SYLLABUS

1. Information about the program

1.1 Higher education institution	UNIVERSITY POLITEHNICA OF TIMISOARA
1.2 Faculty[1]/ Department [2]	ELECTRONICS, TELECOMUNICATON AND INFORMATION TECHNOLOGIES/ EA
1.3 Field of study (name/code[3])	ELECTRONIC ENGINEERING, TELECOMUNICATION AND INFORMATION TECHNOLOGIES
1.4 Study cycle	License
1.5 Study program (name/code/qualification)	TST-ENG/20/20/10/100/10/TST-ENG

2. Information about the discipline

2.1 Name of discipline/ formative category[4]			Embedded Systems/DS				
2.2 Coordinator (holder) of course activities			Dr. Habil Eng. Cătălin-Daniel CĂLEANU, Professor				
2.3 Coordinator (holder) of applied activities[5]			Dr. Eng. Radu MÎRȘU, Lecturer				
2.4 Year of study[6]	3	**2.5** Semester	6	**2.6** Type of evaluation	E	**2.7** Regime of discipline[7]	DI

3. Total estimated time – hours / semester: direct teaching activities (fully assisted or partly assisted) and individual training activities (unassisted) [8]

3.1 Number of fully assisted hours / week	4 of which:	**3.2** course	2	**3.3** seminar / laboratory / project	0/ 2/0
3.1* Total number of fully assisted hours / semester	56 of which:	**3.2*** course	28	**3.3*** seminar / laboratory / project	0/ 28/ 0
3.4 Number of hours partially assisted / week	0 of which:	**3.5** training	0	**3.6** hours for diploma project elaboration	0
3.4* Total number of hours partially assisted / semester	0 of which:	**3.5*** training	0	**3.6*** hours for diploma project elaboration	0
3.7 Number of hours of unassisted activities / week	3.14 of which:	additional documentary hours in the library, on the specialized electronic platforms and on the field			1.14
		hours of individual study after manual, course support, bibliography and notes			1
		training seminars / laboratories, homework and papers, portfolios and essays			1
3.7* Number of hours of unassisted activities / semester	44 of which:	additional documentary hours in the library, on the specialized electronic platforms and on the field			16
		hours of individual study after manual, course support, bibliography and notes			14
		training seminars / laboratories, homework and papers, portfolios and essays			14
3.8 Total hours / week [9]	7.14				
3.8* Total hours /semester	100				
3.9 Number of credits	4				

4. **Prerequisites** (where applicable)

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[1] The name of the faculty which manages the educational curriculum to which the discipline belongs
[2] The name of the department entrusted with the discipline, and to which the course coordinator/holder belongs.
[3] The code provided in HG - on the approval of the Nomenclature of fields and specializations / study programs, annually updated.
[4] Discipline falls under the educational curriculum in one of the following formative disciplines: Basic Discipline (DF), Domain Discipline (DD), Specialist Discipline (DS) or Complementary Discipline (DC).
[5] Application activities refer to: seminar (S) / laboratory (L) / project (P) / practice/training (Pr).
[6] Year of studies in which the discipline is provided in the curriculum.
[7] Discipline may have one of the following regimes: imposed discipline (DI) or compulsory discipline (DOb)-for the other fundamental fields of studies offered by UPT, optional discipline (DO) or optional discipline (Df).
[8] The number of hours in the headings 3.1 *, 3.2 *, ..., 3.8 * is obtained by multiplying by 14 (weeks) the number of hours in headings 3.1, 3.2, ..., 3.8. The information in sections 3.1, 3.4 and 3.7 is the verification keys used by ARACIS as: (3.1) + (3.4) ≥ 28 hours / wk. and (3.8) ≤ 40 hours / wk.
[9] The total number of hours / week is obtained by summing up the number of hours in points 3.1, 3.4 and 3.7.

4.1 Curriculum	•
4.2 Competencies	•

5. Conditions (where applicable)

5.1 of the course	•
5.2 to conduct practical activities	•

6. Specific competencies acquired through this discipline

Specific competencies	• Problem definition, solution identification and project management of embedded systems. • Application of testing and diagnosis models and of quality engineering principles to software applications implemented on embedded systems. • Development of hardware and software applications for automotive systems using up-to-date informatics technologies. • Innovating solving of core problems in inter-disciplinary co-operation and team-working
Professional competencies ascribed to the specific competencies	• Use of fundamentals in terms of devices, circuits, systems, instrumentation and electronics technology. • Application of basic methods for signal acquisition and processing. • Application of knowledge, concepts and basic methods related to computer system architecture, microprocessors, microcontrolers, programming languages and techniques. • Design, implementation and service operation of data, voice, video multimedia, based on understanding and applying fundamental concepts in communications and information transmission. • Solving technological problems in fields of applied electornics.
Transversal competencies ascribed to the specific competencies	• Methodical analysis of field-related problems aimed at identifying acknowledged solutions, thus ensuring the accomplishment of professional tasks • Definition of activity stages and their distribution to subordinates in terms of responsabilities, providing effective exchange of information and interpersonal communication. • Adaptation to new technologies, professional and personal development through continuous training, using printed documentation sources, specialized software and electronic resources in Romanian and at least one foreign language.

