# COURSE SYLLABUS

*Academic year 2024-2025*

## 1. Programme Information

| | |
|---|---|
| 1.1. Higher education institution | **Lucian Blaga University of Sibiu** |
| 1.2. Faculty | Faculty of Engineering |
| 1.3. Department | Department of Computer Science and Electrical and Electronics Engineering |
| 1.4. Field of study | Computer Science and Information Technology |
| 1.5. Level of study[1] | Master |
| 1.6. Programme of study/qualification | EMBEDDED SYSTEMS |

## 2. Course Information

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|---|---|---|---|---|---|
| 2.1. Name of course | Cyber-Physical Systems | | | Code | ES.305.ZA |
| 2.2. Course coordinator | Prof. Bălă Constantin ZAMFIRESCU, PhD | | | | |
| 2.3. Seminar/laboratory coordinator | Prof. dr. ing. Constantin-Bala ZAMFIRESCU | | | | |
| 2.4. Year of study[2] | 2 | 2.5. Semester[3] | 3 | 2.6. Evaluation form[4] | E |
| 2.7. Course type[5] | A | 2.8. The formative category of the course[6] | | | Z |

## 3. Estimated Total Time

| 3.1. Course Extension within the Curriculum – Number of Hours per Week | | | | | |
|---|---|---|---|---|---|
| 3.1.a. Lecture | 3.1.b. Seminar | 3.1.c. Laboratory | 3.1.d. Project | 3.1.e. Other | Total |
| 2 | | 2 | | | **4** |
| 3.2. Course Extension within the Curriculum – Total Number of Hours within the Curriculum | | | | | |
| 3.2.a. Lecture | 3.2.b. Seminar | 3.2.c. Laboratory | 3.2.d. Project | 3.2.e. Other | Total[7] |
| 28 | | 28 | | | **56** |

| **Time Distribution for Individual Study[8]** | **Hours** |
|---|---|
| Learning by using course materials, references and personal notes | 12 |
| Additional learning by using library facilities, electronic databases and on-site information | 12 |
| Preparing seminars / laboratories, homework, portfolios and essays | 56 |
| Tutorial activities[9] | 10 |
| Exams[10] | 4 |

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|---|---|
| **3.3. Total Individual Study Hours[11] *(NOSI$_{sem}$)*** | **94** |
| **3.4. Total Hours in the Curriculum *(NOAD$_{sem}$)*** | **56** |
| **3.5. Total Hours per Semester[12] *(NOAD$_{sem}$ + NOSI$_{sem}$)*** | **150** |
| **3.6. No. of Hours / ECTS** | **25** |
| **3.7. Number of credits[13]** | **6** |

**4. Prerequisites (if needed)**

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|---|---|
| 4.1. Courses that must be successfully completed first (from the curriculum)[14] | Basic courses in informatics (programming, algorithms), software engineering, and artificial intelligence. |
| 4.2. Competencies | Design patterns, Software Architecture |

**5. Conditions** (where applicable)

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|---|---|
| 5.1. For course/lectures[15] | *Board, video projector, flipchart, specific teaching materials, online platforms* |
| 5.2. For practical activities (lab/sem/pr/app) [16] | *Computing technology, software packages, online platforms* |

**6. Specific competencies acquired[17]**

| | | | |
|---|---|---|---|
| Number of credits assigned to the discipline[18] | | 6 | Credits distribution by competencies[19] |
| **6.1. Professional competencies** | PC5 | perform scientific research | 0,5 |
| | PC6 | evaluate research activities | 1 |
| | PC9 | prepare production prototypes | 0,5 |
| | PC12 | promote the transfer of knowledge | 1 |
| | PC13 | perform data analysis | 0,5 |
| | PC15 | apply statistical analysis techniques | 0,5 |
| **6.2. Transversal competencies** | TC1 | apply knowledge of science, technology and engineering | 1 |
| | TC2 | show initiative | 0,5 |
| | TC3 | assume responsibility | 0,5 |

**7. Course objectives** (resulted from developed competencies)

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|---|---|
| 7.1. Main course objective | • The course will address from the engineering perspective the advanced application and implementation issues of formal control systems - such as inventory control, manufacturing planning, operations scheduling.<br>• Topics will include the state of the art methodologies to engineer agent-based intelligent manufacturing systems. |
| 7.2. Specific course objectives | • Understanding what a complex system is, and engineering methods to master its complexity<br>• Working with Interaction protocols<br>• Employing advanced software engineering abstractions |

