## **SYLLABUS**

### Computational models for embedded systems

### University year 2025-2026

### 1. Information regarding the programme

1.1. Higher education institution	Babes-Bolyai University
1.2. Faculty	Faculty of Mathematics and Computer Science
1.3. Department	Computer Science
1.4. Field of study	Computer Science
1.5. Study cycle	Master
1.6. Study programme/Qualification	Software engineering
1.7. Form of education	Full time

### 2. Information regarding the discipline

2.1. Name of the dis	scipli	ne <b>Computat</b>	Computational models for embedded systems				Discipline code	MME8026	
2.2. Course coordinator				Assoc. Prof. dr. Vescan Andreea					
2.3. Seminar coordinator				Assoc. Prof. dr. Vescan Andreea					
2.4. Year of study	2	2.5. Semester	3	2.6. Type of evaluation	on	E	2.7. Dis	scipline regime	Compulsory

### 3. Total estimated time (hours/semester of didactic activities)

3.1. Hours per week	4	of which: 3.2 course	2	3.3 seminar/laboratory/project	2
3.4. Total hours in the curriculum	56	of which: 3.5 course	28	3.6 seminar/laboratory/project	28
Time allotment for individual study (ID) and self-study activities (SA)					
Learning using manual, course support,	bibliogra	aphy, course notes (SA)			84
Additional documentation (in libraries, on electronic platforms, field documentation)					28
Preparation for seminars/labs, homework, papers, portfolios and essays					28
Tutorship					
Evaluations					
Other activities:					0
3.7. Total individual study hours   144					
3.8. Total hours per semester	200				
3.9. Number of ECTS credits	its 8				

#### 4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competencies	

### 5. Conditions (if necessary)

5.1. for the course	Video projector, Internet access				
5.2. for the seminar /lab activities	Laboratory with computers; model checking tools, FSM/PN tools				
6.1 Specific compatencies acquired 1					

#### 6.1. Specific competencies acquired

<sup>&</sup>lt;sup>1</sup> One can choose either competences or learning outcomes, or both. If only one option is chosen, the row related to the other option will be deleted, and the kept one will be numbered 6.

Professional/essential competencies	<ul> <li>advanced programming skills in high-level programming languages</li> <li>use of theoretical foundations of computer science as well as of formal models</li> </ul>
Transversal competencies	<ul> <li>efficient development of organized activities in an interdisciplinary group and the development of empathetic abilities for interpersonal communications, to relate to and cooperate with various groups</li> <li>use of efficient methods and techniques to learn, inform, research and develop the abilities to bring value to knowledge, to adapt at the requirements of a dynamical society and to communicate efficiently in Romanian language and in an international language</li> </ul>

# 6.2. Learning outcomes

Knowledge	The student knows: • The graduate is able to present and explain methods, algorithms, paradigms and techniques used in various branches of computer science. • The graduate is able to define/identify/understand research problems in computer science.
Skills	The student is able to: • The graduate is able to write a scientific/technical report. • The graduate has the knowledge to apply model-based software development techniques.
Responsibility and autonomy:	<ul> <li>The student has the ability to work independently to obtain:</li> <li>The graduate is familiar with the concepts related to software modelling and is able to implement functional and non-functional requirements described in specific documents for the analysis and design of software systems.</li> <li>The graduate has the necessary skills to use research support tools.</li> </ul>

# 7. Objectives of the discipline (outcome of the acquired competencies)

	<ul> <li>know and understand fundamental concepts of embedded computation;</li> </ul>
7.1 General objective of the discipline	• to develop skills in modeling embedded systems with various computational models;
	• to describe and verify safety and liveness properties of the system being modeled.
	• will acquire theoretical aspects regarding specification, designing and verification of an embedded system;
7.2 Specific objective of the	• will acquire theoretical aspects regarding various computational
discipline	models for embedded systems;
	• will know how to model a system and specify restrictions on
	functionalities

## 8. Content

8.1 Course	Teaching methods	Remarks
(1) Introduction. Model: Why? What?		
How?	Internative experime	
Types of systems.	Explanation Conversation	
Requirements and Safety	Didactical demonstration	
Requirements.	Didactical demonstration	
(2) Model checking	Interactive exposure	
	Explanation, Conversation	
	Didactical demonstration	
(3) Model checking	Interactive exposure	
	Explanation, Conversation	
	Didactical demonstration	
(4) Synchronous models	Interactive exposure	
Asynchronous models.	Explanation, Conversation	
	Didactical demonstration	
(5) Automotive Invited Lecture	Interactive exposure	
	Explanation, Conversation	
	Didactical demonstration	
(6) $IoT + Real time:$	Interactive exposure	
	Explanation, Conversation	
	Didactical demonstration	
(7) Finite State Machines (1)+(2)	Interactive exposure	
	Explanation, Conversation	
	Didactical demonstration	
(8) Finite State Machines (1)+(2)	Interactive exposure	
	Explanation, Conversation	
	Didactical demonstration	
(9) Petri nets	Interactive exposure	
	Explanation, Conversation	
	Didactical demonstration	
(10) Timed models	Interactive exposure	
	Explanation, Conversation	
	Didactical demonstration	
(11) Hybrid systems	Interactive exposure	
	Explanation, Conversation	
(10) D 1 1	Didactical demonstration	
(12) Dynamical systems	Interactive exposure	
	Explanation, Conversation	
(12) P 1 (	Didactical demonstration	
(13) Research report	Interactive exposure	
presentation by students	Explanation, Conversation	
(14) Dessent was art	Didactical demonstration	
(14) Research report	Explanation Conversation	
presentation by students	Didactical demonstration	
Bibliography	Didactical demonstration	
Bioliography		
Bibliography Books		

