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

OPERATIONAL SYSTEMS

Minsk 2017

1. COURSE PLAN

Course code 21

Year of study	Semester	Academic hours					Hours of course work	ECTS	Number of hours
		Total	Lectures	Lab	Practice/ seminar	Independent work			
1	2	82	26	24	0	32	0	3	Full-time
1	2	82	8	6	0	68	0	3	Part-time

2. COMPETENCIES (IT Profile 1-9)

- Develop data structures for use in information systems, operational analysis systems and intellectual systems
- Perform comprehensive testing of the developed software products and applied software

3. COURSE GOAL

Formation of knowledge about the design of operating systems, their main components and functional principles, and formation of skills in using operating systems tools in the organization of a computational process and work of computational devices.

4. COURSE OUTCOMES (4-5)

After completing this course student will be able to:

- analyze building operating systems principles;
- solve problems of installation, administration and configuration of operating systems;
- develop programs that extend the capabilities of operating systems
- protect operating systems

5. COURSE CONTENT (FULL TIME)

№	Name of the topic	Number of academic hours					Form of knowledge control
		TOTAL	Lectures	practical tasks	labs	Independent work	
1	2	3	4	5	6	7	8
1.	**Evolution, functions and architecture of operating systems (OS)**	**7**	**3**		**4**		Testing
2.	**Processes and threads. Processor time management and synchronization**	**13**	**5**		**4**	**4**	Testing
3.	**Memory architecture and virtual memory**	**12**	**4**			**8**	Testing
4.	**External devices management and file systems organization**	**12**	**2**		**8**	**2**	Testing
5.	**Communication tools for multi-machine**	**11**	**3**			**8**	Testing

	systems						
6.	**Virtualization technologies**	**6**	**2**		**4**		Testing
7.	**OS security**	**15**	**5**		**4**	**6**	Testing
8.	**Features of the embedded, mobile and real-time operating systems.**	**6**	**2**			**4**	Testing
	Total	**82**	**26**		**24**	**32**	

6. COURSE CONTENT (PART TIME)

№	Name of the topic	Number of academic hours					Form of knowledge control
		TOTAL	Lectures	practical tasks	labs	Independent work	
1	2	3	4	5	6	7	8
1.	**Evolution, functions and architecture of operating systems (OS)**	**8**				**8**	Testing, report
2.	**Processes and threads. Processor time management and synchronization**	**13**	**2**		**2**	**9**	Testing, report
3.	**Memory architecture and virtual memory**	**11**	**2**			**9**	Testing, report
4.	**External devices management and file systems organization**	**13**	**2**		**2**	**9**	Testing, report
5.	**Communication tools for multi-machine systems**	**9**				**9**	Testing, report
6.	**Virtualization technologies**	**8**				**8**	Testing, report
7.	**OS security**	**12**	**2**		**2**	**8**	Testing, report
8.	**Features of the embedded, mobile and real-time operating systems.**	**8**				**8**	Testing, report
	Total	**82**	**8**		**6**	**68**	

7. THEORETICAL CONTENT

№	Names of topics	Content
1.	**Evolution, functions and architecture of operating systems (OS)**	The concept of the operating system. Evolution of operating system (OS). OS classification. Client and server OS. Package servicing OS. Real time OS. Structure OS. OS kernel . Types of OS kernels.
2.	**Processes and threads. Processor time management and synchronization**	Process and flow concept. Process properties. Process Descriptor. Flow model. Semaphores. Mutexes. Critical sections. Impasses. Synchronization of processes. Typical synchronization tasks. Events and signals. Process planning.
3.	**Memory architecture and virtual memory**	Organization and architecture of RAM. Multiprogramming. Package servicing. Segmentation. Pages. Fragmentation. Caching. Virtual memory. Swap.
4.	**External devices management and file systems organization**	Iinput-output subsystem. Tires. Interrupts. External storage devices. Magnetic storage. Principles of storing information on a magnetic disk.

		Solid State Drives. The notion of a file and a directory. File systems. Caching.
5.	**Communication tools for multi-machine systems**	Message exchange. Remote procedures call. Tools of interaction between distributed computer systems. Communication task decomposition. Levels and interlevel interfaces. Protocols and protocol stacks.
6.	**Virtualization technologies**	Virtualization goals. OS as a virtual machine. The concept of a hypervisor. Hypervisors of the first, second and mixed types. Operative memory virtualization. Processor virtualization. Hardware virtualization.
7.	**OS security**	The notion of security. Confidentiality, integrity, accessibility. Security tools. Authentication. Authorization. Classification of security threats. Malicious software. Network security.
8.	**Features of the embedded, mobile and real-time operating systems.**	Features of built-in OS and real-time OS . OS for embedded systems: Windows CE/Mobile, Symbian, Android, RTOS, QNX etc.

