



ALYTAUS
KOLEGIJA



SCHOOL OF BUSINESS
AND MANAGEMENT OF
TECHNOLOGY OF BSU



DE MONTFORT
UNIVERSITY
LEICESTER



Université
de Lille
SCIENCES
ET TECHNOLOGIES



UNIVERSITY OF
ECONOMY

Innovative ICT Education for Social-Economic Development (IESED)
574283-EPP-1-2016-1-LT-EPPKA2-CBHE-JP

MICROTECHNOLOGY OF AUTOMATED SYSTEMS

Minsk 2017

1. PLAN OF EDUCATIONAL DISCIPLINE

Course code	Year of study	Semester	Academic hours				Hours of course work	Credits	Number of hours
			Total	Lecture	Practice/ Seminar	Independent work			
Full-time	2	4	108	34	50	24	–	4	108
Part-time	2	3,4	28	12	16	80	–	4	108

2. COMPETENCIES

1. Analyze perspectives and directions of development of information systems and technologies
2. Perform modeling, design of software tools and documentation to support activities in various subject areas
3. Plan and organize automated support of various activities

3. COURSE AIMS:

Training of a specialist with fundamental knowledge and practical skills in the field of microprocessor technology and microprocessor control systems.

4. COURSE OUTCOMES

- list the areas and explain features of the application of microprocessor technology for the creation of control systems;
- develop programs for the microprocessor controllers for control systems using network technologies of automation systems.
- explain the structure and basis of construction, software and hardware of microprocessor control systems;
- make use of microprocessor technology in the construction of automatic control systems of technological processes;
- make use and configure physical, logical, and network interfaces

5. EDUCATIONAL AND METHODOLOGICAL MAP (for full-time education)

Section number	Topics, classes, list of issues to be studied	Number of academic hours					Form of knowledge control
		Total	Lecture	Practical classes (seminar)	laboratory classes	Supervised independent	
1	2	3	4	5	6	7	8
1.	Basic concepts and definitions.	2	1	0	1		
1.1.	Basic concepts and definitions.	2	1	0	1		Test
2.	Structure and organization of a microprocessor system.	2	1	0	1		
2.1.	Structure and organization of a microprocessor system.	2	1	0	1		Test

3.	Design tools and the software for development of microprocessor systems.	8	2	4	2		
3.1.	Features of design of hardware and technique of development of application programs.	4	1	2	1		Test, individual tasks
3.2.	Methods of debugging of equipment rooms and software.	4	1	2	1		Test, individual tasks
4.	Control of a microprocessor system.	2	1	0	1		
4.1.	Control of a microprocessor system.	2	1	0	1		Test, individual tasks
5.	General information about family of AVR microcontrollers.	2	1	0	1		
5.1.	Distinctive features.	2	1	0	1		Test, individual tasks
6.	Organization of memory.	6	1	0	5		
6.1.	Organization of memory.	3	0,5	0	2,5		Test, individual tasks
6.2.	Addressing modes of memory of data	3	0,5	0	2,5		Test, individual tasks
7.	Input/output ports.	6	1	2	3		
7.1.	Registers of input/output ports.	3	0,5	1	1,5		Test, individual tasks
7.2.	Configuring of input/output ports.	3	0,5	1	1,5		Test, individual tasks
8.	Strain measurement and output to the LCD display	5	0	2	3		
8.1.	Configuring of ADC in the controller.	3		1	2		Test, individual tasks
8.2.	Connection of LCD library of the display.	2		1	1		Test, individual tasks
9.	7-segment indicators and with dynamic indication.	5	1	2	2		
9.1.	Dynamic indication.	2	0,5	1	0,5		Test
9.2.	7-segment indicators, connection methods.	3	0,5	1	1,5		Test, individual tasks
10.	Matrix keypad.	4	0	2	2		
10.1	Matrix keypad 3x4.	1		1	0		Test
10.2	Use of inputs/outputs for reading the keypad.	3		1	2		Test, individual tasks
11.	Interrupts	10	0,5	0	9,5		
11.1	Interrupt vector table.	2	0,5		1,5		Test
11.2	Interrupt handling.	4			4		Test, individual tasks
11.3	External interrupt.	4			4		Test, individual tasks
12.	Timers.	4	0	0	4		
12.1	Timers.	4			4		Test, individual tasks
13.	Operation modes of timers/counters	4	0	0	4		
13.1	Operation modes of timers/counters	4			4		Test, individual tasks
14.	"Point-to-point" interfaces.	6	0,5	0	5,5		
14.1	"Point-to-point" interfaces.	6	0,5		5,5		Test, individual tasks
15.	Interfaces of "short-range range"	6	0,5	0	5,5		
15.1	Interfaces of "short-range range"	6	0,5		5,5		Test, indi-

