Syllabus
Course Program

Modern operating systems

Specialty
172 – Electronic communications and radio engineering

Institute
Institute of Computer Modeling, Applied Physics and Mathematics

Educational program
Network technologies and telecommunications

Department
Information systems named after V.O. Kravets (169)

Level of education
Master's level

Course type
Elective

Semester
2

Language of instruction
English

Lecturers and course developers

Lyudmila Nikitina

liudmyla.nikitina@khpi.edu.ua
Candidate of technical sciences, associate professor, associate professor of the department of information systems named after V.O. Kravets of NTU "KhPI"

Author of more than 60 publications. Lecturer of courses "Operating Systems", "Systems of AI", " Methods of analysis and automated data processing in telecommunication systems", "Decision Making Theory".
More about the lecturer on the department's website

General information

Summary

This course provides a comprehensive overview of modern operating systems, focusing on their architecture, functionality, and application in telecommunication systems. Topics include process management, memory organization, file systems, virtualization, and security mechanisms. Students will explore the design principles behind operating systems and gain hands-on experience with practical implementations, equipping them with the skills to manage and optimize operating systems in modern communication infrastructures.

Course objectives and goals

The objective of this course is to develop a solid understanding of modern operating systems and their role in telecommunication systems. By studying the structure, components, and design of operating systems, students will learn to analyze performance, troubleshoot issues, and implement optimization strategies. The course also emphasizes practical skills, enabling learners to configure, monitor, and secure operating systems in real-world applications.

Format of classes

Lectures, laboratory classes, consultations, self-study. Final control in the form of an exam.

Competencies

GC1. Ability to abstract thinking, analysis and synthesis.

GC7. Ability to conduct research at the appropriate level
SC1. Ability to apply scientific facts, concepts, theories, principles and methodologies of scientific research.
SC3. Ability to reasonably choose and effectively apply mathematical methods, computer modeling technologies, as well as approaches and methods for optimizing electronic communication and radio engineering systems, complexes, technologies, devices and their components at all stages of their life cycle.
SC5. Ability to develop, improve and use modern software, hardware and software-hardware support for electronic communication and radio engineering devices (means, systems, complexes)
SC9. Ability to solve current scientific problems in the field of electronic communications and radio engineering with the justified use of modern theoretical and experimental research methods.

Learning outcomes

LO4 - plan and carry out scientific and applied research in the field of electronic communications and radio engineering, apply methods of mathematical and physical modeling, information processing, interpret research results and justify conclusions
LO8 - apply general and specialized programming languages, analytical and simulation modeling packages, as well as software and hardware development tools to solve complex problems in electronic communications and radio engineering.

Student workload

The total volume of the course is 120 hours (4 ECTS credits): lectures - 32, laboratory classes - 0 hours, workshops - 32 hours, self-study - 56 hours.

Course prerequisites

"Programming", "Object-oriented programming", "System software for telecommunications systems".

Features of the course, teaching and learning methods, and technologies

Classes are made interactively using multimedia technologies for lecture presentations and online demonstrations of task execution examples. The lecture classes use explanatory-illustrative, reproductive, problem-oriented methods and the method of critical thinking. Training materials are available for students through OneNote (Class Notebook).

Program of the course

Topics of the lectures

Topic 1. Introduction to Modern Operating Systems:
Overview of operating system functions, evolution, and significance in telecommunication systems.
Topic 2. Operating System Architecture:
Exploring monolithic, microkernel, and modular operating system architectures.
Topic 3. Process Management and Scheduling:
Understanding process lifecycle, scheduling algorithms, and their impact on system performance.
Topic 4. Memory Management Techniques:
Examining virtual memory, paging, segmentation, and memory allocation strategies.
Topic 5. File Systems and Storage Management:
Analyzing file system structures, disk management, and file access methods.
Topic 6. Device Management:
Understanding how operating systems handle input/output devices and communication with hardware.
Topic 7. Multitasking and Multithreading:
Exploring concurrent execution, thread synchronization, and inter-process communication.
Topic 8. Virtualization and Containers:
Introduction to virtualization concepts, hypervisors, and container technologies.
Topic 9. Operating System Security:
Examining authentication, access control, encryption, and other security mechanisms.

