SYLLABUS

1. Information regarding the major

1.1 Higher education institution	Babeș–Bolyai University
1.2 Faculty	Faculty of Mathematics and Computer Science
1.3 Department	Department of Computer Science
1.4 Major	Computer Science
1.5 Study Cycle	Undergraduate
1.6 Major / Qualification	Computer Science

2. Information regarding the course

2.1 Name of the course	Microcontrollers						
2.2 Course coordinator	Assoc. Prof. András Libál, PhD						
2.3 Seminar coordinator	Assoc. Prof. András Libál, PhD						
2.4 Year of Study	3	2.5 Semester	2	2.6. Type of evaluation	Written	2.7 Type of course	Facultative
2.8 Course code							

3. Total estimated study time (hours/semester of activities)

3.1 Hours per week	3	3.2 Of which courses 2 hrs	3.3 Of which labs 1 hrs
3.4 Cumulative hours in the curriculum	36	3.5 Of which courses 24 hrs	3.6 Of which labs 12 óra
Time allotment:	in hours		
Learning using manual, course support, bibliography, course notes	12		
Additional documentation (in libraries, on electronic platforms, field documentation)	12		
Preparation for seminars/labs, homework, papers, portfolios and essays	12		
Tutorship	6		
Exams	5		
Other activities:			
3.7 Total Individual study hours	47		
3.8 Total hours per semester	83		
3.9 Number of ETCS credits	4		

4. Prerequisites (if necessary)

4.1 Curriculum	none (Electronics is recommended but not required)
4.2 Competences	Basics of electronic circuits, C/C++ programming

5. Conditions (if necessary)

5.1 For the course	Projector, Board
5.2 For the seminar/lab activities	Projektor, Board, a laboratory equipped with microcontrollers (Arduino, Node MCU) sensors, Arduino shields

6. Specific competencies acquired

Professional competencies	Understanding the structure and functionality of microcontrollers at the register level. The timer system and its uses. Programming GPIO ports. Several widely used communication protocols such as serial port, one wire (1W), two wire TWI or I2C, SPI, IR communication (remote controls). Using LCD screens, LEDs, RGB LEDs, etc. Building a simple IoT (Internet of Things) system.
Transversal competencies	Being able to design and understand an electronical circuit with embedded systems, including possible applications in robotics or for an iOT system

7. Obejctives of the course (specification of the acquires competencies)

7.1 Generic objectives of the course	Show students the basics of the operation of microcontrollers, how they are programmed both on a high level (using pre-written libraries) and low level (reading specifications and setting the correct bits in the registers in C language, utilizing the hardware to its full capability). Learning the use of different sensors, reading digital and analog signals or communicating with the sensors using a standard protocol. Understanding the analog-digital conversion. Being able to generate output and read input from different components using standard protocols (1W,I2C, SPI, ...).
7.2 Specific objectives of the course	We will study the Arduino UNO board and platform, the Arduino IDE and language (libraries built on C) and in detail the design and capabilities of the Atmel Atmega 328P processor at the level of registers. We will read values from different sensors (liquid level, light intensity, temperature, acceleration, magnetic field etc) we will scan digital inputs (switches, keypads, tilt switches etc) and we will learn to use the most used communication protocols such as the UART serial port, 1W protocol, TWI (I2C) protocol, SPI and we will also talk about specific protocols related to some devices (for example LCD screens). We will also learn about controlling different types of motors such as DC, stepper and servo motors.

