Universitatea Națională de Știință și Tehnologie Politehnica București
Facultatea de Electronică, Telecomunicații și
Tehnologia Informației

COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	**National University of Science and Technology Politehnica Bucharest**
1.2 Faculty	**Electronics, Telecommunications and Information Technology**
1.3 Department	**Electronic Devices, Circuits and Architectures**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Masters
1.6 Programme of studies	Advanced Microelectronics

2. Date despre disciplină

2.1 Course name (ro) (en)				Microcontrolere și sisteme încorporate Microcontrollers and Embedded Systems			
2.2 Course Lecturer				S.l./Lect. Dr. George-Vlăduț Popescu			
2.3 Instructor for practical activities				S.l./Lect. Dr. George-Vlăduț Popescu			
2.4 Year of studies	1	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		DS	2.9 Course code	UPB.04.M1.O.04-01		2.10 Tipul de notare	Nota

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week	3	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	42.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	14
Distribution of time:					hours
Study according to the manual, course support, bibliography and hand notes Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					37
Tutoring					7
Examinations					0
Other activities (if any):					0

3.7 Total hours of individual study	58.00
3.8 Total hours per semester	100
3.9 Number of ECTS credit points	4

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Computer Programming Microprocessor Architecture Microcontrollers

4.2 Results of learning	Programming in C/C++ Basic knowledge of computer architecture

5. Necessary conditions for the optimal development of teaching activities (where applicable)

5.1 Course	Room with projector
5.2 Seminary/ Laboratory/Project	Laboratory with computers and microcontroller-based development boards

6. General objective *(Reffering to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the currcula of the study programme, etc. will be described in a general manner)*

Understand what an embedded system is and its main components.

Understand computer architecture concepts.

Understand ARM Architecture concepts: Operation modes, Register Set, Instruction Set, CPU Organization, Memory Organization, Interrupts, Interfaces, Security.

Understand basic embedded systems software concepts: Firmware, BIOS, OS.

7. Competences *(Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and proffesional growth. They refflect the empolyers requirements.)*

Specific Competences	Understand how to read a Product Specification and what the main architectural components are. Understand how different peripherals work (timers, sensors, communication interfaces, etc.) and how to write code for them. Understand how to interface peripherals to a microcontroller. Understand how to write an application description.
Transversal (General) Competences	Extract information from a Product Specification. Team work and task scheduling.

8. Learning outcomes *(Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's acomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)*

Knowledge	*The result of knowledge aquisition through learning. The knowledge represents the totality of facts, priciples, theories and practices for a given work or study field. They can be theoretical and/or factual.* Knowledge of basic computer hardware and software elements and their role

Skills	*The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and intrumentation).* Understand the requirements of an application, identify the needed hardware and software resources, and propose an implementation based on the available resources.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* The ability to transform an application requirement into a final product, using hardware and software knowledge.

9. Teaching techniques *(Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)*

Lecture, explanation, demonstration, exercise

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Introduction to Embedded Systems	2
2	ARM Architecture: Introduction, Register Set, Operating Modes, Addressing Modes	2
3	ARM Instruction Set (A32)	4
4	CPU Organization	2
5	Memory management	2
6	Memory hierarchy	2
7	ARM Exceptions	2
8	AHB Lite, APB	2
9	ARM Clocking and Reset	2
10	ARM Power Management (Cortex-M3). ARM Security	2
11	RISC-V I	2
12	RISC-V II	2
13	Parallel Processing Architectures - Overview	2
	Total:	28

Bibliography:

- ARM System-on-Chip Architecture, 2nd Edition, Steve Furber, 2000.
- ARM Instruction Set Reference Guide, ARM, 2018
- The definitive guide to the ARM CORTEX-M3, 2nd Edition, Joseph Yiu, 2010
- ARM Infocenter (http://infocenter.arm.com/)
- Any materials from ARM University.

LABORATORY		
Crt. no.	**Content**	**No. hours**
1	Introduction to ARM architecture and programming environment	2
2	The operation of basic peripherals and examples of use	2
3	Laboratory project implementation	10
	Total:	14

Bibliography:

- Any documentation related to the hardware and software used in the implementation of the laboratory project.

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Understanding of key theoretical elements taught.	Final Exam	50
11.5 Seminary/laboratory/project	Laboratory project completion (full implementation, the ability to write a clear documentation and the ability to present the result of a project in front of colleagues)	Project presentation (power-point presentation and practical demonstration)	50
11.6 Passing conditions			
Minimum 50% of the Laboratory Project grade. Minimum 50% of the Final Exam grade.			

12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)

By understanding the key elements of the processor architecture and through the experience gained during the implementation of the laboratory project (developing the ability to understand the requirements of an application, identify the necessary hardware and software resources, read the documentation, and understand how to use a particular device), students develop the skills needed for their professional career in industry or research.

Date	Course lecturer	Instructor(s) for practical activities
	S.l./Lect. Dr. George-Vlăduț Popescu	S.l./Lect. Dr. George-Vlăduț Popescu

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Date of department approval	Head of department
31.10.2024	Prof. Dr. Claudius DAN
Date of approval in the Faculty Council	Dean
01.11.2024	Prof. Dr. Mihnea Udrea