RTU Course "Microprocessors - based Automation Systems"

33000 Faculty of Computer Science, Information Technology and Energy

General data

Code	EEP504
Course title	Microprocessors - based Automation Systems
Course status in the programme	Compulsory/Courses of Limited Choice
Responsible instructor	Ilja Galkins
Academic staff	Aleksandrs Bubovičs Kristaps Vītols
Volume of the course: parts and credits points	1 part, 4.5 credits
Language of instruction	LV, EN
Annotation	The study course has been composed for any student who has elementary knowledge in the field of electrical engineering and programming and wish to gain basic practical skills of utilization of microcontrollers MSP430. The study course briefly discusses basic design features of microcontrollers MSP430 in the context of various architectures of microprocessors, microcontrollers and peripheral devices. A significant part of the study course is devoted to the programming of MSP430 using assembler language – including the programming of digital I/O, watchdog and arithmetical operations. The study course is based on practical studies and assumes active individual training of the students in the laboratory or at home. Development of a complete embedded, MSP430 microcontroller-based control system with sensors and actuators is planned within the scope of the study course.
Goals and objectives of the course in terms of competences and skills	The aim of the study course is to develop students' abilities to develop embedded control systems with microcontrollers. The set goal requires given tasks: 1) Introduce students to the structure of microprocessor embedded control systems and its key elements (processor, memory, peripheral devices) to recognize microcontroller and processor architectures and identify their advantages and drawbacks. 2) Provide information about typical microprocessor peripheral modules, their functions and to develop their utilization skills. 3) Train students to quickly design an MSP430 microcontroller machine code by composing the initial code in C language and perform its debugging. 4) Train students to design an efficient MSP430 microcontroller machine code in assembler language and perform its debugging. 5) Develop student skills to use MSP430 microcontrollers with sensors and actuators using typical peripheral modules as required to design fully embedded control systems. 6) Develop student skills to use MSP430 microcontrollers with communication modules as required for design of fully functional embedded control systems.
Structure and tasks of independent studies	Preparation for practical (development of machine code without hardware and using debugging in simulation mode) and laboratory (development of machine code with hardware and debugging with real microprocessor system) activities: analysis of literature, preparation of activity description, design of program code, modification of existing code according to a given task. Processing of results of practical and laboratory activities: systematization and analysis of obtained data, calculation of final parameters, evaluation of activity completion, formulation of conclusions. Preparation for exam: accomplishing of training tests, preparation of new questions regarding training tests.
Recommended literature	Obligātā/Obligatory: 1)I.Galkins, MSP430 mikrokontrolleru pielietošanas pamati, Rīga: RTU izdevniecība, 2009. gads, 229 lpp., ISBN 978-9984-32-460-9; 2)Apse-Apsītis, P., Assanovic, B., Čaiko, J., Galkins, I., Kovalenko, D., Kyriakides, E., Kuņicina, N., Liauchuk, V., Ribickis, L., Varuyeu, A., Zabašta, A., Žiravecka, A. Applied Informatics. Riga, 2018. 258 lpp. ISBN 978-9934-22-144-6; 3)Getting Started with the MSP430 LaunchPad - Student Guide and Lab Manual, http://software-dl.ti.com/trainingTTO/trainingTTO_public_sw/MSP430_LaunchPad_Workshop/v2.20/MSP430_LaunchPad_Workshop_v2.22.pdf; Papildu/Additional: 4)MSP430x2xx Family User's Guide, Texas Instruments 2004-2014, TI's document SLAU144H; 5)MSP430G2553 Datasheet, Texas Instruments 2011-2014, TI's document SLAS735J; 6)Jerry Luecke, „Analog and Digital Circuits for electronic control system applications using the TI MSP430 microcontroller", Elsevier-Newnws, 2005; 7)Manuel Jiménez, Rogelio Palomera, Isidoro Couvertier, „Introduction to Embedded Systems Using Microcontrollers and the MSP430", Springer New York, 2014; 8)Adrian Fernandez and Dung Dang «Getting Started with the MSP430 Launchpad», Elsevier Inc., 2013, ISBN: 978-0-12-411588-0;
Course prerequisites	Basic knowledge in the field of electrical engineering, digital electronics and programming.

Course contents

Content	Full- and part-time intramural studies		Part time extramural studies	
	Contact Hours	Indep. work	Contact Hours	Indep. work
L0 Introduction, LC1 Structure of microcontrollers.	3	4	1	6

LC2A Digital inputs/outputs.	3	5	1	7
LC2B Interrupts of digital inputs/outputs.	3	4	1	6
LC3 Clock system.	3	5	1	7
LC4 Watchdog timer.	3	4	1	6
LC5 Interval measurement, pulse signal generation and its parameter measurement using timer TA.	3	5	1	7
LC6 Measurement of analog signals with analog comparator, ADC and options of synthesis of analog signals.	3	4	1	6
LA1 MCU architectures, LA2A Structure of processor, commands, operands.	3	5	1	7
LA2B Assembler statements and cycles, processing of arrays, LA2C Assembler arithmetic.	3	4	1	6
LA3, LA4 Processor command formats, addressing modes, command sizes and execution time, LA5 Design of machine code.	3	5	1	7
LA6 Stack, subroutines, interrupts, LA7 Simultaneous use of Assembler and C code.	3	4	1	6
LK11 Utilization of timer TA and analog devices to connect sensors. Information extraction from sensors.	3	5	1	7
LK12 Utilization of timer TA to control actuators.	3	4	1	6
LK21 Utilization of microcontroller UART communication to connect sensors and obtain measurement data.	3	5	1	7
LK22 Utilization of microcontroller SPI communication to connect sensors and obtain measurement data.	3	4	1	6
LK23 Utilization of microcontroller I2C communication to connect sensors and obtain measurement data.	3	5	1	7
Total:	48	72	16	104

Learning outcomes and assessment

Learning outcomes	Assessment methods
Is able to recognize the most significant elements of microprocessors and microprocessor systems (processor, memory, peripheral devices), identify their architectures, benefits and drawbacks. Knowledge about microprocessor embedded control system component interaction.	Exam (weekly quizzes as an alternative).
Is able to explain operation of CPU, memory, some peripheral devices (digital I/Os and watchdog) and other significant part of MSP430.	Exam (weekly quizzes as an alternative).
Is able to quickly design and debug MSP430 microcontroller machine code to initialize and utilize peripherals in C language.	Laboratory tasks.
Is able to design and debug efficient MSP430 microcontroller machine code.	Practical tasks.
Is able to connect sensors and actuators to MSP430 microcontroller using typical peripherals.	Laboratory tasks.
Is able to connect sensors and actuators to MSP430 microcontroller using communication modules.	Laboratory tasks.

Evaluation criteria of study results

Criterion	%
Laboratory tasks	30
Practical tasks	30
Exam or quizzes	40
Total:	100

Study subject structure

Part	CP	Hours			Tests		
		Lectures	Practical	Lab.	Test	Exam	Work
1.	4.5	1.0	1.0	1.0		*	