[Kat08] C. Baier, J.-P. Katoen, Principles of Model Checking, ISBN 978-0-262-02649-9, 2008

- [Ari08] M. Ben-Ari, Principles of the Spin Model Checker, ISBN 978-1-84628-769-5, 2008
- [Noe05] T. Noergaard, Embedded systems architecture: a comprehensive guide to engineers and programmers, Elsevier, 2005
- [Hoa04] Hoare, CAR (2004) (1985), Communicating Sequential Processes, Prentice Hall International
- [Pon02] M. Pont, Embedded C, Addison-Wesley, 2002
- [Boo67] Taylor Booth (1967) Sequential Machines and Automata Theory, John Wiley and Sons, New York. Library of Congress Catalog Card Number: 67-25924.

# Articles

[Har87] D. Harel, "Statecharts: A Visual Formalism for Complex Systems", Sci. Comput. Programming 8 (1987), 231-274

[Pet66] Petri, CA (1966) Communication with automata. DTIC Research Report AD0630125 **Tutorials** 

During lectures/seminars/laboratories tutorials will be given for each assignment.

8.2 Seminar / laboratory	Teaching methods	Remarks
Seminar 1, 2, 3 Model Cheking Specifying safety and liveness requirements.	Presentation, Conversation, Problematizations, Discovery, Individual study, Exercises	
Seminar 4, 5, 6 Finite State Machines Project Activity Using Finite State Machines or/and PetriNets to model an embedded system	Presentation, Conversation, Problematizations, Discovery, Individual study, Exercises	
Seminar 7 Delivery of projects (not delivered in Seminar 3 or Seminar 6)	Presentation, Conversation, Problematizations, Discovery, Individual study, Exercises	
D		

Remark:

- Students will search and use model cheking tools suitable for their Model Checking Project Activity. <u>http://spinroot.com/spin/whatispin.html</u>
- Students will search and use FSM/PN tools suitable for their FSM/PN Project Activity.

## Bibliography

See from Courses content.

# 9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

- This course follows the IEEE and ACM Curriculla Recommendations for Computer Science studies;
- The course exists in the studying program of all major universities in Romania and abroad; http://www.seas.upenn.edu/~cis540/

https://inst.eecs.berkeley.edu/~ee249/fa07/

http://www.ict.kth.se/courses/IL2202/

http://users.abo.fi/lmorel/MoCs/

http://bears.ece.ucsb.edu/class/ece253/

Course content is considered very important by the software companies for improving advance embedded systems modeling and verifying skills.

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Course	The correctness and completeness of the accumulated knowledge of computational models for embedded systems.	Written exam (in the regular session) InClass - Quiz TakeHome - Evaluation of the research report documentation+present ation	50%
	Problem definition	Evaluation of investigation of the Problem definition	10%
10.5 Seminar/laboratory	Problem definition and specification in JSpin, Show that it is possible to reach the desired end state	Evaluation of the project (modeling, verification properties)	20%
	Use Finite State Machine to model the embedded system.	Evaluation of the project (modeling, I/O, computational model used)	20%

**Remark evaluation:** Research Paper on a topic related to Embedded systems as extra credit for evaluation.

# Remark .

- Seminar/Laboratory assignments/Projects laboratory work may not be redone in the retake session.
- Written exams can be taken during the retake session.
- Students from Previous Years to current academic year
  - All the above rules apply to students from previous years.
  - Seminar/Laboratory assignments and practical laboratory activity must be redone during didactic activity time (in the 14 weeks before normal session).
- The final grade computed with the given formula must be at least 5 in order to pass the exam.
- Final grade = 50%WrittenExan (10%InClassExam+40%

ReportSLR)+10%ProblemStatement+20%ProjectJSpin+20%ProjectFSM

10.6 Minimum standard of performance

Each student has to prove that:

 (s)he acquired an acceptable level of knowledge and understanding of the computational models for embedded systems;

> (s)he has the ability to establish certain connections and to use the knowledge in solving different problems.

Successful passing of the exam is conditioned by the final grade that has to be at least 5.

# 11. Labels ODD (Sustainable Development Goals)<sup>2</sup>

<sup>&</sup>lt;sup>2</sup> Keep only the labels that, according to the <u>Procedure for applying ODD labels in the academic process</u>, suit the discipline and delete the others, including the general one for *Sustainable Development* – if not applicable. If no label describes the discipline, delete them all and write "*Not applicable*.".

# Not applicable.

Date:

Signature of course coordinator Assoc. Prof. Vescan Andreea Signature of seminar coordinator

Assoc. Prof. Vescan Andreea

Date of approval:

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Signature of the head of department

Assoc.prof.phd. Adrian STERCA