COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
Microcontrollers in embedded systems	

Lecturer(s)	Department(s) where the course unit (module) is delivered
Coordinator: assoc. prof. Vytautas Jonkus **Other(s):**	VU Faculty of Physics

Study cycle	Type of the course unit (module)
second	compulsory

Mode of delivery	Period when the course unit (module) is delivered	Language(s) of instruction
face-to-face	2 semester	Lithuanian

Requirements for students	
Prerequisites: "Introduction to programming", "Electronics", "Introduction to microcontrollers"	**Additional requirements (if any):**

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
5	140	64	76

Purpose of the course unit (module): programme competences to be developed		
Aim: to provide knowledge about microcontroller development tendencies, to develop microcontroller programming skills, to provide knowledge about implementation of operating systems and communication protocols in microcontrollers, to learn to analyze electronic circuits with microcontrollers.		
Learning outcomes of the course unit (module)	**Teaching and learning methods**	**Assessment methods**
Students will know microcontroller progress trends; microcontroller application area; Students will be able to analyze an electronic circuit with a microcontroller.	Lecture, reading of literature, discussion during laboratory work.	Exam
Students will be able to write programs for ARM microcontrollers. Students will be able to embed file system, USB, TCP/IP protocol libraries in their project. Students will be able to embed the operating system into their project.	Electronic circuit diagram analysis, demo board programming, program debugging and testing.	Demonstration of program operation, explanation of program operation.

Content: breakdown of the topics	Contact hours							Self-study work: time and assignments	
	Lectures	Tutorials	Seminars	Exercises	Laboratory work	Internship/work placement	**Contact hours**	**Self-study hours**	**Assignments**

1. **Introduction.** Application areas of microcontrollers, architectural diversity, main technical characteristics. Microcontroller development trends and news. ARM Architecture family: A, R, and M processor classes. Cortex M0 / M3 / M4 / M7 cores; kernel states; memory and peripheral control; interrupt logic. Integrated development environments and compilers. Programming/debugging tools and programming interfaces.	4				2		**6**	**16**	Read the literature on the specified topics
2. **Microcontroller in electronic circuit.** Clock sources; Reset signal; power supply circuit; integration of microcontroller analogue circuits (analogue - digital converters, comparators) into an electronic circuit; connection of peripherals; software and hardware protection from program hanging; protection of communication lines from electromagnetic interference;	8				8		**16**	**16**	Write program for microcontroller
3. **Program for Microcontroller**. The program types: Endless Cycle Program and Operating System. Formatted output. Blocking and non-blocking functions. Operating systems for microcontrollers: processes and their management, pauses, events, mutexes, queues, critical code, and interrupts in the operating system.	8				8		**16**	**16**	Write program for microcontroller
4. **Microcontroller applications**. Libraries for microcontroller's hardware management: main principles; functionality; ST and NXP microcontroller module management libraries. Wired bus drivers. RS232, RS485, and CAN interface programming. SD Cards: Characteristics; interfaces; file system; FatFS library. USB interface: physical characteristics of the USB interface; interface modes; data logic; time tick; transaction; USB device status; device descriptors; device classes; USB interface in microcontrollers. Ethernet interface: physical characteristics of the Ethernet interface; standards; data coding; IPv4 and IPv6 packets; UDP, TCP, ARP and other protocols; Ethernet interface in microcontrollers; uIP, LwIP, and other protocol libraries for microcontrollers.	12				14		**26**	**28**	Write program for microcontroller
Total	**32**				**32**		**64**	**76**	

Assessment strategy	**Weigh t,%**	**Deadline**	**Assessment criteria**
Write a program for microcontroller and answer to questions.	60	semester	5-6 points: the ability to write, test and demonstrate program. 7-8 points: the ability to explain the logic of the operation of the program, reasoning in answering questions. 9-10 points: ability to explain alternative ways of programming the problem, ability to think reasonably in response to problematic issues.
Exam	40	session	Test of 40 questions.

Author	**Year**	**Title**	**Issue of a**	**Publishing place and house**

	of publication		periodical or volume of a publication	or web link
Compulsary reading				
1. Daniel W. Lewis	2011	Fundamentals of Embedded Software with the ARM® Cortex-M3.		Prentice Hall
2. Joseph Yiu	2014	The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors.		Elsevier
Optional reading				
1. Richard Barry	2010	Using the freeRTOS Real Time Kernel: A Practical Guide, LPC17XX Version		Real Time Engineers Ltd
2. Jan Axelson	2003	Embedded Ethernet and Internet Complete (Complete Guides series).		Lakeview Research LLC
3. Steve Oualline	2010	Practical C++ programming		O'Reilly