INTERNATIONAL EUROPEAN UNIVERSITY
Education and Research Institute "European Business School"
Department of Information Technology

Approved by
The Scientific and Methodical Council of the
University, protocol dd._____, 2023,
No. _____

Chair of SMC _____

WORKING PROGRAM OF THE ACADEMIC DISCIPLINE:

DATA AND KNOWLEDGE BASE ORGANIZATION

Knowledge area: 12 Information Technology

Specialty: 121 Software Engineering

Educational program: 121 Software Engineering

Discipline status: Compulsory

Kyiv – 2023

The working program of the Data and knowledge base organization academic discipline is based on the 121 Software Engineering educational and professional program for the first (Bachelor) level of the 121 Software Engineering specialty approved by the University Academic Council on May 26, 2022, protocol No. 4.

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The working program of the academic discipline is reviewed and approved by the Department of Information Technology, protocol dd. August 31, 2023, No. 1.

Head of the Department _____ O.V. Nesterenko, Doctor of Science (Techn.),
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The program is reviewed and approved by the Academic Council of the European Business School, protocol dd. September 11, 2023, No. 1.

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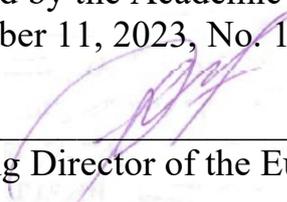
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INTRODUCTION

The **program of the Data and knowledge base organization academic discipline** is designed according to the Higher Education Standard of Ukraine (hereinafter referred to as the Standard) of the knowledge area: 12 Information Technology, specialty: 121 Software Engineering.

Discipline description (annotation). This academic discipline is an obligatory component of the Software engineering educational program for future software developers.

Table 1

Criteria	Knowledge area, training program, educational level	Discipline characteristics	
		full-time mode of study	part-time mode of study
Number of credits – 8	**Knowledge area: 12 INFORMATION TECHNOLOGY**	**Compulsory**	
Sections – X	**Specialty:** 121 SOFTWARE ENGINEERING	Year of training	
Content sections – 2		2023-2024	2023-2024
Individual research task: startup		Semester	
		3rd, 4th	3rd, 4th
		Lectures	
		32 hours	6 hours
Weekly load: class hours – 4 independent work of students – 6		Laboratory classes	
		64 hours	10 hours
	Educational level: Bachelor	Independent work	
		144 hours	35 hours
		Type of control:	
		Pass/Fail test, exam	Pass/Fail test, exam

Subject matter of the academic discipline: databases.

Interdisciplinary links: the program is arranged according to the annotation of the educational and professional program of Bachelor training and is based on the knowledge of the Methods and tools of computer information technology discipline, as well as precedes the study of such compulsory disciplines as Software architecture and design and Software modeling and analysis.

The knowledge obtained while studying of the Data and knowledge base organization discipline is the foundation for mastering professional training disciplines as well as can be applied during on-the-job practical training, preparation of term papers and qualifying papers on the specialty.

1. GOAL AND OBJECTIVES OF THE ACADEMIC DISCIPLINE

1.1. The **goal** of the discipline is to provide future Bachelors of Software Engineering with computer culture, theoretical knowledge and practical skills in basics of developing and operating relational and logical databases, data storages and intelligent systems based on various artificial intelligence methodologies.

1.2. **Key objectives** of the Data and knowledge base organization discipline:

- to explore technologies and methodologies of database operations, database modifications: creating, deleting, editing;

- to learn areas, methods and tools for designing, developing, integrating and applying software products, databases and data storages created using object-oriented programming languages, industrial client-server database management systems, as well as intelligent systems based on various approaches;

- to acquire skills in data manipulation and explore principles of creating SQL queries: sorting and grouping of results; maintenance of security measures.

- to develop the ability to actualize and control queries, use queries for data analysis;

- to be able to make managerial decisions based on the information analysis in databases and data storages, predict the situation, keep data security and integrity.