						vidual tasks
16.	The universal multipoint interfaces	2	0	0	2	
16.1	The universal multipoint interfaces	2			2	Test
17.	Microprocessor controllers in the systems of automation	10	0	0	10	
17.1	Assignment and the PLC functions in the systems of control.	5			5	Test, individual tasks
17.2	IEC 61131 standard.	1			1	Test
17.3	Programming.	4			4	Test, individual tasks
18.	PLC programming	24	1,5	4	18,5	
18.1	Study of the IEC 61131 standard	2	0,5		1,5	Test
18.2	A study of technology of programming with use of languages of the IEC 61131 standard: IL, ST, LD, FBD, SFC.	22	1	4	17	Test, individual tasks
	TOTAL	108	12	16	80	

6. EDUCATIONAL AND METHODOLOGICAL MAP (for part-time education)

Section number	Topics, classes, list of issues to be studied	Number of academic hours				Form of knowledge control
		Total	Lecture	laboratory classes	Supervised independent work of a student	
1	2	3	4	5	6	7
1.	Basic concepts and definitions.	2	1	0	1	Test
1.1.	Basic concepts and definitions.	2	1	0	1	Test
2.	Structure and organization of a microprocessor system.	2	1	0	1	Test
2.1.	Structure and organization of a microprocessor system.	2	1	0	1	Test
3.	Design tools and the software for development of microprocessor systems.	8	2	4	2	Test, individual
3.1.	Features of design of hardware and technique of development of application programs.	4	1	2	1	Test, individual tasks
3.2.	Methods of debugging of equipment rooms and software.	4	1	2	1	Test, individual tasks
4.	Control of a microprocessor system.	2	1	0	1	Test,
4.1.	Control of a microprocessor system.	2	1	0	1	Test, individual tasks
5.	General information about family of AVR microcontrollers.	2	1	0	1	Test, individual
5.1.	Distinctive features.	2	1	0	1	Test, individual tasks
6.	Organization of memory.	6	1	0	5	Test,
6.1.	Organization of memory.	3	0,5	0	2,5	Test, individual tasks

6.2.	Addressing modes of memory of data	3	0,5	0	2,5	Test, individual tasks
7.	Input/output ports.	6	1	2	3	Test,
7.1.	Registers of input/output ports.	3	0,5	1	1,5	Test, individual tasks
7.2.	Configuring of input/output ports.	3	0,5	1	1,5	Test, individual tasks
8.	Strain measurement and output to the LCD display	5	0	2	3	Test,
8.1.	Configuring of ADC in the controller.	3		1	2	Test, individual tasks
8.2.	Connection of LCD library of the display.	2		1	1	Test, individual tasks
9.	7-segment indicators and with dynamic indication.	5	1	2	2	Test,
9.1.	Dynamic indication.	2	0,5	1	0,5	Test
9.2.	7-segment indicators, connection methods.	3	0,5	1	1,5	Test, individual tasks
10.	Matrix keypad.	4	0	2	2	Test,
10.1	Matrix keypad 3x4.	1		1	0	Test
10.2	Use of inputs/outputs for reading the keypad.	3		1	2	Test, individual tasks
11.	Interrupts	10	0,5	0	9,5	Test,
11.1	Interrupt vector table.	2	0,5		1,5	Test
11.2	Interrupt handling.	4			4	Test, individual tasks
11.3	External interrupt.	4			4	Test, individual tasks
12.	Timers.	4	0	0	4	Test,
12.1	Timers.	4			4	Test, individual tasks
13.	Operation modes of timers/counters	4	0	0	4	Test,
13.1	Operation modes of timers/counters	4			4	Test, individual tasks
14.	"Point-to-point" interfaces.	6	0,5	0	5,5	Test
14.1	"Point-to-point" interfaces.	6	0,5		5,5	Test, individual tasks
15.	Interfaces of "short-range range"	6	0,5	0	5,5	Test
15.1	Interfaces of "short-range range"	6	0,5		5,5	Test, individual tasks
16.	The universal multipoint interfaces	2	0	0	2	Test
16.1	The universal multipoint interfaces	2			2	Test
17.	Microprocessor controllers in the systems of automation	10	0	0	10	Test
17.1	Assignment and the PLC functions in the systems of control.	5			5	Test, individual tasks
17.4	IEC 61131 standard.	1			1	Test
17.5	Programming.	4			4	Test, individual tasks
18.	PLC programming	24	1,5	4	18,5	Test,
18.1	Study of the IEC 61131 standard	2	0,5		1,5	Test

