Universitatea Naţională de Ştiinţă şi Tehnologie Politehnica Bucureşti
Facultatea de Electronică, Telecomunicaţii şi
Tehnologia Informaţiei

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	**Applied Electronics and Information Engineering**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Bachelor/Undergraduate
1.6 Programme of studies	Applied Electronics

2. Date despre disciplină

2.1 Course name (ro) (en)				Arhitectura microprocesoarelor 2. Microcontrolere Microprocessor Architecture 2. Microcontrollers			
2.2 Course Lecturer				Conf. Dr. Horia Cucu			
2.3 Instructor for practical activities				Conf. Dr. Horia Cucu			
2.4 Year of studies	2	2.5 Semester	II	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		D	2.9 Course code	04.D.04.O.018		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	3.5	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	1.5
3.4 Total hours in the curricula	49.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	21
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.					48
Tutoring					0
Examinations					3
Other activities (if any):					0

3.7 Total hours of individual study	51.00
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 and Programming Languages 1 • Computer Programming and Programming Languages 2 • Microprocessor Architecture
4.2 Results of learning	Applying knowledge about the basic concepts and methods of programming languages and techniques

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

5.1 Course	• Room equipped with a video projector.
5.2 Seminary/ Laboratory/Project	• Room equipped with computers and specific software. • Compulsory presence at laboratory classes, according to current POLITEHNICA Bucharest regulations.

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)*

Introducing several typical microcontroller architectures: 8051 core, “Arduino” Systems and ARM family. Study of the advanced principles in CISC and RISC microprocessor architecture: memory management, protected mode, multitasking, CISC and RISC architecture convergence in actual processors.

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	**C2.** Design of hardware, software and telecommunication systems **C2.1.** Description of the structure and of the architecture for hardware, software and telecommunication systems **C2.2.** Explaining the purpose and the operation details for hardware, software and telecommunication systems **C4.** Using programming technologies and environments
Transversal (General) Competences	• Honorable, responsible and ethical behavior to ensure the reputation of the profession. • Awareness of the need for continuous training; efficient use of resources and learning techniques for personal and professional development.

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.* • Defines specific characteristics of microcontrollers • Lists the main architecture attributes for 8051, ARM, Atmega and RISC V microcontrollers • Classify microcontrollers based on application and performance • Describes the operation characteristics of the memory management mechanisms, protection and multiprocessing of x86 in protected mode • Highlight the main differences between microprocessors and microcontrollers
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).* • Uses specific principles in the development of applications for microcontroller-based systems • Adequately interprets causal relationships between the main characteristics of a microcontroller and corresponding types of use-cases in application development • Identifies solutions and develops plans to solve the proposed problem • Analyze, compare and group microcontrollers based on their main characteristics • Motivate the identified solutions and the ways of solving them • Formulates conclusions on developed applications
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* • Demonstrates responsiveness to new learning contexts • Demonstrates collaboration with other colleagues and teaching staff in carrying out teaching activities • Demonstrates autonomy in organizing the learning context and the problem situation to be solved • Demonstrates social responsibility through involvement in academic community events • Contributes through new solutions related to the specialized field to improve the quality of social life • Realizes the value of his contribution in the field of engineering to the identification of viable/sustainable solutions to solve problems in social and economic life • Apply principles of professional ethics in the analysis of the technological impact of the proposed solutions in the specialized field on the environment • Analyzes and exploits opportunities for entrepreneurial development in the specialized field • Demonstrates real-life situation management skills

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.)*

The lectures are presented in a multimedia amphitheater of the faculty. The lecture slides are available online on the faculty's "Moodle" platform.

In the laboratory-type applications, the teacher presents briefly the theoretical concepts that will be used in the laboratory, and then guides the students to develop practical applications for the C8051F040 microcontroller. The teaching materials are the laboratory papers.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	**Memory Management** 1.1. Virtual Memory 1.2. Virtual Memory Segmentation 1.2.1. Virtual Memory Segmentation Examples 1.2.2. Descriptor Tables for Segments 1.2.3. Virtual Address Translation 1.2.4. Task Organization 1.2.5. Segment Descriptor Anatomy 1.2.6. Cache Registers for Segmentation 1.3. Paging Mechanism 1.3.1. Paging Fundamentals 1.3.2. Segment Paging Example	6
2	**Protection Methods** 2.1. Types of Protection 2.2. Memory Management and Protection 2.3. Multi-Level Privileges and Protection 2.4. Data and Programs Protection 2.5. Control Transfer between Protection Levels 2.6. Page Protection 2.7. Interrupts and Exceptions in Virtual (Protected) Mode 2.7.1. Definitions 2.7.2. Virtual Mode Interrupts 2.7.3. Interrupt Gates	6
3	**Multitasking** 3.1. Definitions 3.2. Task State Segment and the Related Descriptor 3.3. Task switching 3.4. Task Gate	4
4	**8051 Microcontroller Core** 4.1. General Features 4.2. Memory Organization 4.3. Register Set 4.4. Addressing Techniques 4.5. Instruction Set 4.6. Instruction Timing	4
5	**Arduino Systems** 5.1. Arduino Uno 5.2. ATmega48A/PA/88A/PA/168A/PA/328/P 5.3. AVR CPU Core 5.4. GALILEO Board 5.5. Programming Examples	2

