engineers in order to identify and solve problems raised by the market.

### 10. Evaluation

| Activity type | Assessment criteria   | Assessment methods  | Weight in the final grade |
|---------------|---|---------------------|---------------------------|
| Course        | Abilities of understanding and using creatively the concepts and proofs | Written examination | 30%                       |
| Seminar       | Abilities of solving problems and applying algorithms                   | Written examination | 70%                       |
| Laboratory    |   |                     |                           |
| Project       |   |                     |                           |

Minimum standard of performance:

Ability to present coherently a theoretical subject and to solve problems with practical content.

| Date of filling in: | Titulari     | Titlu Prenume NUME       | Semnătura |
|---------------------|--------------|--------------------------|-----------|
|                     | Course       | Prof.dr. Ioan Radu Peter |           |
|                     | Applications | Conf. dr. Dalia Campean  |           |

|  |   |
|--|---|
| <b>Date of approval in the department</b>      | Head of department<br>Prof.dr.ing. Rodica Potolea |
| <b>Date of approval in the Faculty Council</b> | Dean<br>Prof.dr.ing. Liviu Miclea                 |