SYLLABUS

1. Data about the program of study

1.1 Institution	The Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Automation and Computer Science
1.3 Department	Computer Science
1.4 Field of study	Computer Science and Information Technology
1.5 Cycle of study	Bachelor of Science
1.6 Program of study / Qualification	Computer science / Engineer
1.7 Form of education	Full time

2. Data about the subject

2.1 Subject name	***Design with microprocessors***			Subject code	**30**
2.2 Course responsible / lecturer	Prof. dr. eng. Dănescu Radu - radu.danescu@cs.utcluj.ro				
2.3 Teachers in charge of seminars / Laboratory / project	Assist.drd.eng. Rednic Ana - Ana.Rednic@cs.utcluj.ro Assist. drd. eng. Füzes Attila - Attila.Fuzes@cs.utcluj.ro Assist. drd. eng. Bărăian Andrei - Andrei.Baraian@cs.utcluj.ro				
2.4 Year of study	III	2.5 Semester	5	2.6 Type of assessment (E - exam, C - colloquium, V – verification)	E
2.7 Subject category	Formative category: DF – fundamental, DS – speciality, DC – complementary				DF
	Optionality: DOB – mandatory, DOP – optional (alternative), DFA – optional (free choice)				DOB

3. Estimated total time

3.1 Number of hours per week	4	of which:	Course	2	Seminars	-	Laboratory	1	Project	1
3.2 Number of hours per semester	56	of which:	Course	28	Seminars	-	Laboratory	14	Project	14
3.3 Individual study:										
(a) Manual, lecture material and notes, bibliography										23
(b) Supplementary study in the library, online and in the field										14
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays										28
(d) Tutoring										-
(e) Exams and tests										4
(f) Other activities:										-

3.4 Total hours of individual study (sum (3.3(a)...3.3(f)))	69
3.5 Total hours per semester (3.2+3.4)	125
3.6 Number of credit points	5

4. Pre-requisites (where appropriate)

4.1 Curriculum	Computer Architecture, Computer Programming
4.2 Competence	Hardware design, Assembly language programming, C language programming

5. Requirements (where appropriate)

5.1. For the course	Black-board/ White-board, projector, computer
5.2. For the applications	Computer, Atmel Studio, Arduino IDE, Arduino & ESP32 development boards, Pmods and several other components, modules, sensors etc.

6. Specific competence

6.1 Professional competences	**C2** – Designing hardware, software and communication components (2 credits • **C2.1 -** Describing the structure and operation of hardware, software and communication components • **C2.2 -** Explaining the role, interaction and operation of hardware, software and communication components • **C2.3 -** Construction of hardware and software components of computing systems using design methods, languages, algorithms, data structures, protocols and technologies • **C2.4 -** Metric based evaluation of functional and non-functional characteristics of computing systems • **C2.5 -** Implementation of hardware, software and communication components **C5** - Designing, managing the lifetime cycle, integrating and ensuring the integrity of hardware, software and communication systems (3 credits) • **C5.1 -** Specifying the relevant criteria regarding the lifetime cycle, quality, security and computing system's interaction with the environment and human operator • **C5.2 -** Using interdisciplinary knowledge for adapting an information system to application domain requirements • **C5.3 -** Using fundamental principles and methods for security, reliability and usability assurance of computing systems • **C5.4 -** Adequate utilization of quality, safety and security standards in information processing • **C5.5 -** Realization of a project including problem identification and analysis, design and development, while proving the understanding of the basic quality needs and requirements
6.2 Cross competences	Technical communication and the ability to synthesize the information Solving issues specific to the interconnection of microprocessors with sensors Structuring and organizing data in microprocessor memory Team work

7. Expected Learning Outcomes

Knowledge	Describes, identifies, and summarizes elementary concepts and methods related to modeling, analysis, digital circuit design, and testing of microcontrollers and microprocessors, and data acquisition systems, namely: • Basic concepts for AVR and ESP32 microprocessor based systems: internal architecture, addressing modes, peripherals, interface to personal computer, etc. • Specifications related to Instruction Set Architectures of diverse microprocessors. • Input/output systems, timers, usage of serial communication interfaces. • Interfacing and communication between microcontrollers and digital and analog sensors. • Utilization of advanced communication protocols like WiFi and Bluetooth through microcontrollers.
Skills	Designs and implements functional systems of low/medium complexity using microprocessors. Uses specific methods and tools for the analysis, design and implementation of communication systems between sensors and microprocessors, display and interpretation of data from diverse sensors. Develops specific models for different computing systems components, hardware and software, and evaluates their functional and non-functional features. Utilizes programming environments and debugging tools specific for microprocessors and microcontroller programming.
Responsibilities and autonomy	Shows spirit of initiative and action for updating the appropriate skills in professional, economical and organizational culture.