8. Practical content

9. Laboratory practice

№	Names of topics	Content
1.	**Evolution, functions and architecture of operating systems (OS)**	Apparatus (Hardware), software and information resources of the computing system. OS functions. Operational requirements for OS. OS services. Monolithic and multilevel (multi-layer) systems. OS kernel (supervisor). Supervisor functions. OS auxiliary modules. OS hardware support. OS machine-dependent components. OS microkernel architecture concept.
2.	**Processes and threads. Processor time management and synchronization**	Processes interaction. Critical resource. Critical part of the process. Processes synchronization by the elementary lower level techniques. Hardware indivisible operations "Memory Locking" and "Check and Install." Dekker's algorithm.
3.	**External devices management and file systems organization**	File system functions. Multi-level file management system organization. Input/output ports. Input/output mapped to an address space of operative memory. File organization methods. File operations. Accessing file records methods (synchronous / asynchronous, sequential/ direct). File descriptor. File system integrity. Excess disk RAID systems.
4.	**Virtualization technologies**	Applications of virtualization technologies: software development and testing; simulation of performance of real systems on rack; demonstration and study of a new software; software deployment and updating under existing information systems conditions; heterogeneous computing. Hardware and software emulation. Emulator modular structure.
5.	**OS security**	Matrix presentation of protection status. Opportunity list. Access management list. Lock-and-key mechanism. Cryptography. Cryptographic secret systems. Cipher. Public-key systems. Digital signatures. Encryption schemes.

10. Assignment for independent work

1. Evolution, functions and architecture of operating systems (OS) Study of the main and additional literature on a topic. To prepare a talk and presentation on newest OS.
2. Processes and threads. Processor time management and synchronization Study of the main and additional literature on a topic. To prepare a talk and presentation on different ways of synchronizing flows.
3. Memory architecture and virtual memory Study of the main and additional literature on a topic. To prepare a talk and presentation on ways of distribution of RAM between processes.
4. External devices management and file systems organization Study of the main and additional literature on a topic. To prepare a talk and presentation on different types of file systems

5. Communication tools for multi-machine systems Study of the main and additional literature on a topic. To prepare a talk and presentation on different stacks of network protocols
6. Virtualization technologies Study of the main and additional literature on a topic. To prepare a talk and presentation on different types of virtual machines
7. OS security Study of the main and additional literature on a topic. To prepare a talk and presentation on various types of OS threats
8. Features of the embedded, mobile and real-time operating systems. Study of the main and additional literature on a topic. To prepare a talk and presentation on different types of mobile OS

11. SYSTEM OF ASSESSMENT OF KNOWLEDGE AND SKILLS (ACCORDING TO THE NATIONAL REQUIREMENTS)

A ten-point scale, depending on thegradeand 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 fulland 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 acomparative 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, law 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, law 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.

12. METHODS AND MEANS OF IMPLEMENTATION OF THE CONTENT OF THE EDUCATIONAL PROGRAM AND PREPARATION OF EDUCATIONAL AND METHODICAL MATERIALS

The training will be conducted using interactive methods (project method, implementation of individual practical assignments, individual solution of situational tasks, work in groups) and distance learning technologies, implemented by means of the training portal (eLearning Server). The students will be provided with electronic presentations of lectures, electronic and printed versions of handouts for practical classes.

On full-timeclasses, students will learn the discipline directly in the computer lab. The following software (SW) will be used during the training:

1. VMware workstation player
2. MS DOS
3. Windows server 2003
4. Windows 10
5. Ubuntu Linux
6. Mac OS X

13. RESOURCES

Basic literature

1. Мартемьянов, Ю.Ф. Операционные системы. Концепции построения и обеспечения безопасности / Ю.Ф. Мартемьянов, А.В. Яковлев, А.В. Яковлев - М.: Горячая линия-Телеком, 2011. - 336 с.
2. Назаров, С. В. Операционные системы. Практикум / С.В. Назаров, Л.П. Гудыно, А.А. Кириченко. - Москва: КноРус, 2012. - 374 с.
3. Назаров, С.В. Технологии многопользовательских операционных систем: монография / С.В. Назаров, А.И. Широков; под ред. С. В.Назарова. - М.: Изд. Дом МИСиС, 2012. - 296 с.
4. Спиридонов, Э.С. Операционные системы / Э. С. Спиридонов[и др.]. - М. : Либроком.- 2017. - 350 с.
5. Спиридонов, Э.С. Практикум по операционным системам / Э. С. Спиридонов[и др.]. - М. : Либроком.- 2017. - 326 с.
6. Стащук, П. В. Краткое введение в операционные системы: / П.В. Стащук. - М.: ФЛИНТА, 2014. - 128 с.

Additional literature

1. Кетов, Д. Внутреннее устройство Linux / Д. Кетов. – СПб.: БХВ-Петербург – 2017. – 320 с.

2. Мако Хилл, Б. Ubuntu Linux : официальный учебный курс / Б. Мако Хилл [и др.]. - М. : Триумф.- 2008г. - 384 с.
7. Назаров, С.В. Архитектура и проектирование программных систем: монография / С. В. Назаров. -М.: ИНФРА-М, 2016. - 376 с.
3. Робачевский, А. Операционная система UNIX, 2-е издание /А. Робачевский, С. Немнюгин, О. Стесик// - СПб.: БХВ-Петербург - 2010.- 528 С.
4. Таненбаум, Э. Операционные системы. Разработка и реализация / Э.Таненбаум, А. Вудхал. - СПб. : Питер, 2007. - 704 с.
5. Робачевский, А. Операционная система UNIX, 2-е издание /А. Робачевский, С. Немнюгин, О. Стесик// – СПб.: БХВ-Петербург – 2010г.– 528 С.
6. Silberschatz, Galvin, Gagne "Operating System Concepts", 9th edition. 2012. – 944 p.