1.3. **Competencies and learning outcomes** encouraged by the discipline (interrelation with the statutory content of student training stipulated in learning outcome terms of the Standard).

According to the Standard requirements, the discipline provides students with the following *competencies* (Table 2):

Table 2

Integral competence	Ability to solve complicated specialized tasks and practical problems in software development characterized by complexity and uncertainty of conditions.
General competencies	Ability to abstract thinking, analysis and synthesis. Ability to apply knowledge in practical situations. Ability to know and understand the subject area and professional activities. Ability to learn and acquire contemporary knowledge. Ability to find, process and generalize information from different sources. Ability to keep and multiply moral, cultural, scientific values, as well as multiply achievements of society based on the understanding of history and regularities of subject area development, its place in the general system of knowledge about nature and society and in the evolution of society, engineering and technologies, as well as to use different types and forms of physical activity for outdoor activities and a healthy lifestyle.
Specialized (professional, subject) competencies	Ability to analyze the object of design or operation and its subject area. Ability to use information systems and technology standards in developing functional profiles, designing and integrating systems, products, services and infrastructure elements of an organization.

	Ability to design, develop and use the means of implementation of information systems, technologies and information communications (methodical, informational, algorithmic, technical, software, etc.). Ability to select, design, deploy, integrate, manage, administer and maintain information systems, technologies and information communications, services and infrastructure of the organization. Ability to conduct computational experiments, compare the results of experimental data and obtained solutions.

Specification of competencies according to the National Qualifications Framework descriptors in the Competency matrix form:

Table 3

No.	Competence	Knowledge	Skills / Abilities	Communication	Autonomy and responsibility
Integral competence					
1.	Ability to solve complicated specialized tasks and practical problems in software development characterized by complexity and uncertainty of conditions.	Experience in using information technologies in different industries	To use information technologies, basic system and application software to solve practical problems	Human-machine interaction	Independent design and testing on the production site
General competencies					
2.	Ability to abstract thinking, analysis and synthesis. Ability to apply knowledge in practical situations. Ability to know and understand the subject area and professional activities. Ability to learn and acquire contemporary knowledge. Ability to find, process and generalize information from different sources.	the structure of a computer, general principles of functioning of its main devices	perform operations using PC and peripheral devices, application and service software programs	Relation between theoretical and practical knowledge	Monitoring of information processing processes
Specialized (professional, subject) competencies					
3.	Ability to analyze the object of design or operation and its subject area. Ability to use information systems and	purpose, functionality and rules of use of basic system programs, Internet services, rules	the use of information technology software and hardware to prepare documents,	Application of Internet technology for data collection and analysis	Description of information processes

technology standards in developing functional profiles, designing and integrating systems, products, services and infrastructure elements of an organization. Ability to design, develop and use the means of implementation of information systems, technologies and information communications (methodical, informational, algorithmic, technical, software, etc.). Ability to select, design, deploy, integrate, manage, administer and maintain information systems, technologies and information communications, services and infrastructure of the organization. Ability to conduct computational experiments, compare the results of experimental data and obtained solutions.	of information search and processing in the global network	presentations, perform calculations, etc.		

Integrated final program learning outcomes encouraged by the academic discipline:

Program learning outcomes   Bachelor's qualifying paper

Learning outcomes:
After learning the discipline, students should
know:
  –   the structure of major databases;

- database management systems.

be able to:
- apply acquired skills in presenting internal and external information of complex economic-organizational and production systems;

- use methods and tools for designing different types of databases, knowledge-based software and intelligent systems to solve specialized tasks.

2. INFORMATION CAPACITY OF THE ACADEMIC DISCIPLINE

SECTION 1

CONTENT SECTION 1.
BASIC CONCEPTS OF DATABASE SYSTEMS
Topic 1.1. Concept of data and knowledge bases.
Topic 1.2. Data model concept.
Topic 1.3. Relational algebra and relational calculus.
Topic 1.4. Semantic modeling.
Topic 1.5. SQL.

