Syllabus
Course Program

Automated design of telecommunication 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
Optional

Semester
2

Language of instruction
English

Lecturers and course developers

Nataliia Dzheniuk

Nataliia.Dzheniuk@khpi.edu.ua
Associate Professor of NTU "KhPI", Associate Professor of the Department of
Information Systems named after V.O. Kravets of NTU "KhPI". Work experience - 38 years. Author of more than 40 scientific and educational works. Leading lecturer in the following disciplines: "Computer Networks", "Computer Engineering and Information Technologies", "Algorithmization and
Programming", "Global Computer Networks".

More about the lecturer on the department's website

General information

Summary

This course provides a comprehensive overview of the principles, tools, and methodologies for the automated design of telecommunication systems. It explores system modeling, simulation, optimization, and deployment strategies using advanced software tools and algorithms. Through a mix of theory and hands-on practice, students will gain the knowledge and skills necessary to design efficient and scalable telecommunication infrastructures.

Course objectives and goals

The primary objective of this course is to equip students with the ability to use automated tools and methodologies for designing and optimizing telecommunication systems. Students will learn to apply advanced algorithms, simulation techniques, and modeling frameworks to address real-world challenges. The course also aims to develop critical thinking and problem-solving skills to ensure reliable, efficient, and future-proof telecommunication designs..

Format of classes

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

Competencies

GC1. Ability to think abstractly, analyze and synthesize.
GC2. Ability to apply knowledge in practical situations
GC3. Knowledge and understanding of the subject area and understanding of professional activities.
GC9. Ability to develop and manage projects.
SC1. Ability to apply scientific facts, concepts, theories, principles and methodologies of scientific research.
SC2. Ability to implement the principles of a systematic approach in conducting research on processes occurring in electronic communication and radio engineering systems, complexes and devices.
SC5. Ability to develop, improve and use modern software, hardware and software and hardware of electronic communication and radio engineering devices (tools, systems, complexes)..

Learning outcomes

LO1 - to organize own professional, research and innovation activities based on the principles of a systematic approach and research methodology.
LO3 - develop and implement modern and advanced telecommunication and radio engineering systems, complexes, technologies, devices and their components
LO8 - apply general and specialized programming languages, analytical and simulation modeling packages, as well as software and hardware development tools to solve complex problems of telecommunications 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

"Architecture of computer networks", "System software of telecommunication 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 Automated Design:
Overview of automated design concepts and their relevance to telecommunication systems.
Topic 2. Fundamentals of Telecommunication System Design:
Exploring the components and architecture of telecommunication systems.
Topic 3. System Modeling in Telecommunication Design:
Techniques for creating accurate models to simulate telecommunication networks.
Topic 4. Software Tools for Automated Design:
Introduction to software tools like MATLAB, NS-3, and OPNET for system modeling and simulation.
Topic 5. Algorithmic Approaches to Network Design:
Using algorithms like Dijkstra, genetic algorithms, and machine learning for network optimization.
Topic 6. Traffic Analysis and Network Planning:
Methods to analyze network traffic and plan resources effectively.
Topic 7. Simulation Techniques in Telecommunication Systems:
Simulating telecommunication networks to evaluate performance and scalability.
Topic 8. Performance Metrics and Optimization:
Understanding throughput, latency, jitter, and methods for system optimization.
Topic 9. Cost-Effective Telecommunication Design:
Balancing performance and budget constraints in system design.

Topic 10. Fault Tolerance and Redundancy in Design:
Incorporating fault-tolerant strategies and redundant components into designs.
Topic 11. Security Considerations in Automated Design:
Integrating security features and assessing vulnerabilities in telecommunication systems.
Topic 12. Cloud and Edge Integration:
Designing systems with cloud and edge computing capabilities for enhanced performance.
Topic 13. Sustainable Telecommunication Design:
Applying energy-efficient practices and sustainable design principles.
Topic 14. Case Studies in Automated Design:
Analyzing real-world examples of automated telecommunication system designs.
Topic 15. Emerging Trends in Automated Design:
Exploring AI-driven automation, digital twins, and advanced modeling techniques.
Topic 16. Future Challenges in Telecommunication Design:
Discussing challenges like 5G/6G integration, IoT scalability, and global connectivity.

Topics of the workshops

Topic 1. Introduction to System Modeling Tools:
Setting up and exploring software tools like NS-3, MATLAB, or OPNET.
Topic 2. Basic Telecommunication System Modeling:
Creating and simulating a simple telecommunication network model.
Topic 3. Traffic Simulation and Analysis:
Simulating network traffic patterns and analyzing the results.
Topic 4. Implementing Routing Algorithms:
Developing and testing routing algorithms in a simulated network.
Topic 5. Performance Evaluation of Telecommunication Systems:
Measuring key performance metrics and identifying bottlenecks.
Topic 6. Fault Tolerance Implementation:
Simulating fault scenarios and designing recovery strategies.
Topic 7. Security Features in Design:
Adding encryption and access control to a simulated telecommunication system.
Topic 8. Cloud-Based Network Simulation:
Designing a telecommunication network using cloud-based tools.
Topic 9. Energy Efficiency Simulation:
Optimizing a network for energy consumption and sustainability.
Topic 10. Cost Optimization in Network Design:
Designing a cost-efficient telecommunication system while meeting performance targets.
Topic 11. Multi-Objective Optimization:
Applying optimization techniques to balance multiple system objectives.
Topic 12. Real-Time System Simulation:
Simulating real-time applications such as VoIP or streaming services.
Topic 13. Advanced Simulation Scenarios:
Simulating complex scenarios, including 5G and IoT networks.
Topic 14. Machine Learning for Network Optimization:
Using machine learning techniques to optimize network parameters.
Topic 15. Final Project Setup:
Designing and simulating a comprehensive telecommunication system.
Topic 16. Final Project Presentation:
Presenting and evaluating the results of the simulated telecommunication system.

Topics of the laboratory classes

Not included

Self-study

Students are encouraged to explore advanced tools, algorithms, and case studies in telecommunication system design. This includes researching emerging trends, practicing with simulation software, and

developing independent projects. Self-study activities will deepen their understanding of automated design methodologies and prepare them to address practical challenges in telecommunication systems.

Course materials and recommended reading

1. Designing Data-Intensive Applications by Martin Kleppmann (2020)
2. Telecommunication System Engineering by Roger L. Freeman (2021)
3. Modern Wireless Communications by Simon Haykin (2022)
4. Simulation and Modeling of Telecommunication Networks by Tarek S. Sobh (2023)
5. Network Optimization for Telecommunication Systems by Dimitris P. Bertsekas (2021)
6. Cloud Networking: Understanding Cloud-Based Telecommunication by Victor C. Lam (2022)
7. MATLAB for Engineers and Scientists: Telecommunication Applications by Holly Moore (2021)
8. Machine Learning for Telecommunications by Jacek M. Zurada (2023)
9. Sustainable Telecommunication System Design by Emily R. Johnston (2022)
10. Automated Network Design: Tools and Applications by Laura P. Simmons (2023)

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