7. Objectives of the discipline (based on the grid of specific competencies acquired - pct.6)

7.1 The general objective of the discipline	• Understand and design embedded systems comprised of both hardware and software

7.2 Specific objectives	• Good understanding of:
	  • Embedded hardware
	  • Embedded software
	  • System design
	  • System testing
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8. Content [10]

8.1 Course	Number of hours	Teaching methods [11]
1. An Introduction to Embedded Systems 1.1 Definition. Examples. 1.2 Requirements, common characteristics 1.3 The General Architecture of an Embedded System	2	PowerPoint Presentation + Whiteboard, Discussion
2. Embedded Hardware	12	

[10] It details all the didactic activities foreseen in the curriculum (lectures and seminar themes, the list of laboratory works, the content of the stages of project preparation, the theme of each practice stage). The titles of the laboratory work carried out on the stands shall be accompanied by the notation "(*)".
[11] Presentation of the teaching methods will include the use of new technologies (e-mail, personalized web page, electronic resources etc.).

2.1 Embedded Processors - ARM Architecture. Enhancements to basic RISC features. The principal components of the core data path. Registers. Banked Registers. Status registers. Processor modes. Data processing instructions. The barrel shifter. Load-Store instructions. Control flow instructions. SWI. Thumb instructions. Exception treatment mechanism. Vector table. ARM7 CPU core. ARM7TDMI organization. 3 stage pipeline. ARM9TDMI. AMBA. Simple ARM based system; 2.2 Board Memory - SRAM. Embedded SRAM. DRAM. Embedded DRAM. Non-volatile memory. Embedded non-volatile storage. Basic ARM memory Interface. Cache memory. Definition, proprieties, location. Cache policies. Virtual memory. Integrating VM and cache. MMU. MMU in ARM; 2.3 Board I/O and Buses - Bus. Definition. Advantages. Disadvantages. Bus types (serial, parallel, synchronous, asynchronous). PCI. I2C. SPI. USB. Ethernet		
3. Embedded Software 3.1 Software for Embedded Systems - Requirements of Software for Embedded System. Steps in developing the software. Choice of programming languages. Compiling & linking for embedded systems. The role of the start-up code. Programing languages (C, C++, C#, Java; 3.2 Embedded Operating Systems - Arguments for using an embedded OS. BSP Kernel. Processes. PCB. Programs, tasks and threads. Saving the context. ARM case. Loading the context. ARM case. Pre-emption. Embedded OS – examples	8	
4. Design and Development. Implementation and Testing 4.1 Embedded Systems Design - Design Process. Hardware-Software Co-design. 4.2 Practical Examples 4.3 Embedded Automotive Applications (body, chassis and safety, driver assistance, power train and transmission, infotainment, etc.)	6	
Bibliography [12] 1. ARM University, Efficient Embedded Systems Design and Programming, 2018 2. T. Noergaard, Embedded Systems Architecture. A Comprehensive Guide for Engineers and Programmers, Elsevier Embedded Technology Series, 2005 3. C. Căleanu, Course notes, UPT Virtual Campus, 2022		
8.2 Applied activities [13]	Number of hours	Teaching methods
1. Embedded Toolchain	2	Experiments using PC+hardware
2. Keil uVision IDE Overview	2	
3. ARM Assembly Code	2	
4. Development boards: LPC2148, Cortex M0, TI Tiva, Hercules, Sitara	2	

[12] At least one title must belong to the discipline team and at least one title should refer to a reference work for discipline, national and international circulation, existing in the UPT library.
[13] Types of application activities are those specified in footnote 5. If the discipline contains several types of applicative activities then they are sequentially in the lines of the table below. The type of activity will be in a distinct line as: "Seminar:", "Laboratory:", "Project:" and / or "Practice/training".

5. Timers and Interrupts		
6. Serial communications	2	
7. Analog and Digital Input and Output	2	
8. Embedded project	14	

Bibliography [14] 1. ARM University, Rapid Embedded Systems Design and Programming, 2018
2. A.N. Sloss et al, ARM System Developers Guide-Designing and Optimizing System Software, Elsevier, 2004.
3. D. Ianchiş, C. Căleanu, Practical Aspects of Embedded Systems, Politehnica Publishing House, 2014.

9. Corroboration of the content of the discipline with the expectations of the main representatives of the epistemic community, professional associations and employers in the field afferent to the program

- The syllabus was certified within the framework of the POSDRU/156/1.2/G/136302, Orientarea programelor de studii pe realitatea economică regională, validarea acestora de către actorii economici și dinamizarea relației in tripleta universitate-student-companii, pentru un învățământ superior tehnic performant – OVDIP project by the representatives of the major companies, e.g. Continental Automotive, Hella, Nokia, Flex, HUF, etc

10. Evaluation

Type of activity	**10.1** Evaluation criteria [15]	**10.2** Evaluation methods	**10.3** Share of the final grade
10.4 Course	theoretical subjects as well as applications	closed-book, written examination	66%
10.5 Applied activities	**S:**		
	L:	lab reports + project assesment	34%
	P[16]**:**		
	Pr:		
10.6 Minimum performance standard (minimum amount of knowledge necessary to pass the discipline and the way in which this knowledge is verified [17])			
• score at least 5 from the maximum of 10			

Date of completion	**Course coordinator (signature)**	**Coordinator of applied activities (signature)**
22.06.2023		
Head of Department (signature)	**Date of approval in the Faculty Council** [18]	**Dean (signature)**
	14.09.2023	

[14] At least one title must belong to the discipline team.
[15] Syllabus must contain the procedure for assessing the discipline, specifying the criteria, methods and forms of assessment, as well as specifying the weightings assigned to them in the final grade. The evaluation criteria shall be formulated separately for each activity foreseen in the curriculum (course, seminar, laboratory, project). They will also refer to the forms of verification (homework, papers, etc.)
[16] In the case where the project is not a distinct discipline, this section also specifies how the outcome of the project evaluation makes the admission of the student conditional on the final assessment within the discipline.
[17] It will not explain how the promotion mark is awarded.
[18] The endorsement is preceded by the discussion of the board's view of the study program on the discipline record.