CONTENT SECTION 2.
INTELLIGENT SYSTEMS
Topic 2.1. Cutting-edge DBMS.
Topic 2.2. The concept of building data stores and data mining.
Topic 2.3. Knowledge bases and knowledge engineering.

SECTION 2

CONTENT SECTION 3.
INTEGRATED DATABASE MANAGEMENT SYSTEM ENVIRONMENT
Topic 3.1. MS SQL Server components. Administration. Physical and logical database architecture and its objects.
Topic 3.2. Transact SQL - programming language in MS SQL Server environment.
Topic 3.3. SQL queries for data definition and processing.
Topic 3.4. Creation of a database and development of a user application.
Topic 3.5. Course design.

CONTENT SECTION 4.
ADDITIONAL ISSUES OF DATABASE MANAGEMENT SYSTEMS
Topic 4.1. Special database objects (triggers, views and storage procedures).
Topic 4.2. Supporting data integrity in DBMS.
Topic 4.3. Non-relational (non-SQL) DBMS.

Content sections and topics	Amount of hours			
	Total	including		
		Lectures	Laboratory work	Inde pend ent work
Section 1.				
Content section 1. Basic concepts of database systems				
Topic 1.1. Concept of data and knowledge bases.	15	2	4	9
Topic 1.2. Data model concept.	15	2	4	9
Topic 1.3. Relational algebra and relational calculus.	15	2	4	9
Topic 1.4. Semantic modeling.	15	2	4	9
Topic 1.5. SQL.	15	2	4	9
Content section 2. Intelligent systems				
Topic 2.1. Cutting-edge DBMS.	15	2	4	9
Topic 2.2. The concept of building data stores and data mining.	15	2	4	9
Topic 2.3. Knowledge bases and knowledge engineering.	15	2	4	9
Total per section 1	120	16	32	72
Section 2.				
Content section 3. Integrated database management system environment				
Topic 3.1. MS SQL Server components. Administration. Physical and logical database architecture and its objects.	15	2	4	6
Topic 3.2. Transact SQL - programming language in MS SQL Server environment.	15	2	4	6
Topic 3.3. SQL queries for data definition and processing.	15	2	4	6
Topic 3.4. Creation of a database and development of a user application.	15	2	4	6
Topic 3.5. Course design.	15	2	4	30
Content section 4. Additional issues of database management systems				
Topic 4.1. Special database objects (triggers, views and storage procedures).	15	2	4	6
Topic 4.2. Supporting data integrity in DBMS.	15	2	4	6
Topic 4.3. Non-relational (non-SQL) DBMS.	15	2	4	6
Total per section 2	120	16	32	72