18.2	A study of technology of programming with use of languages of the IEC 61131 standard: IL, ST, LD, FBD, SFC.	22	1	4	17	Test, individual tasks
	TOTAL	108	12	16	80	

7. THE CONTENT OF TOPICS OF THE LECTURES

№	Topic number	Content
1.	Basic concepts and definitions	
1.1	Basic concepts and definitions.	The universal microprocessor. Specialized microprocessor. Microprocessor set or kit. Microprocessor system. Architecture of the microprocessor. Architecture of a micro computer. Information representation in a microprocessor system.
2.	Structure and organization of a microprocessor system	
2.1	Structure and organization of a microprocessor system.	Structure of the microprocessor system (MS). Interface of microprocessor systems Trunk principle of creation of the MS. Organization of operation of the MS. Control of the MS.
3.	Control of a microprocessor system	
3.1	Control of a microprocessor system.	Control cycle Neumann's background. Principle of the pipeline. Clocking of the microprocessor and synchronization of operation of a microprocessor system.
4.	General information about family of AVR microcontrollers	
4.1	Distinctive features.	Distinctive features. Characteristics of the processor. Characteristics of a subsystem of input-output. Peripheral devices. Architecture of a kernel. Pin-connection diagram and description of outputs.
5.	Organization of memory	
5.1	Organization of memory.	Program memory. Memory of data. Static RAM. General purpose registers. Registers of input/output. Format of the register of a status of SREG
5.2	Addressing modes of memory of data	Use of the external RAM Addressing modes of memory of data Non-volatile memory of data (EEPROM).
6.	Input/output ports	
6.1	Registers of input/output ports.	Registers of input/output ports.
6.2	Configuring of input/output ports.	Configuring of input/output ports.
7.	Interrupts	
7.1	Interrupt vector table.	Interrupt vector table.
7.2	Interrupt handling.	Interrupt handling.
7.3	External interrupt.	External interrupt.
8.	Timers	

№	Topic number	Content
8.1	Timers.	Assignment of outputs of timers/counters. Interruptions from timers/counters. Predividers of timers/counters. Use of an external clock signal. Operation modes of timers/counters.
9.	Operation modes of timers/counters	
9.1	Operation modes of timers/counters	Formation of a PWM signal. Normal mode. The mode of ROC (reset in case of coincidence). Fast PWM mode. Phase Correct PWM mode. Asynchronous mode.
10.	"Point-to-point" interfaces	
10.1	Point-to-point" interfaces.	"Current loop" interface. RS-232 interface (UART). SPI interface.
11.	Interfaces of "short-range range"	
11.1	Interfaces of "short-range range"	Parallel interfaces. The instrumental I2C interface. The instrumental interface 1-Wire.
12.	The universal multipoint interfaces	
12.1	The universal multipoint interfaces	RS-485 interface. USB interface. Industrial CAN networks.
13.	Microprocessor controllers in the systems of automation	
13.1	Assignment and the PLC functions in the systems of control.	Assignment and the PLC functions in the systems of control. PLC components. Working cycle.
13.2	IEC 61131 standard.	IEC 61131 standard.
13.3	Programming.	Programming. Integration of PLC into avtomaizirovanny management system. Distributed control systems.

8. THE CONTENT OF TOPICS OF THE PRACTICAL CLASSES

№	Topic number	Content
1.	Programming in the environment of "CodeVisionAVR"	1. Configuring of parameters of the controller. 2. Development of the program in language C.
2.	Simulation in the environment of "Proteus"	1. Creation of the diagram for simulation. 2. Debugging of the program. 3. Check of operation on the bench "EasyAVR v7".
3.	Operation with the discrete ports	1. Configuring of ports of the controller. 2. Development of the program in language C. 3. Simulation and debugging of the program. 4. Check of operation on the bench "EasyAVR v7".
4.	Measurement of tension and output to the LCD display	1. Configuring of ADC in the controller. 2. Connection of LCD library of the display. 3. Development of the program in language C. 4. Simulation and debugging of the program. 5. Check of operation on the bench "EasyAVR v7".
5.	7-segment indicators and with dynamic indication	1. Dynamic indication. 2. 7-segment indicators, connection methods. 3. Development of the program in language C. 4. Simulation and debugging of the program. 5. Check of operation on the bench "EasyAVR v7".