**8. Content**

| **8.1. Lectures[20]** | | **Teaching methods[21]** | **Hours** |
|---|---|---|---|
| Lecture 1 | Introduction: fundamental differences from traditional systems | Exposition, lecture, use of video projector, discussions with students | 4 |
| Lecture 2 | System modelling: continuous systems | Exposition, lecture, use of video projector, discussions with students | 2 |
| Lecture 3 | System modelling: discrete system | Exposition, lecture, use of video projector, discussions with students | 2 |
| Lecture 4 | System modelling: hybrid systems | Exposition, lecture, use of video projector, discussions with students | 2 |

| | | | |
|---|---|---|---|
| Lecture 5 | Cyber-physical systems models as interactions | Exposition, lecture, use of video projector, discussions with students | 2 |
| Lecture 6 | Engineering approaches and programming languages | Exposition, lecture, use of video projector, discussions with students | 4 |
| Lecture 7 | Model-driven engineering of cyber-physical systems | Exposition, lecture, use of video projector, discussions with students | 2 |
| Lecture 8 | Multi-paradigmatic modelling of cyber-physical systems | Exposition, lecture, use of video projector, discussions with students | 2 |
| Lecture 9 | Human in the loops issues | Exposition, lecture, use of video projector, discussions with students | 2 |
| Lecture 10 | Trust, robustness, verification | Exposition, lecture, use of video projector, discussions with students | 2 |
| Lecture 11 | Applications of cyber-physical system | Exposition, lecture, use of video projector, discussions with students | 2 |
| Lecture 12 | Relevant research projects and initiatives | Exposition, lecture, use of video projector, discussions with students | 2 |
| | | **Total lecture hours:** | **28** |

| **8.2. Practical activities** (8.2.a. Seminar[22]/ 8.2.b. Laboratory[23]/ 8.2.c. Project[24]) | | **Teaching methods** | **Hours** |
|---|---|---|---|
| Act.1 | The FESTO flexible production line | Practical demonstration, exercise | 2 |
| Act.2 | Programming the sensors and actuators | Practical demonstration, exercise | 2 |
| Act.3 | PLC programming | Practical demonstration, exercise | 4 |
| Act.4 | Workstation programming (synchronization and real time control of the available set of sensor and actuators) | Practical demonstration, exercise | 8 |
| Act.5 | Workflow programming (synchronization and dispatching of manufacturing operations among the available workstation) | Practical demonstration, exercise | 8 |
| | | **Total seminar/laboratory hours:** | 28 |

**9. Bibliography**

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|---|---|
| 9.1. Recommended Bibliography | Andre Platzer (2013). Foundations of Cyber-Physical Systems, Lecture Notes, Carnegie Mellon University, symbolaris.com/courses/fcps13/fcps13.pdf |
| | Multi-Paradigm Modelling Approaches for Cyber-Physical, Academic Press. Academic Press, 2020 |
| | Rajeev Alur (2015) Principles of Cyber-Physical Systems. MIT Press |
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| 9.2. Additional Bibliography | Elsevier Journal of Engineering Applications of Artificial Intelligence |
| | Elsevier Journal of Mechatronics |
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| | |

**10. Conjunction of the discipline's content with the expectations of the epistemic community, professional associations and significant employers of the specific study program[25]**

Students will acquire research skills preparing them for the transition to a new stage of doctoral admission. It is carried out through regular discussions in a formal and informal setting with the representatives of the profile companies.

**11. Evaluation**

| Activity Type | 11.1 Evaluation Criteria | 11.2 Evaluation Methods | | 11.3 Percentage in the Final Grade | Obs.[26] |
|---|---|---|---|---|---|
| 11.4a Exam / Colloquy | • Theoretical and practical knowledge acquired (quantity, correctness, accuracy) | Tests during the semester[27]: | 10% | 60% | CPE |
| | | Homework: | 20% | | |
| | | Other activities[28]: | 10% | | |
| | | Final evaluation: | 60% | | |

| | | | | |
|---|---|---|---|---|
| 11.4c Laboratory | • Knowledge of the equipment, how to use specific tools; evaluation of tools, processing and interpretation of results | • Written questionnaire<br>• Oral response<br>• Laboratory notebook, experimental works, reports, etc.<br>• Practical demonstration | 40% | CPE |
| 11.5 Minimum performance standard[29]<br>The final assessment will include written work consisting of (partial) grid tests and problems.<br>• Knowledge, understanding and explaining the basics of evolutionary computing.<br>• Constant interest to acquire discipline.<br>• Partial fulfilment (50%) of homework, essays and tests given during the semester. | | | | |