8. Content of the course

8.1 Course material	Teaching Methods	Remarks
1. Introduction to Microcontrollers and Embedded Systems. Using GPIO ports to read/write digital information	Presentation, demonstration	
2. Timer system, Normal Timer operation. Driving a 7 segment display. Sound generation.	Presentation, demonstration	
3. Timer system, CTC operation, Timer interrupts, event capture. Measuring time: ultrasonic sensors.	Presentation, demonstration	
4. Timer system. PWM operation. Controlling laser intensity with PWM. Motors and PWM.	Presentation, demonstration	

5. Sensing. Differet Sensors. Analog-Digital Conversion. Sampling Theorem. ADC with a microcontroller.	Presentation, demonstration	
6. Actuating. Different Motor, Motor Drivers, transistor decoupling, H Bridge, L293D, Motor Shields, DC, servo and stepper motors. Relays.	Presentation, demonstration	
7. UART protocol. Parity.1W protocol in detail. CRC check. DS18B20 thermometer. DS2431 EEPROM module. Non-standard one wire: Smart RGB LEDs and DHT11 temperature and humidity sensors.	Presentation, demonstration	
8. TWI (I2C) protocol. I2C EEPROM module, I2C real time clock. I2C interfacing of an LCD module. LCD module low-level programming (Hitachi HD44780U interfacing).	Presentation, demonstration	
9. SPI protocol. SPI stereo DAC. Writing SD cards in SPI mode. SPI LED dot matrix. SPI Bluetooth module. SPI RC522 RFID card-keyfob reader.	Presentation, demonstration	
10. IR communication, IR comunication protocols, remote controls. Radio communication. Ethernet board, wireless communication with ESP8266 module.	Presentation, demonstration	
11. Introduction to IoT: the ESP8266 module, Node MCU, WeMOS boards	Presentation, demonstration	
12. Other embedded systems (Arduino Mega, Arduino Due, different WeMOS boards, particle Photon)	Presentation, demonstration	

Bibliography

Horowitz, Hill - The Art of Electronics
Scherz, Monk - Practical Electronics for Inventors
Richard G. Lyons - Understanding Digital Signal Processing
Bezhad, Razavi - Fundamentals of Microelectronics

8.2 Seminar/Laboratory	Teaching Methods	Remarks
1. Simple Digitial IO, LED, Switches, Keypads	Presentation, demonstration, teamwork in groups of 2-3	
2. Timer generated outputs, Seven segment display, Sound generation Timed inputs: ultrasonic distance measurement, event capture	Presentation, demonstration, teamwork in groups of 2-3	
3. Sensing and Actuating: ADC of different sensor values, multiplexing at the input, motor driver shield, driving DC, stepper and servo motors.	Presentation, demonstration, teamwork in groups of 2-3	
4. One Wire and Two Wire (I2C) protocols (DS18B20, DHT11, Smart RGB LED), (RTC clock, I2C EEPROM, I2C LCD interfacing etc.)	Presentation, demonstration, teamwork in groups of 2-3	
5. SPI protokoll (8x8 LED matrix, RFID reading with RC522), IR protocol, reading an IR remote	Presentation, demonstration, teamwork in groups of 2-3	

6. Simple IoT project with Node MCU, interfacing the Node MCU with the Arduino with a voltage level converter	Presentation, demonstration, teamwork in groups of 2-3	
Bibliography Hayes, Horowitz - Learning the Art of Electronics, A Hands-On Lab course		

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program.

The material of the course is something students can use in their embedded and IoT projects, it is being refreshed every year to correspond to current trends and new hardware available. It is relevant for students who will participate in any embedded, IoT or robotic projects in the future.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the final grade
10.4 Course	Every class beings with a simple quiz from the last lecture with 5 questions (10 minutes)	All quizes count the same 10 points	30% from the final grade
10.5 Seminar/Lab activities	Every Lab students work together in groups of 2-3 people to complete the lab assignment	All labs count 20 points with the possibility to earn extra +2 points for some additional work	30% from the final grade
10.6 Minimum performance standards			
Average of all the quizes has to be a minimum of 3.0, quizes can only be recovered during the year Average of all the quizes and the labs has to be a minimum of 5.0. The written exam has to be a minimum of 5.0.			

Date	Course coordinator	Seminar coordinator
2018.04.22	Libál András	Libál András

Date of departmental approval	Head of Department
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