Syllabus

Course Program

Data Models and Structures

Specialty
121 – Software Engineering

Institute
Institute of Computer Science and Information Technology

Educational program
Software Engineering

Department
Software Engineering and Management Intelligent Technologies (321)

Level of education
Bachelor's level

Course type
Special (professional), Mandatory

Semester
3

Language of instruction
English, Ukrainian

Lecturers and course developers

Andrii Kopp

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Doctor of Philosophy (Ph.D.), Associate Professor, Associate Professor of Software Engineering and Management Intelligent Technologies Department

Google Scholar: https://scholar.google.com/citations?user=B8fggLEAAAAJ
ORCID: https://orcid.org/0000-0002-3189-5623
Scopus: https://www2.scopus.com/authid/detail.uri?authorId=57202887287
Web of Science: https://www.webofscience.com/wos/author/record/T-4283-2018).
More about the lecturer on the department's website

General information

Summary

The objective of the discipline is to provide students with the knowledge and skills necessary to build data models, select and use database management systems (DBMS), design, normalize and create databases in relational DBMS, and work with them using DML (Data Manipulation Language) tools of SQL (Structured Query Language).

Course objectives and goals

Developing students' theoretical and practical knowledge necessary to work with models and data structures in solving problems related to the software development, maintenance and quality assurance.

Format of classes

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

Competencies

К01. Ability to think abstractly, analyze and synthesize.
К05. Ability to learn and master modern knowledge.
К06. Ability to search, process and analyze information from various sources.

К14. Ability to participate in software design, including modeling (formal description) of its structure, behavior and processes of functioning.
К15. Ability to develop architectures, modules and components of software systems.
К19. Knowledge of data information models, ability to create software for storing, extracting and processing data.
К22. Ability to accumulate, process and systematize professional knowledge of software development and maintenance and recognize the importance of lifelong learning.
К26. Ability to think algorithmically and logically.

Learning outcomes

PLO01. Analyze, purposefully search and select information and reference resources and knowledge necessary for solving professional problems, taking into account modern achievements of science and technology.
PLO05. To know and apply relevant mathematical concepts, methods of domain, system and object-oriented analysis and mathematical modeling for software development.
PLO07. To know and apply in practice the fundamental concepts, paradigms and basic principles of functioning of language, tools and computing tools of software engineering.
PLO13. Know and apply methods of developing algorithms, designing software and data structures and knowledge.
PLO18. To know and be able to apply information technologies for data processing, storage and transmission.

Student workload

The total volume of the course is 120 hours (4 ECTS credits): lectures – 16 hours, laboratory classes – 32 hours, self-study – 72 hours.

Course prerequisites

Fundamentals of Programming
Fundamentals of Software Engineering
Computer Architecture and Operating Systems

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

Teaching and learning methods:
interactive lectures with presentations, discussions, laboratory classes, teamwork, case method, student feedback, problem-based learning.
Forms of assessment:
written individual assignments for laboratory work (CAS), assessment of knowledge in laboratory classes (CAS), express surveys (CAS), online tests (CAS), final/semester control in the form of a semester exam, according to the schedule of the educational process (FAS).

Program of the course

Topics of the lectures

Topic 1: Introduction to databases
Databases and database management systems (DBMS). Requirements for DBMS. Independence of data and applications. Query languages. Data integrity and consistency. Fault tolerance of data systems. Security and access control to data. Performance of data systems. Development of applications for working with databases. The most common DBMS in the corporate segment.
Topic 2. Data storage structures
Classes of database applications. Data storage structures. Application interaction architectures. Hardware and storage devices. Data warehouses. Choosing a DBMS for application development. Libraries and frameworks of programming languages for working with DBMS.
Topic 3. Data models

Data models and their main features. Identification and modifiability. Navigation and search by values. Objects and collections of objects. Properties of data models. Data models that implement the most common DBMSs.

Topic 4. Relational data model

Basic concepts. Relational algebra. Other query languages. Features of the relational data model. Normal forms. Normal forms: practical aspects.

Topic 5. Data modeling

Entity-relationship model. Conceptual model. Object model. Weakly structured models. Models of knowledge representation. Key-value models. Outdated data models. Examples of database modeling.

Topic 6. SQL query language: DML tools and their application

The purpose of the SQL language. Simple data types. SQL basics: syntax features, SELECT, INSERT, UPDATE, DELETE queries. SQL window functions. Optimization of queries.

Topics of the workshops

Workshops are not provided within the discipline.

Topics of the laboratory classes

Topic 1: Choosing a subject area, building an entity-relationship model
Topic 2. Building a relational data model
Topic 3. Implementing a database in PostgreSQL
Topic 4. Manipulating data using INSERT, UPDATE, DELETE expressions
Topic 5. Extracting data using SELECT queries, sorting and grouping data
Topic 6: Extracting data from multiple tables using JOIN expressions

Self-study

Individual assignments are not provided in the curriculum.
Students are recommended with additional materials (videos, articles) for self-study and processing.

Course materials and recommended reading

Key literature

1. M. Negi, Fundamentals of Database Management System: Learn essential concepts of database systems, BPB Publications, 2019, 175 p.
2. E. Sciore, Database Design and Implementation: Second Edition, Springer Nature, 2020, 468 p.
3. G. Powell, Database Modeling Step by Step, CRC Press, 2020, 268 p.
4. C. J. Date, Database Design and Relational Theory: Normal Forms and All That Jazz, Apress, 2019, 451 p.
5. A. Beaulieu, Learning SQL: Generate, Manipulate, and Retrieve Data, O'Reilly Media, Inc., 2020, 384 p.

Additional literature

1. L. Ferrari, E. Pirozzi, Learn PostgreSQL: Build and manage high-performance database solutions using PostgreSQL 12 and 13, Packt Publishing Ltd, 2020, 650 p.
2. A. Meier, M. Kaufmann, SQL & NoSQL Databases: Models, Languages, Consistency Options and Architectures for Big Data Management, Springer, 2019, 229 p.
3. M. T. Özsu, P. Valduriez, Principles of Distributed Database Systems, Springer Nature, 2019, 674 p.
4. B. Gour, M. Shrivastava, V. Richhariya, Database Management System Concepts & Normalization, Educreation Publishing, 2019, 94 p.
5. A. Molinaro, R. de Graaf, SQL Cookbook, O'Reilly Media, Inc., 2020, 572 p.

Assessment and grading

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

100% of the final grade consists of the results of the assessment in the form of an exam (40%) and current assessment (60%):
- 6 laboratory works (6% each);
- 2 tests (12% each).

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	08.06.2023	Head of the department Ihor HAMAIUN
	08.06.2023	Guarantor of the educational program Uliya LITVINOVA