8. Discipline objective (as results from the *key competences gained*)

8.1 General objective	Knowledge, understanding and use of concepts like microprocessor/ microcontroller, bus, memory system, data transfer methods, interface circuits and peripheral devices interfacing, analysis and design of microprocessor systems.
8.2 Specific objectives	To achieve the main objective, specific objectives are pursued: • Knowledge of microprocessors and microcontrollers features and capabilities: hardware capabilities, instruction set architecture, assembly language, and programming solutions. • Knowledge of hardware components used with the microprocessors: electrical and logical characteristics, connection modes. • Development of skills to find solutions based on microprocessors or microcontrollers for real problems with average complexity. • Acquaintance with microcontroller development boards and their software programming tools.

9. Contents

9.1 Lectures	Hours	Teaching methods	Notes
Lecture Overview. Introduction to MP based systems (AVR MCU family)	2	Oral, blackboard and multimedia, interactive teaching style, consultations, involvement of students in research / design.	
AVR registers and instructions	2		
AVR I/O ports and interrupts	2		
Input/output and interrupts for Arduino systems	2		
AVR timers. Timing events with Arduino	2		
Serial data communication. Serial data transfer with Arduino	2		
Analog signals processing	2		
Microcontroller based applications: usage of sensors	2		
Microcontroller based applications: usage of actuators	2		
The ESP32 microcontroller – basic I/O operations	2		
The ESP32 microcontroller – Interrupts and peripherals	2		
WiFi communication using ESP32	2		
Bluetooth communication using ESP32	2		
External memories, DMA	2		

Bibliography:

1. S. Nedevschi, “Microprocesoare”, Editura UTCN, 1994.
2. M.A. Mazidi, S. Naimi, S. Naimi, “AVR Microcontroller and Embedded Systems: Using Assembly and C”, Prentice Hall, 2010, ISBN 9780138003319.
3. M. Margolis, “Arduino Cookbook, 2-nd Edition”, O’Reilly, 2012.
4. N. Kolban, Kolban’s Book on ESP 32, 2017

Online:

5. http://users.utcluj.ro/~rdanescu/teaching_pmp.html
6. https://mihai.utcluj.ro/design-with-micro-processors/

9.2 Applications - Seminars / Laboratory / Project	Hours	Teaching methods	Notes
Laboratory			
Introduction to the Arduino boards.	1	Presentation on the blackboard, experiments on microcontroller development boards (Arduino, ESP32, peripherals, sensors), use of specialized IDE	
Applications with simple I/O modules	1		
Working with the LCD shield and the interrupt system	1		
Usage of timers	1		
Communication interfaces	1		
Digital sensors. Analogue keypad	1		
Analogue signals processing.	1		
Project			

Project specification	1	design tools (Arduino IDE, Atmel studio), involvement of students in research / design.	
Study of the required technologies	1		
Logic design of the solution.	1		
Implementation of the solution.	1		
Implementation of the solution.	1		
Optimization, testing and validation.	1		
Project assessment.	1		

Bibliography:

1. Atmel ATmega2560 - 8 bit AVR Microcontroller datasheet, http://www.atmel.com/Images/Atmel-2549-8-bit-AVR-Microcontroller-ATmega640-1280-1281-2560-2561_datasheet.pdf
2. Arduino Mega 2560, http://arduino.cc/en/Main/ArduinoBoardMega2560
3. Abdul Maalik Khan, AVR Project Book, http://www.digisoft.com.pk/products/avr-project-book
4. Mike McRoberts, Beginning Arduino, 2-nd Edition, Technology in Action.
5. M. Margolis, Arduino Cookbook, 2-nd Edition, O'Reilly, 2012.
6. N. Kolban, Kolban's Book on ESP 32, 2017
7. Online: http://users.utcluj.ro/~rdanescu/teaching_pmp.html

10. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field.

11. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Testing theoretical knowledge and problem solving skills	Written exam	50 %
Seminar	-	-	-
Laboratory Project	Practical skills for problem solving and implementation of specific problems for applications design. Attendance and activity.	Continuous evaluation of the laboratory work, continuous and final evaluation of the project	50 %

Minimum standard of performance:
Modeling and implementation of typical engineering problems using the theoretical models and applicative tools specific to the domain.
Grade computation: 25% laboratory + 25% project + 50% final exam Conditions for participating in the final exam: Laboratory ≥ 5, Project ≥ 5 Conditions for passing: final exam ≥ 5

Date of filling in: 30.04.2026	**Responsible**	**Title First name Last name**	**Signature**
	Course	Prof.dr.eng. Radu DĂNESCU	
	Applications	Assist.drd.eng. Ana REDNIC	
		Assist.drd.eng. Attila FÜZES	
		Assist.drd.eng. Andrei BĂRĂIAN	

Date of approval in the department	Head of department, Prof.dr.eng. Rodica Potolea
Date of approval in the Faculty Council	Dean, Prof.dr.eng. Vlad Mureșan