4. TOPICS OF LECTURES

No.	Topics and list of key questions
1	CONCEPT OF DATA AND KNOWLEDGE BASES. Data and its accumulation. The concept of information, data, knowledge. The concept of information space. Data structure. Data processing technology. Basic concepts, purpose of databases (DB) and database management systems (DBMS). The place of databases in modern information systems. Definition and classification of data models. Brief characteristics. Data types and varieties of databases: hierarchical, network and relational. Comparison of classical data models. Relational data model. Database representation at the logical and physical levels. Structure of an automated database, DBMS functions. Local and distributed databases, file-server and client-server data management technologies.
2	DATA MODEL CONCEPT. Optimal logic model. Relationship normalization. Functional dependencies of props, common forms of relationships in relational data models. Display of network and hierarchical data model in relational data model. Relationship as the basic unit of information representation in relational databases. Abnormalities of non-normalized relations in databases. Algorithm of bringing relations to the third normalized form. Advantages of a normalized database.
3	RELATIONAL ALGEBRA AND RELATIONAL CALCULUS. Dependencies between attributes. Properties of functional dependencies. The concept of relationship compatibility. Basic operations on relations in relational models.
4	SEMANTIC MODELING. Levels of database architecture description. Object/relationship model (Chen model). ER diagrams. An example of developing a simple ER model.
5	SQL. SQL structured query language. Purpose and composition of speech. Standards and data types. Categories of basic commands of SQL standard. Categories of SQL operators.
6	CUTTING-EDGE DBMS. SQL Server client-server DBMS. Characteristics and main features of the industrial database management system. DBMS functions of information analysis: table cross-analysis (roliup, cube) and compilation (rank, cume_dist, etc.). DBMS functions of information analysis: window method processing, statistical, late and leading. Open Source DBMS - MySQL and PostgreSQL.
7	THE CONCEPT OF BUILDING DATA STORES AND DATA MINING. Basic theoretical concepts and terms revealing the essence of data storages, data spaces and their place in modern information technologies. The concept of an intelligent system. Elements of intelligent systems. The concept of data storages and prerequisites for their creation. The main features of a data storage (DS). Architecture of DS. Multidimensional and relational models of data storages. Differences of data storage design from database design. Definition of the main elements of a data storage: definition and requirements for variables, definition of the degree of detail of variables, definition and requirements for measurements and factors. Dimensional modeling of data storages. Defining metadata in data storage design. Methods of DS design. Data storage tools. Development of data storage tools market. Storage creation tools. Storage management tools. Storage access tools. Data storage appliances. Levels of knowledge extracted from data - technologies and analytical tools. Online Analytical Processing (OLAP). Types of OLAP systems.

	Structure of tools for intelligent data manipulation with the introduction of OLAP. Intelligent data analysis - Data Mining. The essence of Data Mining technology.
8	KNOWLEDGE BASES AND KNOWLEDGE ENGINEERING. Basic theoretical concepts and terms revealing the essence of knowledge bases and their place in modern intelligent technologies. Introduction of the concept of knowledge engineering. Methods and technologies of design and development of intelligent software systems. Expert systems. Architecture and classification of EC. Toolkit of EC creation.
9	MS SQL SERVER COMPONENTS. Administration. Physical and logical database architecture and its objects. Spreadsheet processing software. Input, editing of tabular data. Entering formulas. Working with book letters. Formatting of data. Development of tabular information using built-in functions. Processing of tabular information. Building diagrams. Processing tabular information using logical functions (Counts, Sums, etc.). Conditional formatting. Developing tabular information using the logical function If. Using functions and graphics to analyze tabular information.
10	TRANSACT SQL. Programming language in MS SQL Server. Commands to define and destroy data. The CREATE query syntax creates a new database and a new table in the existing database. Using a DROP query to destroy a database, table, index and functions. Data processing commands: adding (INSERT) and adjusting (UPDATE) a row. Merge commands in a table (MERGE).
11	SQL QUERIES FOR DATA DEFINITION AND PROCESSING. The concept of sampling from a database. SELECT query syntax for creating a selection. Use of query functions. Limiting, sorting and manipulating data. Queries with grouping and string composition: advanced data sampling (group by, having). Writing single-row, multi-row, multi-column subqueries and built-in views. Particularities of creating queries for many tables. Joining queries.
12	CREATION OF A DATABASE AND DEVELOPMENT OF A USER APPLICATION. Modeling as a way of information technology. Modeling in different activity areas. Modeling software. Particularities of designing software and user interface.
13	COURSE DESIGN. Definition and characteristics of control systems. Architecture of information management systems. Theoretical and practical foundations for the creation and design of enterprise management systems. Information and calculation analytical systems.
14	SPECIAL DATABASE OBJECTS (triggers, views and storage procedures). The process and methods of decision making. Knowledge engineering. Models and criteria in decision support system (DSS). Fundamentals of knowledge. Basic approaches to the design of DSS. Examples of DSS construction.
15	SUPPORTING DATA INTEGRITY IN DBMS. Means of ensuring the reliability and consistency of data. Declarative integrity constraints. Definition of integrity rules. Methods of ensuring the integrity of the database. Integrity constraints imposed on database attributes, integrity constraints imposed on database files, integrity constraints imposed on database links. Data management language. Database administrator and its main functions. Information object protection management. Data protection tools. File checksum value, encryption. Database loading and conversion operations, performance