***The Course Syllabus will encompass components adapted to persons with special educational needs (SEN – people with disabilities and people with high potential), depending on their type and degree, at the level of all curricular elements (skills, objectives, contents, teaching methods, alternative assessment), in order to ensure fair opportunities in the academic training of all students, paying close attention to individual learning needs.***

Filling Date: 13.09.2024
Department Acceptance Date: 16.09.2024

| | Academic Rank, Title, First Name, Last Name | Signature |
|---|---|---|
| **Course Teacher** | Prof. Bălă Constantin ZAMFIRESCU, PhD | |
| **Study Program Coordinator** | Prof. Arpad GELLERT, PhD | |
| **Head of Department** | Assoc. Prof. Radu George CREȚULESCU, PhD | |
| **Dean** | Prof. Maria VINȚAN, PhD | |

[1] *Bachelor / Master*
[2] *1-4 for bachelor, 1-2 for master*
[3] *1-8 for bachelor, 1-3 for master*
[4] *Exam, colloquium or VP A/R - from the curriculum*
[5] *Course type: R = Compulsory course; E = Elective course; O = Optional course*
[6] *Formative category: S = Specialty; F = Fundamental; C = Complementary; I = Fully assisted; P = Partially assisted; N = Unassisted*
[7] *Equal to 14 weeks x number of hours from point 3.1 (similar to 3.2.a.b.c.)*
[8] *The following lines refer to individual study; the total is completed at point 3.37.*
[9] *Between 7 and 14 hours*
[10] *Between 2 and 6 hours*
[11] *The sum of the values from the previous lines, which refer to individual study.*
[12] *The sum (3.5.) between the number of hours of direct teaching activity (NOAD) and the number of hours of individual study (NOSI) must be equal to the number of credits assigned to the discipline (point 3.7) x no. hours per credit (3.6.)*
[13] *The credit number is computed according to the following formula, being rounded to whole neighbouring values (either by subtraction or addition*

$$No.credits = \frac{NOCpSpD \times C_C + NOApSpD \times C_A}{TOCpSdP \times C_C + TOApSdP \times C_A} \times 30\ credits$$

Where:

- NOCpSpD = Number of lecture hours / week / discipline for which the credits are calculated
- NOApSpD = Number of application hours (sem./lab./pro.) / week / discipline for which the credits are calculated
- TOCpSdP = Total number of course hours / week in the Curriculum
- TOApSdP = Total number of application hours (sem./lab./pro.) / week in the Curriculum
- $C_C/C_A$ = Course coefficients / applications calculated according to the table

| **Coefficients** | **Course** | **Applications (S/L/P)** |
|---|---|---|
| Bachelor | 2 | 1 |
| Master | 2,5 | 1,5 |
| Bachelor - foreign language | 2,5 | 1,25 |

[14] *The courses that should have been previously completed or equivalent will be mentioned*
[15] *Board, video projector, flipchart, specific teaching materials, online platforms, etc.*
[16] *Computing technology, software packages, experimental stands, online platforms, etc.*
[17] *Competences from the Grids related to the description of the study program, adapted to the specifics of the discipline*
[18] *From the curriculum*
[19] *The credits allocated to the course are distributed across professional and transversal competences according to the specifics of the discipline*
[20] *Chapter and paragraph titles*
[21] *Exposition, lecture, board presentation of the studied topic, use of video projector, discussions with students (for each chapter, if applicable)*
[22] *Discussions, debates, presentations and/or analyses of papers, solving exercises and problems*
[23] *Practical demonstration, exercise, experiment*
[24] *Case study, demonstration, exercise, error analysis, etc.*
[25] *The relationship with other disciplines, the usefulness of the discipline on the labour market*
[26] *CPE – Conditions Exam Participation; nCPE – Does Not Condition Exam Participation; CEF - Conditions Final Evaluation; N/A – not applicable*
[27] *The number of tests and the weeks in which they will be taken will be specified*
[28] *Scientific circles, professional competitions, etc.*
[29] *The minimum performance standard in the competence grid of the study program is customized to the specifics of the discipline, if applicable*