



Syllabus Course Program



Advanced Databases and Information Systems

Specialty

113 Applied Mathematics

Educational program

Intelligent data analysis

Level of education

Bachelor's level

Semester

5

Institute

Educational and Scientific Institute of Computer Science and Information Technology

Department

Computer Mathematics and Data Analysis

Course type

Special (professional), Selective

Language of instruction

Ukrainian

Lecturers and course developers



Nikulchenko Artem

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PhD, Associate Professor, Associate Professor of the Department of CMAD, NTU "KhPI"

Work experience – 12 years. Author of numerous scientific and educational-methodological works. 15 years of experience in IT. Lead lecturer in the disciplines: "Databases and Information Systems," "Software Development."

[More about the lecturer on the department's website](#)

General information

Summary

The fundamentals of databases are basic and essential knowledge for any specialist in the IT field. IT is called Information Technology because its foundation is information, and databases (both relational and non-relational) are used to store this information. This course is designed to introduce students to the basic knowledge of information systems and databases as well as lay the groundwork for the further study in areas such as data analysis, software development, and database administration.

Course objectives and goals

Formation of a system of theoretical knowledge and practical skills in the fundamentals of database theory; teaching the basics of database theory and information storing, with a primary focus on relational databases; developing practical skills in creating, managing, and using relational databases.

Format of classes

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

Competencies

- GC 1. Ability to learn and acquire modern knowledge.
- GC 2. Ability to apply knowledge in practical situations.
- GC 7. Ability to search for, process, and analyze information from various sources.
- GC 8. Knowledge and understanding of the subject area and professional activity.
- GC 10. Skills in using information and communication technologies.
- GC 5. Ability to develop algorithms and data structures, software tools, and software documentation.
- GC 6. Ability to design databases, information systems, and resources.

Learning outcomes

- LO 11. Be able to apply modern programming and software development technologies, as well as the technologies for the software implementation of numerical and symbolic algorithms.
- LO 12. Solve individual engineering tasks and/or tasks arising in at least one subject area: sociology, economics, ecology, or medicine.
- LO 13. Use specialized software products and computer mathematics systems in practical work.
- LO 14. Demonstrate the ability for self-learning and continued professional development.
- LO 15. Be able to organize one's own activities and achieve results within a limited time frame.
- LO 16. Demonstrate teamwork and interaction skills with others.
- LO 18. Effectively communicate information, ideas, problems, and solutions with both specialists and the general public.

Student workload

The total volume of the course is 180 hours (6 ECTS credits): lectures – 32 hours, laboratory classes – 32 hours, self-study – 116 hours.

Course prerequisites

To successfully complete the course, it is necessary to have knowledge and practical skills in the following subjects: 'Algorithmization and Programming', 'Computer Discrete Mathematics', 'Object-Oriented Programming'; course "Databases and Information Systems".

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

Lectures are conducted interactively using multimedia technologies. In laboratory classes, the focus is on the practical application of databases and information systems. Individual assignments are carried out (an inquiry-based learning method).

Program of the course

Topics of the lectures

- Topic 1.
SQL Server Architecture and Internals
- Topic 2.
Advanced T-SQL Programming Techniques
- Topic 3.
Complex Data Types and Temporal Tables
- Topic 4.
Concurrency Control and Isolation Levels
- Topic 5.
Transaction Management and Error Handling
- Topic 6.
SQL Server Security and Data Protection
- Topic 7.
Query Performance Troubleshooting and Execution Plans
- Topic 8.
Indexing Techniques

- Topic 9.**
Query Optimization Techniques
- Topic 10.**
Partitioning and Data Sharding
- Topic 11.**
High Availability and Disaster Recovery (HADR)
- Topic 12.**
In-Memory OLTP (Memory-Optimized Tables)
- Topic 13.**
Data Warehousing and ETL with SSIS
- Topic 14.**
SQL Server Integration with Cloud and Hybrid Architectures
- Topic 15.**
Analytics with SQL Server Machine Learning Services
- Topic 16.**
Big Data Clusters and PolyBase Integration

Topics of the practical classes

Not included in the curriculum.

Topics of the laboratory classes

- Topic 1.**
Transaction Management and Error Handling in T-SQL
- Topic 2.**
Implementing Row-Level Security and Data Masking
- Topic 3.**
SQL Server Database Performance Analysis
- Topic 4.**
Building and Optimizing Indexes for Complex Queries
- Topic 5.**
Building and Managing Partitioned Tables
- Topic 6.**
High Availability and Always On Configuration
- Topic 7.**
Using In-Memory OLTP for High Performance
- Topic 8.**
ETL with SQL Server Integration Services (SSIS)
- Topic 9.**
Implementing and Querying External Data with PolyBase

Self-study

Understand and implement basic version of TPC-C benchmark.

<https://www.tpc.org/tpcc/>

Course materials and recommended reading

Main materials

1. SQL Server technical documentation. <https://learn.microsoft.com/en-us/sql/sql-server/?view=sql-server-ver16>
2. SQL Server internals and architecture guides <https://learn.microsoft.com/en-us/sql/relational-databases/sql-server-guides?view=sql-server-ver16>
3. Pro SQL Server Internals 2nd ed. Edition, Dmitri Korotkevitch
4. SQL Server Concurrency: Locking, Blocking, and Row Versioning, by Kalen Delaney

5. Securing SQL Server, Third Edition 3rd Edition by Denny Cherry
6. T-SQL Fundamentals (Developer Reference) 3rd Edition by Itzik Ben-Gan

Recommended materials

Assessment and grading

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

Students are advised to attend both lectures and laboratory classes. Completing the practical assignments is a necessary condition for receiving a grade. Completing the tests is mandatory.

Students' scores in the course are allocated as follows:

- Tests: 30% of the semester grade;
- Self-study: 15% of the semester grade;
- Individual assignments: 15% of the semester grade;
- Exam: 40% of the semester grade.

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
29.08.2024



Head of the department
Олена АХІЄЗЕР

Date, signature
29.08.2024



Guarantor of the educational program
Олена АХІЄЗЕР