Federal State Autonomous Educational Institution of Higher Education "Moscow Institute of Physics and Technology (National Research University)"

APPROVED
Head of the Phystech School of Applied Mathematics and Informatics
A.M. Raygorodskiy

Work program of the course (training module)

course:	Databases/Базы данных
major:	Applied Mathematics and Informatics
specialization:	Computer Science/Информатика
	Phystech School of Applied Mathematics and Informatics
	Chair of Algorithms and Programming Technologies
term:	2
qualification:	Bachelor

Semester, form of interim assessment: 4 (spring) - Grading test

Academic hours: 60 AH in total, including:
lectures: 30 AH.
seminars: 0 AH.
laboratory practical: 30 AH.

Independent work: 120 AH.

In total: 180 AH, credits in total: 4

Author of the program: V.V. Yakovlev, candidate of physics and mathematical sciences, assistant

The program was discussed at the Chair of Algorithms and Programming Technologies 21.05.2020

Annotation

The course covers topics on relational database design and relational algebra theory. During the course students will have practice on SQL language and PostgreSQL server to learn step-by-step database principles from schema design to database implementation and various optimizations.

1. Study objective

Purpose of the course

The course "Database" is designed for students who have the basics of programming and requires knowledge of the basic principles of computer operation - working with memory and disk subsystem. Students get acquainted with the basics of relational algebra, the SQL language, get acquainted with the general DBMS device, learn to design a database schema for solving an applied problem, learn the principles of the query optimizer, get acquainted with the mechanisms for ensuring fault tolerance and correct competitive access.

Tasks of the course

- Familiarization of students with tasks that require the use of a database;
- study of existing relational databases;
- the acquisition by students of the skill of using SQL queries.

2. List of the planned results of the course (training module), correlated with the planned results of the mastering the educational program

Mastering the discipline is aimed at the formation of the following competencies:

Code and the name of the competence	Competency indicators
Gen.Pro.C-1 Apply fundamental knowledge of physics, mathematics, and/or natural sciences in professional settings	Gen.Pro.C-1.1 Analyze the task in hand, develop appproaches to complete it

3. List of the planned results of the course (training module)

As a result of studying the course the student should:

know:

- Fundamentals of relational algebra;
- principles of database design;
- definition of normal forms;
- general database device;
- basics of SQL;
- basic principles of the query optimizer;
- fault tolerance algorithms;
- isolation levels;
- operating principles of the blocking and multi-version scheduler.

be able to:

- Design a database with ER charts;
- write efficient SQL queries;
- create transactions taking into account parallel execution;
- identify and eliminate the causes of deadlocks.

master:

- Tools for working with the database;
- tools for database design.

4. Content of the course (training module), structured by topics (sections), indicating the number of allocated academic hours and types of training sessions

4.1. The sections of the course (training module) and the complexity of the types of training sessions

№	Topic (section) of the course	Types of training sessions, including independent work			
		Lectures	Seminars	Laboratory practical	Independent work
1	Introduction to the theory of databases	2			15
2	Data logical models	4		8	15
3	Entity-Relation diagram	4		6	15
4	Table-Relation diagram	4		8	15
5	Relational Algebra	4		8	15
6	Database schema and data	4			15
7	Integrity constraints	4			15
8	Triggers	4			15
AH in total		30		30	120
Exam preparation		0 AH.			
Total complexity		180 AH., credits in total 4			

4.2. Content of the course (training module), structured by topics (sections)

Semester: 4 (Spring)

1. Introduction to the theory of databases

The concept of a database. Relational data model. Data types and domains. Relations. Modern relational DBMS

2. Data logical models

SQL language overview. The SELECT construct. Grouping and aggregate functions.

3. Entity-Relation diagram

Three-valued logic. NULL values. Predicates.

4. Table-Relation diagram

Data integrity. The first, second, third normal forms. The keys. Normalization of databases: theory and practice.

5. Relational Algebra

Constructs UPDATE, INSERT, DELETE.

6. Database schema and data

Locks. Transactions ACID requirements. Isolation levels. The causes of deadlocks and methods of dealing with them.

7. Integrity constraints

Query performance. Optimization methods. The physical device of a relational database.

8. Triggers

Database Administration. The role of DBA. Providing fault tolerance and disaster tolerance. Stages of certification. DDL

5. Description of the material and technical facilities that are necessary for the implementation of the educational process of the course (training module)

A classroom equipped with a computer and multimedia equipment (projector, sound system).

6. List of the main and additional literature, that is necessary for the course (training module) mastering

Main literature

1. Введение в системы баз данных [Текст] : [учебник для вузов] / К. Дж. Дейт ; [пер. с англ. К. А. Птицына] .— 8-е изд. — М. : Вильямс, 2008 .— 1328 с.
2. Базы и банки данных [Текст] : учебное пособие / В. Н. Четвериков, Г. И. Ревунков, Э. Н. Самохвалов .— М. : Высшая школа, 1987 .— 248 с.
3. SQL для начинающих [Текст] / П. Уилтон, Дж. Колби ; пер. с англ. А. Г. Сивака .— М. : Вильямс, 2006 .— 496 с.

Additional literature

1. Параллельные системы баз данных [Текст] : учеб. пособие для вузов / Л. Б. Соколинский ; Нац. исслед. Южно-Урал. гос. ун-т .— М. : Изд-во Моск. ун-та, 2013 .— 184 с.

7. List of web resources that are necessary for the course (training module) mastering

http://msdn.microsoft.com
http://www.sqlpass.org/
http://www.sql.ru
http://www.rsdn.ru/
http://citforum.ru/database/osbd/contents.shtml

8. List of information technologies used for implementation of the educational process, including a list of software and information reference systems (if necessary)

Software prerequisite: SQL Server Express (Database Engine) 2008 R2 + SQL Server Management Studio 2008 R2.