	requirements. Assignment and control of capabilities. Database update operations, cases of their application.
16	NON-RELATIONAL (NON-SQL) DBMS. Combination of hardware and software with device parts designed to perform a separate function. Real-time operation. Types of integrated systems. Microprogramming. Monocrystal solutions and programmable chips.

5. TOPICS OF LABORATORY AND PRACTICAL CLASSES

No.	Topic	Amount of hours
1.	Development of data tables of the selected subject area	4
2.	Relationship normalization	4
3.	PowerDesigner, BPWin and ERWin CASE technologies, their purpose and functions. Construction of ER diagrams in the selected software tool	4
4.	Building queries in SQL structured query language. Modification of SQL queries in the Access environment.	4
5.	Introduction to the Ms. SQL Server DBMS. Converting the database into the SQL Server format.	4
6.	Introduction to the MySQL DBMS. Exporting tables	4
7	Data Mining intelligent data analysis	4
8	Creating a knowledge base in the interactive environment of the CLIPS expert shell.	4
9	DBMS technology: design and development of a relational database of the selected subject area.	4
10	Development of relational database protection methods: password setting, system and object authorization, access rights setting, database backup.	4
11	Writing single-line, multi-line, multi-column subqueries and embedded views.	4
12	Transactions	4
13	Creating views, triggers, indexes, and storage procedures	4
14	Loading and unloading a database. Replication	4
15	Technologies of database access Web-applications development	4
16	Creating and using a non-SQL database (in Redis environment)	4
Total:		64

6. INDEPENDENT WORK

No.	Topic	Amount of hours
1.	Data flows. Big data. Information economy as a field of application of database technologies.	9
2.	Characteristics of algorithms, problems arising in data modeling.	9
3.	Secrecy, data integrity protection, synchronization, failure protection and recovery. Comparative characteristics of local and distributed databases, as well as file-server and client-server data management technologies	9
4.	Define and characterize the following concepts: entity, attribute, relationships, entity types, hierarchy, succession mimic, keys, tables and views. Describe the technology (sequence of steps and tools) of linking process and data model.	9

5.	Data management in databases. Security management in DBMS	9
6.	SQL wildcards and regular expressions (LIKE)	9
7.	Possibilities of the Select operator where the value of its parameters are defined in dialog and automatic modes.	9
8.	Requirements for selection requests in a common combination request	9
9.	DBMS background (DBWO, LGWR, SCRT, SMON, PMON) and server (dedicated and shared) processes.	9
10.	Storage virtualization. Differences between data storages and accounting systems.	9
11.	Objectives of data mining	27
12.	Blockchain technology: design and application.	27
Total:		144

7. TRAINING METHODS

Teaching the Data and knowledge base organization discipline, one uses information and practical training methods: classical lectures, laboratory and practical classes using simulation laboratory workshops, as well as consultations on the accomplishment of independent work of students, written assignments during test works.

Methods of learning and cognitive activity: explanatory and illustrative method, reproductive method, problem presentation method, partially exploratory or heuristic method, research method.

Methods of stimulation and motivation of learning and cognitive activity: inductive and deductive teaching methods; methods of stimulation and motivation of learning.

8. CONTROL METHODS

The plan of the Data and knowledge base organization discipline implies carrying out of current and final control.

Current control is the assessment of the level of knowledge, skills and abilities of students carried out during the educational process by conducting a written survey at the end of sections (module colloquium). Modular control in special situations can be carried out in the form of a computer-based online test with a fixed answer time.

