Syllabus
Course Program

Specialized Computer Systems

Specialty
123 – Computer Engineering

Institute
Institute of Computer Modeling, Applied Physics and Mathematics

Educational program
Computer science. Modeling, design, and computer graphics

Department
Computer Engineering and Programming)

Level of education
Modern Programming, Mobile Devices and Computer Games

Course type
Professional – Selective

Semester
2

Language of instruction
English, Ukrainian

Lecturers and course developers

Glavchev Maxim Igorevich
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PhD in Economics, Associate Professor, Professor of the Department of Computer Engineering and Programming, NTU "KhPI" He has more than 100 publications. Teaches courses: "Specialized Computer Systems", "Design of Programs for Diagnostics of Computer Systems and Networks", "Hardware Means of Information Security", "Software Means of Information Security". More information about the teacher on the website of the Department of https://web.kpi.kharkov.ua/cep/2021/09/03/glavchev-maksym-igorovych

First name and surname
email@khpi.edu.ua
Academic degree, academic title, position

General information, number of publications, main courses, etc.
More about the lecturer on the department's website

General information

Summary

Specialized computer systems are computer systems that are designed and configured to perform specific tasks or functions. They differ from generally-assigned computers, such as personal computers or servers, because their functionality and configuration are configured specifically to perform specific tasks. Specialized computer systems are typically designed for use in specific areas or industries where high performance, accuracy, or specialized features are required.

Course objectives and goals

Lectures, laboratory work, independent work, consultations. The final control is a differential test.

Format of classes

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

Competencies

SK1. Ability to determine technical characteristics, design features, application and operation of software, software and hardware, computer systems and networks for various purposes.
SK4. Ability to build and research models of computer systems and networks.
SK10. Ability to identify, classify, and describe the operation of software and hardware, computer systems, networks, and their components.
SK11. Ability to choose effective methods for solving complex computer engineering problems, critically evaluate the results obtained and argue the decisions made.

Learning outcomes

PH2. Find the necessary data, analyze and evaluate it.
PH3. Build and study models of computer systems and networks, assess their adequacy, determine the limits of applicability.
PH3. Apply knowledge of technical characteristics, design features, purpose and rules of operation of software and hardware of computer systems and networks to solve complex problems of computer engineering and related problems.
PH11. Make effective decisions on the development, implementation and operation of computer systems and networks, analyze alternatives, assess risks and likely consequences of decisions.

Student workload

The total volume of the discipline is 120 (4 ECTS credits): lectures – 32 hours, laboratory work – 16 hours, independent work – 72 hours.

Course prerequisites

To successfully complete the course, you need to know: programming, computer architecture, computer networks, computer circuitry, computer systems.

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

Lectures are held using multimedia technologies, including the interactive cloud environment Microsoft Teams.

Program of the course

Topics of the lectures

Topic 1. General provisions, definitions of terms and processes of computer systems design
Theory and methodology of systems construction. Computer systems. Classification of computer equipment. Specialized computer systems.
Topic 2. Basic theoretical provisions of Petri nets and their application in SCS design
Petri net theory. Graphs and networks. Graph trees. Network. Adjacency matrices and Petri net incidents
Topic 3. Architectures of specialized computer systems
Classification of SCS architectures and characteristics. Characteristics of emergence of different SCS structures. Characteristics of Processor Architectures for Forming and Digital Data Processing.
Topic 4. Strategy, performance criteria and laws of expediency of SCS design solutions .
The concept and characteristics of data movement in SCS. SCS design strategy. Laws of expediency and efficiency of SCS design solutions.
Topic 5. Functions, system and functional objects of the global SCS model.
Formalization of the description of the characteristics of SCS system objects. System specifications of the processor. System characteristics of the data. System characteristics of SPD. System characteristics of operators.
Topic 6. System Properties of SCS Control Objects

Classification of system characteristics of SCS control objects . Characteristics of models of management objects. The complexity of the OU SCS. Divisibility of OU SCS. Polycriteria of OU SCS. Cybernetics of the OU SCS. Closure of the OU SCS. Hierarchy of the OU SCS. Emergence of OU SCS. Stationarity of OU SCS. Dynamism of OU SCS. Stability of OU SCS. Adaptability of OU SCS. Aftereffect of OU SCS.

Topic 7. Models of SCS control objects.

Lattice models of OU information sources. Statistical models of the OU. Correlation models of OU. Nonlinear lattice models of op-amps. Spectral models of op-amp in different numerical theoretical bases. Models of structured sources of information. Cluster models of quasi-stationary op amps. Logical-Statistical Information Models for Diagnostics of Op Amp Conditions. Entropy models of op-amp states.

Topic 8. Information technologies for the formation of digital, alphanumeric and technological data in SCS.

Analysis and justification of the choice of multichannel analog-digital encoders of technological data at the lower levels of SCS. Evaluation of the Influence of Information Aging on Correlation Models of Multichannel CI in Analog-to-Digital Conversion. Analysis of hardware and software for entering alphanumeric data. Performance criteria and research of system characteristics of keyboards for alphanumeric data input. Method of synthesized formation of alphanumeric data. Keyboard for synthesized alphanumeric data generation of the mobile adapter of the lower levels of SCS. Structure and functions of the mobile SD adapter of the lower levels of SCS. Implementation of the principles of synthesized input of alphanumeric data at the lower levels of SCS.