Topic 10. Network Operating Systems:
Features and design considerations of operating systems used in network environments.
Topic 11. Real-Time Operating Systems (RTOS):
Understanding the requirements and characteristics of RTOS in telecommunication systems.
Topic 12. Distributed Operating Systems:
Introduction to distributed systems and their operating system requirements.
Topic 13. Power Management and Energy Efficiency:
Techniques for optimizing power usage in modern operating systems.
Topic 14. Fault Tolerance and Recovery:
Exploring methods to ensure system reliability and recovery in case of failures.
Topic 15. Emerging Trends in Operating Systems:
Discussion on cutting-edge developments such as quantum operating systems and edge computing.
Topic 16. Case Studies of Modern Operating Systems:
Analyzing the design and features of widely used operating systems like Linux, Windows, and Android..

Topics of the workshops

Topic 1. Operating System Installation and Configuration:
Installing and configuring a modern operating system for practical use.
Topic 2. Process Scheduling Simulation:
Implementing and comparing scheduling algorithms to evaluate performance.
Topic 3. Memory Allocation Techniques:
Simulating and analyzing memory allocation methods, including paging and segmentation.
Topic 4. File System Management:
Creating, modifying, and analyzing file system structures.
Topic 5. Device Driver Implementation:
Exploring how to write and test a simple device driver.
Topic 6. Multithreading and Synchronization:
Implementing thread synchronization using semaphores and mutexes.
Topic 7. Virtualization with Hypervisors:
Setting up a virtual environment using tools like VMware or VirtualBox.
Topic 8. Containerization with Docker:
Using Docker to create and manage containerized applications.
Topic 9. Network Configuration and Monitoring:
Configuring network settings and monitoring traffic using built-in tools.
Topic 10. Security Features Implementation:
Implementing user authentication, encryption, and access control policies.
Topic 11. Real-Time Operating System Simulation:
Configuring and testing an RTOS for telecommunication applications.
Topic 12. Distributed System Simulation:
Exploring distributed system concepts through practical simulations.
Topic 13. Power Management Optimization:
Analyzing and implementing power-saving techniques in operating systems.
Topic 14. Fault Injection and Recovery Testing:
Simulating faults and testing the recovery mechanisms of an operating system.
Topic 15. Kernel Customization:
Modifying and recompiling a Linux kernel for specific use cases.
Topic 16. Final Project – OS Customization for a Telecom Use Case:
Designing and implementing a custom operating system feature tailored for telecommunication systems.

Topics of the laboratory classes

Not included.

Self-study

Students are encouraged to explore additional topics beyond the classroom, such as emerging trends in operating systems, advanced configuration techniques, and case studies of real-world applications. Independent research and experimentation with open-source operating systems like Linux will deepen

their understanding of core concepts. Additionally, students should practice troubleshooting and optimization techniques to prepare for practical challenges in operating system management.

Course materials and recommended reading

1. Operating Systems: Three Easy Pieces by Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau (2020)
2. Modern Operating Systems by Andrew S. Tanenbaum and Herbert Bos (2021)
3. Operating System Concepts by Abraham Silberschatz, Peter B. Galvin, and Greg Gagne (2021)
4. Linux Kernel Development by Robert Love (2022)
5. Practical Linux Topics by Chris Binnie (2020)
6. Mastering Linux Administration by Alexandru Calcatinge (2022)
7. Docker Deep Dive by Nigel Poulton (2021)
8. Hands-On System Programming with Linux by Kaiwan N Billimoria (2021)
9. The Art of Monitoring by James Turnbull (2021)
10. Operating Systems and Middleware: Supporting Controlled Interaction by Max Hailperin (2020)

Assessment and grading

Criteria for assessment of student performance, and the final score structure

The final grade is made up of 100% assessment results in the form of an exam (50%) and current assessment (50%).
Breakdown of the grading:
Laboratory work: 30%
Independent work and computational tasks: 20%

Grading scale

Total points	National	ECTS
90–100	Excellent	A
82–89	Good	B
75–81	Good	C
64–74	Satisfactory	D
60–63	Satisfactory	E
35–59	Unsatisfactory (requires additional learning)	FX
1–34	Unsatisfactory (requires repetition of the course)	F

Norms of academic integrity and course policy

The student must adhere to the Code of Ethics of Academic Relations and Integrity of NTU "KhPI": to demonstrate discipline, good manners, kindness, honesty, and responsibility. Conflict situations should be openly discussed in academic groups with a lecturer, and if it is impossible to resolve the conflict, they should be brought to the attention of the Institute's management.
Regulatory and legal documents related to the implementation of the principles of academic integrity at NTU "KhPI" are available on the website: http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Approval

Approved by	Date, signature	Head of the department Pavlo PUSTOVOITOV
	Date, signature	Guarantor of the educational program Vitaliy BRESLAVETS