6	**ARM Architecture Microcontrollers** 6.1. General features 6.2. Processor Modes 6.3. Register Set 6.4. Memory and Port Organization 6.5. Instruction Set 6.6. Programming Examples	6
	Total:	28

Bibliography:

1. H. Cucu, Microcontrolere, suport de curs electronic
2. H. Cucu, Arhitectura microprocesoarelor , suport de curs electronic
3. C. Burileanu, “Arhitectura microprocesoarelor”, Editura Denix, Bucureşti, 1994.
4. C. Burileanu s.a., “Microprocesoarele x86 – o abordare software”, Ed. “Grupul microInformatica”, Cluj-Napoca, 1999.

LABORATORY

Crt. no.	Content	No. hours
1	An integrated development tool for 8051 core microcontrollers (IDE – „Integrated Development Environment”)	3
2	Overall view on Silicon Labs - C8051F040 „System on a Chip”	3
3	Application using the analog to digital converter	3
4	Application using the UART system	3
5	Application using the digital to analog converter	3
6	Application using the interrupts system	3
7	Laboratory assessment	3
	Total:	21

Bibliography:

1. H. Cucu, Microcontrolere, suport de curs electronic
2. H. Cucu, Arhitectura microprocesoarelor, suport de curs electronic
3. Elena-Diana Şandru, Horia Cucu, Corneliu Burileanu, “Arhitectura Microprocesoarelor”, Îndrumar de laborator, Editura MatrixRom (cod CNCSIS: 39), Bucureşti, 2018, ISBN 978-606-25-0443-4

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade

11.4 Course	• knowledge of fundamental theoretical issues; • solving typical, practical problems;	**Notes:** • The final exam may only be taken by students who have passed the laboratory. • Students who do not accumulate at least 50 points from the laboratory and the final exam combined have the option to retake the exam in the resit session. Fourth-year students may also take the final exam in the special session. **The final exam has two components:** • **Written exam stage:** ◦ Multiple-choice test for verifying the fundamental notions from the course; ◦ Does not affect the score allocated to the final exam. • **Oral examination stage:** ◦ Oral verification of the knowledge acquired in all chapters of the course; ◦ The oral exam may only be taken by students who have answered correctly at least half of the multiple-choice test questions;	50%

		◦ Score for the oral examination: between 0 and 50 points.	
11.5 Seminary/laboratory/project	• designing an algorithm for solving a typical problem; • translating the algorithm in a program written in 8051 assembly language; • demonstrating the correct execution of the 8051 program;	**Note:** The laboratory is passed with a minimum of 25 points out of the 50 allocated. If the laboratory is not passed, the course must be retaken in the following academic year. **The evaluation of the laboratory activity is perform as follows:** • Four multiple-choice tests during the lab sessions, each graded from 0 to 10; M – the unrounded arithmetic mean of the test grades. • If M < 5: the student must retake the course in the following academic year. • If M ≥ 5: the student may choose: ◦ To also take a colloquium, in which case the laboratory score will be P_lab = P_colloquium = between 25 and 50 points. ◦ Not to take this colloquium, in which case the laboratory score will be P_lab = 25. • No component of the laboratory evaluation may be retaken.	50%
11.6 Passing conditions			

For passing the course, it is necessary to **simultaneously meet** the following two conditions:

- Passing the laboratory by earning at least 25 points (50% of the laboratory score).
- Accumulating at least 50 points from the laboratory and the final exam combined (50% of the total score).

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)

The course content is largely similar to that of courses with the same objectives taught in other universities in the European Union. The course content is continually updated and adapted after consultations with representatives from the business environment.

Date	Course lecturer	Instructor(s) for practical activities
	Conf. Dr. Horia Cucu	Conf. Dr. Horia Cucu

Date of department approval	Head of department
	Conf. Dr. Bogdan FLOREA

Date of approval in the Faculty Council	Dean
	Prof. Dr. Mihnea UDREA