Topic 9. Matrix models of data movement in computer systems.

Attributes of a matrix model. Three-dimensional matrix models. Modified two-dimensional matrix models. Analysis of the topology of an industrial management object.

Topic 10. Formalization of models of architectures of specialized computer systems.

Formalization of SCS models for concentrated processing of information flows. Formalization of SCS models with one-level network processing of information flows. Formalization of SCS models with multi-level architectures.

Topic 11. Derivative models of SCS data movement.

Development of derived models based on matrix models of data movement. A graph is a branched tree. Temporal information models.The "block diagram of the data processing algorithm" model. Graph-algorithmic model of data processing.

Topic 12. Information technology for constructing diagrams of data movement in SCS.

Methods for constructing data flow diagrams (ERD) based on production models of knowledge representation. Algorithms for constructing one-level models of data movement. Software tools for constructing diagrams of the cost of data movement and assessing the global efficiency of computer systems. Organization of interface dialogue of CAD models of data movement.

Topic 13. Data Movement Models of Multi-Level SCS .

Multi-level matrix model of SCS. Data cycles of multi-level SCS. Multilevel model ''graph - branched tree''. Integrated model ''graph - branched tree''. Parametric time model of multilevel SCS. Structural-temporal model of multilevel SCS. Multi-level model ''network graph''. The ''combined time graph'' model of a multilevel SCS. Model "block diagram of the algorithm" of data movement of multilevel SCS. Graph-algorithmic models of multilevel SCS. Diagrams of the movement of data of multi-level SCS. Substantiation of criteria and study of the effectiveness of representation of a set of MRDs of complex multilevel SCS.

Topic 14. Methods and Algorithms for Modeling the Organization of Structured Data Movement in SCS.

Trends in the development of problems of specialized computer systems. Phenomenological aspects. Stages of formation of computer technologies. Network technologies. Information Technology.

Topic 15. General information about SCS safety. .

The concept of security of specialized computer systems. Security principles of specialized computer systems. Security of hardware and software solutions. Development of technical solutions for critical systems. Security of application software of critical systems. Analysis of the causes and characteristics of the main types of dangerous failures of instrument software.

Topic 16. Simulation of failures and SCS hazard assessment.

Concept and principles of risk assessment. Risk research methods based on the analysis of the causes and consequences of violations. Application of risk management principles throughout the life cycle of specialized computer systems. Building event and failure trees. Examples of Dangerous Failure Trees. Tree of safety of performing a critical function for the microprocessor interlocking system.

Topics of the workshops

Topics of the laboratory classes

Topic 1. Development of a Model of Clogging and Formation of Nuclear Magnetic Resonance Signals
Topic 2. Radon transformation and reverse projection method.
Topic 3. Image processing and histogram processing.
Topic 4. Calculation and study of magnetic fields to stimulate the electromagnetic resonance of atomic nuclei.
Topic 5. Modeling of Bloch's equations.
Topic 6. Filtering linear convolutional images.
Topic 7. Non-linear image filtering.
Topic 8. Distribution of discrete viscous vectors in the Karunena-Loev series by secular vectors of the Corelis matrix.
Comprehensive laboratory work (topics 1-8). Development of a specialized computer information security system.
To develop a specialized computer information security system (SCS ZI), which includes: password protection, permutation cipher, substitution cipher, gamification cipher, information destruction/steganography, digital signature or ICS, archiving, development of a common interface

Self-study

The course involves preparation for laboratory work, the result is a report drawn up in the appropriate form.
Students are also recommended additional materials (videos, articles, textbooks) for self-study and analysis

Course materials and recommended reading

References
1. Главчев М.І. Електронний макет конспекту лекційного матеріалу.
https://drive.google.com/drive/folders/1IBt5a0gKY4LTFSi4NbkdbA-8SuPQwnUE?usp=drive_link
2. Главчев М.І. Електронний практикум з лабораторних робіт.
https://drive.google.com/drive/folders/1jld8ej8Yhir6YisRze-i-W93Bjw6JY3G?usp=drive_link
3. Николайчук Я.Н., Возна М.Я., Пітух І.Р. Проектування спеціалізованих комп'ютерних систем. Навчальний посібник. - Тернопіль ТзОВ "Терно-граф", 2010 - 392 с. іл.
4. Мойсеєнко В. І., Бутенко В. М. Безпечність спеціалізованих комп'ютерних систем: навч. посібник. – Харків: УкрДУЗТ, 2021. – 133 с.
5. Лабораторний практикум по дисципліні «Спеціалізовані комп'ютерні системи» для студентів денної форми навчання по спеціальності 6.050203 - «Спеціалізовані комп'ютерні системи» / Скл. Калашніков В.І., Хавіна І.П. - Харків: НТУ «ХПІ», 2009. - 104 с.

Further reading:
6. Microchip [Електронний ресурс]: https://www.microchip.com.
7 Поморова О. В. Теоретичні основи, методи та засоби інтелектуального діагностування комп'ютерних систем: Монографія. - Хмельницький: Тріада-М, 2007. - 252 с.

Assessment and grading

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

Description of the final score structure, course requirements, and necessary steps to earn points, especially paying attention to self-study and individual assignments.

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 Oleksandr ZAKOVOROTNYI
	Date, signature	Guarantor of the educational program Svitlana GAVRILENKO