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	**Electronic Technology and Reliability**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Masters
1.6 Programme of studies	Advanced Integrated Technologies in Automotive Electronics

2. Date despre disciplină

2.1 Course name (ro) (en)				Constructia şi tehnologia microsistemelor EMBEDDED			
2.2 Course Lecturer				Conf. Dr. Andrei Drumea			
2.3 Instructor for practical activities				Conf. Dr. Andrei Drumea			
2.4 Year of studies	1	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		S	2.9 Course code	5		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	2	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	0
3.4 Total hours in the curricula	28.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	0
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.					40
Tutoring					0
Examinations					4
Other activities (if any):					0

3.7 Total hours of individual study	72.00
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 Data structures and algorithms Computer architecture Integrated digital circuits Computer aided design
4.2 Results of learning	General knowledge regarding the construction, working and programming of computer systems, general knowledge regarding analogue and digital electronics.

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

5.1 Course	Video projector and screen.
5.2 Seminary/ Laboratory/Project	Video projector and screen.

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)*

This course brings new knowledge in the field of computer systems' architecture – microcontrollers, digital signal processors, multiprocessors and multicomputers. The students learn the specific aspects of embedded systems: parallel activities communicating together and interrupted by external or internal events with consideration to real time constrains, using of development tools, techniques for energy consumption reduction and interfacing techniques to sensors and actuators.

The applications focus on microcontroller-based small projects passed through different phases of hardware and software development process, from schematics capture to working product - small complexity application based on microcontroller.

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	According to grids 1 and 2 of study program C1. **C4.2.** To implement and to use hardware and software solutions in advanced technologies for manufacturing electronic modules used in harsh environments; - To apply the knowledge from the field of Applied Electronics in order to perform and complete case studies in the field of dedicated systems for Automotive Electronics - To develop engineering solutions for solving technological problems in the fields of automotive electronics, power electronics, and renewable energy systems;
Transversal (General) Competences	According to grids 1 and 2 of study program **CT3** Adaptation to new technologies, professional and personal development through continuous formation, using printed documentation sources, specific software and electronic resources in Romanian and at least one widely used international language.

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.* After efficient assimilation of knowledge presented in this course, the student will be able to understand how embedded systems work and how to design, program and use them in a real application. Multiprocessing aspects like context switching, process scheduling policies or inter-process communication are required for a deeper understanding of modern computers and their operating systems.
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).* The “Hardware structures and specific algorithms for embedded microsystems” course rises the level of students` knowledge in the fundamental domain of the master study and prepares the engineering activities of research and development of embedded systems for automotive industry.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* The knowledge learned during the course is required to understand the other master courses with applications in the field of automotive electronics development, in other projects and especially on the dissertation project.

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 presentation will be performed using transparency projector and computer beamer. A Flipchart table and a whiteboard may be used for supplementary explanations.

The presentations for the applications are based on the use of the multi-media electronic equipment, video-projector, flip-chart and white table.

The teaching documents/materials are available both in print and in electronic format.

Some materials are also available on internet, at page www.cetti.ro, as well as on Teams and Moodle course classes.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Introduction Introduction in embedded systems. Typical examples of embedded systems.	2

2	Central processing unit of embedded systems. Performance benchmarks for CPUs. Instruction set architecture of a processor. RISC architecture. Splitting of program and data memories. Cache memory. Increasing processing performance using parallelism. Instruction level parallelism. Pipeline mechanism. Processor parallelism. Reducing power consumption in modern processors.	4
3	Peripheral devices of embedded systems. Access techniques to peripheral devices. Input/output digital lines. Timer/counter modules. AD and DA converters. LCD driver circuits. Synchronous and Asynchronous serial communication modules. Supervising modules for embedded systems.	8
4	Software for embedded systems Specific aspects of embedded systems programming. Operating systems for embedded systems. Assemblers, compilers and integrated development environments, in circuit debuggers and programmers.	4
5	Infinite loops programming Introduction. Applications. Estimation of task running times. Limits of infinite loops design.	2
6	Real time operating systems Real time systems and specific aspects of embedded systems. FreeRTOS operating system.	4
7	Software optimizations for embedded systems. Noise reduction techniques for data acquisition. Design techniques for low power consumption. Speed enhancement techniques for embedded systems.	4
	Total:	28

Bibliography:

[1] Andrei Drumea, “Programarea sistemelor embedded”, Ed. PIM, Iaşi, România, 2015.
[2] Andrei Drumea, Robert Dobre, "Programarea în limbajul C a sistemelor embedded cu microcontroler : îndrumar de laborator", Ed. PIM, Iaşi, România, 2014.
[3] Paul Horowitz, Winfield Hill, “The art of electronics”, 2nd edition, Cambridge University Press, New York, USA, 1989.
[4] David Paterson, John Hennessy, “Computer organization and design. The hardware-software interface”, 4th edition, Morgan Kaufmann, Waltham, USA, 2012.
[5] Andrew Tanenbaum, Todd Austin, “Structured Computer Organization”, 6th edition, Pearson Education, New Jersey, USA, 2013.
[6] John H. Davies, “MSP430 microcontroller basics”, Newnes, Burlington, USA, 2008.
[7] Andrei Drumea, “Construcţia şi tehnologia sistemelor embedded”, Ed. PIM, Iaşi, România, 2014.

Bibliography:

11. Evaluation

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

11.4 Course	Knowledge of operating systems and programming techniques specific for embedded systems.	In-semester verification.	20%
	Knowledge of the theoretical aspects of hardware structures and algorithms specific for embedded systems.	Final test in the exams session; the topics cover all the approached subjects.	40%
11.5 Seminary/laboratory/project	Project: Implementation of a simple hardware and software application for an embedded system.	Project evaluation and discussion.	20%
	Laboratory: Development of a simple C application for the microcontroller of the development board	Laboratory testing	20%
11.6 Passing conditions			
Obtaining at least 50% from maximal final score. Knowledge of hardware and software structure of the modern embedded systems. Ability to design and develop simple embedded systems for a given application.			

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 subject meets national and international requirements in the domain of electronics and its economic-financial impact, being correlated with similar subjects in and outside Romania;

In the present development context the domain electronics offers a wide range of activity, potential employers belonging to the industry, to education and research and development with NGOs and national, international and multinational enterprises from the field of electronics;

The students acquire competencies that meet the present requirements and allow them a rapid insertion on the labor market after graduation, as well as the chance to continue to study various master and doctoral programs, this program being well integrated in the policies and strategies of the POLITEHNICA University Bucharest regarding its content and its structure, as well as the skills and the international perspective offered to the students.

Date | Course lecturer | Instructor(s) for practical activities

Conf. Dr. Andrei Drumea

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Date of department approval	Head of department conf.dr.ing. Marian VLĂDESCU
Date of approval in the Faculty Council	Dean prof.dr.ing. Mihnea-Radu UDREA