9. Guidelines for students to master the course

The format of the course involves obtaining a student of confident practical skills, supported by fundamental knowledge. To this end, the student must learn the basic concepts and definitions, most of which are given at the beginning of the course. The student must independently solve all the examples and problems, write each request in at least three versions: in the languages of relational algebra, relational calculus and SQL.

Many issues that are only superficially addressed in lectures (or are not addressed at all), but, nevertheless, are useful for a deeper understanding of the subject, can be studied from the main and additional literature. It is recommended that you refer to the original articles and books of E.F. Coddah and C.J. Data. It is also recommended to study the sources offered by the teacher in classroom classes.

SUPPLEMENT

Assessment funds for course (training module)

major: Applied Mathematics and Informatics
specialization: Computer Science/Информатика
Phystech School of Applied Mathematics and Informatics
Chair of Algorithms and Programming Technologies
term: 2
qualification: Bachelor

Semester, form of interim assessment: 4 (spring) - Grading test

Author: V.V. Yakovlev, candidate of physics and mathematical sciences, assistant

1. Competencies formed during the process of studying the course

Code and the name of the competence	Competency indicators
Gen.Pro.C-1 Apply fundamental knowledge of physics, mathematics, and/or natural sciences in professional settings	Gen.Pro.C-1.1 Analyze the task in hand, develop appproaches to complete it

2. Competency assessment indicators

As a result of studying the course the student should:

know:

- Fundamentals of relational algebra;
- principles of database design;
- definition of normal forms;
- general database device;
- basics of SQL;
- basic principles of the query optimizer;
- fault tolerance algorithms;
- isolation levels;
- operating principles of the blocking and multi-version scheduler.

be able to:

- Design a database with ER charts;
- write efficient SQL queries;
- create transactions taking into account parallel execution;
- identify and eliminate the causes of deadlocks.

master:

- Tools for working with the database;
- tools for database design.

3. List of typical control tasks used to evaluate knowledge and skills

Examples of control tasks:

Typical task involves writing a standard query in the languages of relational algebra, relational calculus and SQL:

1. Queries to extract data from one relationship using one or two relational operations (constraint, projection)
2. Queries to extract data from two to three relationships using two to three relational operations (including at least one join)
3. Queries to extract data from two to three relationships using two to three relational operations (including at least one division)
4. Queries to extract data from multiple relationships using multiple relational operations (including joining and / or division and set-theoretic operations)

4. Evaluation criteria

1. The concept of the subject area. The concept of a subject model. The concept of data model.
2. Network and hierarchical models.
3. The basic concepts of the relational model: domain, relation, tuple, attribute, operations on relations.
4. Data types: scalar and non-scalar.
5. The concept of database and relational database.
6. The concept of a relation variable (relational variable).
7. The concept of a tuple variable.
8. A variable defined on a domain.
9. Connection operation: internal, external (left, right), full
10. The division operation.

11. Equivalence of relational algebra and relational calculus on tuples
12. Equivalence of relational algebra and relational calculus on domains.
13. Relation, type, object, domain, tuple: the relationship of concepts.
14. SQL: the structure of queries in SQL.
15. SQL language: connection with relational algebra.
16. SQL language: connection with relational calculus on tuples.
17. The SQL language. Work with missing values (NULL).
18. Nested queries in the SQL language.
19. The structure of the stored procedure / function in the SQL language.
20. The concept of data definition language. Defining a custom data type.
21. The concept of data definition language. Create a table.
22. The concept of data definition language. Definition of restrictions.
23. Triggers.
24. Features of stored procedures and functions in the MS SQL Server DBMS.
25. Features of stored procedures and functions in Oracle DBMS. Packages.
26. The general architecture of the DBMS.
27. The concept of transaction.
28. Organization of data storage on the hard drive.
29. Views. Materialized views.
30. Indices: purpose and organization.

excellent

10 comprehensive, systematized, deep knowledge of the curriculum of the discipline and the ability to confidently apply them in practice when solving specific problems, free and correct justification of decisions made;

9 systematic, deep knowledge of the curriculum of the discipline and the ability to confidently apply them in practice when solving specific problems, the correct justification of decisions made;

8 deep knowledge of the curriculum of the discipline and the ability to apply them in practice when solving specific problems, the correct justification of decisions made;

good

7 firmly knows the material, correctly and essentially sets out it, knows how to apply the knowledge gained in practice, but admits some inaccuracies in the answer or in solving problems;

6 knows the material, correctly presents it, knows how to apply the acquired knowledge in practice, but admits some inaccuracies in the answer or in solving problems;

5 knows the basic material, correctly presents it, knows how to apply the knowledge gained in practice, but admits inaccuracy in the answer or in solving problems;

satisfactorily

4 fragmented, fragmented nature of knowledge, insufficiently correct wording of basic concepts, violation of logical sequence in the presentation of program material, but at the same time he owns the main sections of the curriculum necessary for further training and can apply the acquired knowledge in the standard situation;

3 the nature of knowledge is sufficient for further training and can apply the acquired knowledge on the model in a standard situation;

unsatisfactory

2 does not know most of the main content of the curriculum of the discipline, makes gross errors in the wording of the basic concepts of the discipline and does not know how to correctly use the knowledge gained in solving typical practical problems.

1 does not know the wording of the basic concepts of the discipline and does not know how to use the knowledge gained in solving typical practical problems.

5. Methodological materials defining the procedures for the assessment of knowledge, skills, abilities and/or experience

Differentiated classification is carried out taking into account current academic performance and the results of the completion of term paper. If necessary, in the process of interviewing a student, a selective survey is conducted on the knowledge of control questions, and typical tasks are offered.