№	Topic number	Content
6.	Matrix keypad	<ol style="list-style-type: none"> 1. Matrix keypad 3x4. 2. Use of inputs/outputs for reading the keypad. 3. Development of the program in language C. 4. Simulation and debugging of the program. 5. Check of operation on the bench "EasyAVR v7".
7.	Programming in the environment of "AVR studio"	<ol style="list-style-type: none"> 1. Configuring of parameters of the controller. 2. Development of the program in language the assembler. 3. Debugging of the program and simulation. 4. Check of operation on the bench "EasyAVR v7".
8.	Organization of system of timers	<ol style="list-style-type: none"> 1. Configuring of timers in the controller. 2. Development of the program in language the assembler. 3. Debugging of the program and simulation. 4. Check of operation on the bench "EasyAVR v7".
9.	Organization of system of interruptions.	<ol style="list-style-type: none"> 1. Configuring of interruptions in the controller. 2. Development of the program in language the assembler. 3. Debugging of the program and simulation. 4. Check of operation on the bench "EasyAVR v7".
10.	PLC programming.	1. Study of technology of programming

9. LIST OF TASKS OF student's independent work

1. Protection of the personal tasks performed on laboratory researches.
2. Protection of estimated and graphic operations.
3. Passing a test on discipline.

№	Task
1.	To configure the project under other controller
2.	To realize the sequence of managing directors of signals set cyclically
3.	To carry out simulation of the developed system
4.	To bring an analog signal into accord with the measured value and to display
5.	To remove warning of an output of an analog signal for admissible value
6.	To poll the matrix keypad and to remove the clicked keys
7.	To realize the program in other language
8.	To organize pulse counting using the hardware opportunities of the controller
9.	To organize a temporal time delay using the hardware opportunities of the controller
10.	To organize protection against "a tinkling sound of contacts"

The evaluation criteria of the results on a ten-point scale.

A ten-point scale, depending on the grade and the mark, includes the following criteria:

10 (ten) points, passed:

- systematized, deep and full knowledge on all sections of the curriculum of the institution of higher education in the academic discipline, as well as on major issues that go beyond its limits;
- accurate use of scientific terminology (including in a foreign language), competent, logically correct statement of the answer to questions;
- perfect mastering of the tools of the academic discipline, the ability to use it effectively in formulation and solution of scientific and professional problems;
- the expressed ability independently and creatively to solve complex problems in non-standard situations;
- complete and profound studying of basic, additional literature on the subject of the discipline;
- the ability to freely navigate in theories, concepts and directions on the discipline and give them an analytical assessment, use the scientific achievements of other disciplines;

- creative independent work on practical, laboratory classes, active creative participation in group discussions, high level of the culture of performance of tasks.

9 (nine) points, passed:

- systematized, deep and full knowledge on all sections of the curriculum of the institution of higher education on the academic discipline;
- accurate use of scientific terminology (including in a foreign language), competent, logically correct statement of the answer to questions;
- mastering of the tools of the academic discipline, the ability to use it effectively in formulation and solution of scientific and professional problems;
- ability independently and creatively to solve complex problems in non-standard situations within the curriculum of the institution of higher education on the academic discipline;
- complete studying of basic, additional literature on the subject of the discipline, recommended by the curriculum of the institution of higher education on the discipline;
- the ability to navigate in theories, concepts and directions on the discipline and give them an analytical assessment;
- Systematic, active independent work on practical, laboratory classes, active creative participation in group discussions, high level of the culture of performance of tasks.

8 (eight) points, passed:

- systematized, deep and full knowledge on all sections of the curriculum of the institution of higher education in the academic discipline in the volume of the curriculum of the institution of higher education on the discipline;
- use of scientific terminology (including in a foreign language), competent, logically correct statement of the answer to questions, the ability to make sound conclusions and generalizations;
- mastering of the tools of the academic discipline (methods of complex analysis, information technology), the ability to use it effectively in formulation and solution of scientific and professional problems;
- ability independently to solve complex problems within the curriculum of the institution of higher education on the academic discipline;
- studying of basic, additional literature, recommended by the curriculum of the institution of higher education on the discipline;
- the ability to navigate in theories, concepts and directions on the discipline and give them an analytical assessment;
- active independent work on practical, laboratory classes, systematic participation in group discussions, high level of the culture of performance of tasks.

7 (seven) points, passed:

- systematized, deep and full knowledge on all sections of the curriculum of the institution of higher education on the academic discipline;
- use of scientific terminology (including in a foreign language), competent, logically correct statement of the answer to questions, the ability to make sound conclusions and generalizations;
- mastering of the tools of the academic discipline, the ability to use it effectively in formulation and solution of scientific and professional problems;
- free possession of generic solutions within the curriculum of the institution of higher education on the academic discipline;
- studying of basic, additional literature, recommended by the curriculum of the institution of higher education on the discipline;

- the ability to navigate in basic theories, concepts and directions on the discipline and give them an analytical assessment;
- independent work on practical, laboratory classes, participation in group discussions, high level of the culture of performance of tasks.

6 (six) points, passed:

- sufficiently full and systematized knowledge in the volume of the curriculum of the institution of higher education on the discipline;
- use of the necessary scientific terminology, competent, logically correct statement of the answer to questions, the ability to make sound conclusions and generalizations;
- mastering of the tools of the academic discipline, the ability to use it effectively in solution of scientific and professional problems;
- ability independently to apply generic solutions within the curriculum of the institution of higher education on the academic discipline;
- studying of basic literature, recommended by the curriculum of the institution of higher education on the discipline;
- the ability to navigate in basic theories, concepts and directions on the discipline and give them a comparative assessment;
- active independent work on practical, laboratory classes, periodic participation in group discussions, high level of the culture of performance of tasks.

5 (five) points, passed:

- sufficient knowledge in the volume of the curriculum of the institution of higher education on the discipline;
- use of scientific terminology, competent, logically correct statement of the answer to questions, the ability to make sound conclusions;
- mastering of the tools of the academic discipline, the ability to use it in solution of scientific and professional problems;
- ability independently to apply generic solutions within the curriculum of the institution of higher education on the academic discipline;
- studying of basic literature, recommended by the curriculum of the institution of higher education on the discipline;
- the ability to navigate in basic theories, concepts and directions on the discipline and give them a comparative assessment;
- active independent work on practical, laboratory classes, periodic participation in group discussions, high level of the culture of performance of tasks;
- independent work on practical, laboratory classes, periodic participation in group discussions, sufficient level of the culture of performance of tasks.

4 (four) points, passed:

- sufficient knowledge within the educational standard of higher education;
- studying of basic literature, recommended by the curriculum of the institution of higher education on the discipline;
- use of scientific terminology, logical statement of the answer to questions, the ability to make sound conclusions;
- ability to draw conclusions without essential errors;
- mastering of the tools of the academic discipline, the ability to use it in solution of standard (typical) tasks;
- ability to solve standard (typical) tasks under the guidance of a teacher;

- ability to navigate in basic theories, concepts and directions on the discipline and give them an assessment;
- work under the guidance of a teacher on practical, laboratory classes, the permissible level of the culture of performance of tasks.

3 (three) points, failed:

- insufficient knowledge within the educational standard of higher education;
- studying of basic literature, recommended by the curriculum of the institution of higher education on the discipline;
- knowledge of a part of the basic literature, recommended by the curriculum of the institution of higher education on the discipline;
- use of scientific terminology, presentation of answers to questions with significant, logical errors;
- weak possession of the tools of the academic discipline, incompetence in solving standard (typical) tasks;
- inability to navigate in basic theories, concepts and directions on the discipline;
- work under the guidance of a teacher on practical, laboratory classes, the permissible level of the culture of performance of tasks.
- passivity on practical, laboratory classes, low level of the culture of performance of tasks.

2 (two) points, failed:

- fragmented knowledge within the educational standard of higher education;
- knowledge of individual literary sources, recommended by the curriculum of the institution of higher education on the discipline;
- inability to use scientific terminology of the academic discipline, the presence in the answer rude, logical errors;
- passivity on practical, laboratory classes, low level of the culture of performance of tasks.

1 (one) point, failed:

- lack of knowledge and (competences) within the educational standard of higher education, failure to answer, failure to appear for attestation without good cause.

10. METHODS AND MEANS OF IMPLEMENTATION OF THE CONTENT OF THE EDUCATIONAL PROGRAM AND TRAINING OF EDUCATIONAL, TRAINING AND METHODOLOGICAL MATERIALS

Training will be provided with use of the classical methods, a project method and distant technologies realized on portal aye by SDO.VSTU.BY. Students will be provided with access to the SDO.VSTU.BY portal.

On internal occupations students will study discipline directly in a computer class. When training the following software (software) will be used:

№	The name of the software	System requirements for the specified software	№ of the topic from the educational and methodical map, for the support of which the specified software will be used	The software will be used for what purpose
1.	Integrated environment of the developer AVR	Operation system: Windows XP SP3, Windows 7, Win-	Topics of section 3,7-13	For programming and debugging of

	Studio v4.19.	dows 10. Processor frequency: 1.6 GHz. The amount of RAM: 1 GB. The amount of disk storage: 2 GB. Video: DirectX 9 (resolution: 1024 x 768). Sound: not needed		algorithms.
2.	AVR Toolchain v3.3.0	Operation system: Windows XP SP3, Windows 7, Windows 10. Processor frequency: 1.6 GHz. The amount of RAM: 1 GB. The amount of disk storage: 0,1 GB. Video: DirectX 9 (resolution: 1024 x 768). Sound: not needed	Topics of section 3,7-13	For programming of algorithms
3.	CodeVisionAVR v2.05.0	Operation system: Windows XP SP3, Windows 7. Processor frequency: 1.6 GHz. The amount of RAM: 1 GB. The amount of disk storage: 0,1 GB. Video: DirectX 9 (resolution: 1024 x 768). Sound: not needed	Topics of section 3,7-10	For programming of algorithms
4.	Proteus v7.7 SP2	Operation system: Windows XP SP3, Windows 7, Windows 10. Processor frequency: 1.6 GHz. The amount of RAM: 1 GB. The amount of disk storage: 1 GB. Video: DirectX 9 (resolution: 1024 x 768). Sound: not needed	Topics of section 3,7-13	For simulation of diagrams and debugging of programs
5.	AVR flesh v2.14	Operation system: Windows XP SP3, Windows 7, Windows 10. The amount of disk storage: 0,01 GB. Sound: not needed	Topics of section 3,7-13	For record of the program in the bench "EasyAVR v7".

By preparation of training, educational and methodical materials the following means and technologies were used:

- Adobe PDF.

- LMS Moodle.
- AVR Studio v4.19
- AVR Toolchain v3.3.0
- CodeVisionAVR v2.05.0
- Proteus v7.7 SP2
- Bench "EasyAVR v7"
- Programs for record and editing video.

11. THE INFORMATION-METHODOLOGICAL PART

Main literature

№.	Authors	Bibliographic description
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2.	Шпак Ю.А.	Программирование на языке С для AVR и PIC микроконтроллеров. Изд. 2-е, переработанное и дополненное./ Сост. Ю.А. Шпак — К.: "МК-Пресс", СПб.: "КОРОНА-БЕК", 2011. — 544 с.
3.	Евстифеев А. В.	Микроконтроллеры AVR семейства Mega. Руководство пользователя. — М.: Издательский дом «Додэка-XXI», 2007. - 592 с.
4.	Александров Е.К., Грушвицкий Р.И., Куприянов М.С. и др.	Микропроцессорные системы: Учебное пособие для вузов (под ред. Пузанкова Д.В.) - СПб: Политехника 2002. – 935 с.
5.	Рюмин, С. М.	1000 и одна микроконтроллерная схема. Вып. 2 / С. М. Рюмик. — М. : Додэка-XXI, 2011. — 400 с.

Additional literature

6.	Рюмин, С. М.	1000 и одна микроконтроллерная схема. Вып. 1 / С. М. Рюмик. — М. : Издательский дом «Додэка-XXI», 2010. — 356 с.
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8.	Гребнев В. В.	Микроконтроллеры семейства AVR фирмы Atmel. — М.: ИП РадиоСофт, 2002— 176 с.
9.	Катцен, Сид	PIC-микроконтроллеры. Все, что вам необходимо знать / С. Катцен; пер. с англ. Евстифеева А. В. — М.: Додэка-XXI, 2008. — 656 с.
10.	Зотов, В. Ю.	Проектирование встраиваемых микропроцессорных систем на основе ПЛИС фирмы XILINX® / В. Ю. Зотов. - М. : Горячая линия-Телеком, 2006. - 519с.