9. FORM OF STUDENT PERFORMANCE FINAL CONTROL

The form of final control is the **exam** taken on-campus (or in the form of computer test in case of a specific situation) in the period stipulated by the Dean's office or according to the individual schedule stipulated by the curriculum.

10. SCORING SYSTEM
Scoring during the semester

No.	Type of activity	Number of points per didactic unit	Number	Total points
1	Testing on lecture materials	3	8	24
2	Accomplishment of laboratory works	4	8	32
3	Accomplishment of independent works	1	4	4
Exam		40		40
Maximum grade				100

General assessment of student knowledge due to current control

The results of current control of student knowledge are assessed in general ranging from **0** to **60** points.

Students are allowed to final control if they fulfil the requirements of the training program and obtain at least **36** points for the current learning activity.

Final assessment of student knowledge

Final assessment of student knowledge is conducted in the form of **exam**.

Knowledge assessment criteria during the exam

Maximum amount of points that can be obtained in the exam is **40** points.

Allocation of assessment points during final control in the academic discipline

Grade in points for current assessment	Grade in points for final assessment	Grade according to the national scale
54-60	36-40	Excellent
45-53	30-35	Good
36-44	24-29	Satisfactory
less than 36	less than 24	Fail

Assessing the answer to the particular question, one takes into account the following gaps and mistakes:

– untidy preparation of work (nonconventional abbreviations, unclear handwriting, use of pencils instead of clear inks) (minus **2** points);

– incorrectness in certain economic categories and definitions (minus **4** points).

Assessment criteria for answers to theoretical questions of the exam card:

1. The full answer to the question rated as *excellent* should correspond to the following requirements:

– detailed, comprehensive representation of the content of the given problem;

– full list of economic categories and laws required to reveal the question;

– ability to carry out a comparative analysis of various theories, concepts, approaches and make logical conclusions and generalizations;

– ability to apply methods for the scientific analysis of economic phenomena, processes and characterize their features and forms of appearance;

– demonstration of the ability to express and reason your own attitude to alternative views on this question;

– use of relevant actual and statistical data, knowledge of dates and historical periods that prove key points of the answer.

2. The answer to the question is rated as ***good*** if:

– the answer for the highest grade does not reveal at least one of the above-mentioned points (if it is definitely required to reveal the question comprehensively), or if:

– revealing the question correctly in general according to the above-mentioned requirements, one makes some mistakes while using digital materials.

3. The answer to the question is rated as ***satisfactory*** if:

– the answer for the highest grade does not reveal four and more points specified in its requirements (if they are required to reveal the question comprehensively);

– there are four or more gaps characterizing individually assessment criteria;

– conclusions made during the answer do not correspond to correct or generally defined ones with the absence of evidence for opposite facts given in the answer;

– the character of the answer gives reason to state that persons fail to understand the question properly or do not know the correct answer, and that is why fail to answer in actual fact, making serious mistakes.

Taking into account the above-said, the exam results are assessed between **0** and **40** points. Besides, if the answer is rated as less than 30%, students receive the fail grade due to the exam results and the fail overall final grade.

The overall final grade in the discipline consists of the sum of points for the results of knowledge current control and for accomplishment of tasks defined for the exam.

The overall final grade cannot exceed **100 points**.

The overall final grade in points according to the national and ECTS scales is put into the examination and test register, academic card and credit book of students.

National and ECTS grading scale

Sum of points for all types of educational activities	ECTS grade	Grade according to the national scale	
		for exam, term paper, practical training	for Pass/Fail test
90-100	A	excellent	pass
82-89	B	good	pass
74-81	C	good	pass
66-73	D	satisfactory	pass
60-65	E	satisfactory	pass
30-59	FX	fail with possible repeated pass	fail with possible repeated pass
1-29	F	fail with obligatory repeated learning of the discipline	fail with obligatory repeated learning of the discipline

11. METHODICAL SUPPORT:

- working program of the discipline;
- MOODLE electronic course with key points of lectures, guidelines to laboratory works, tests and materials for independent work of students;
- list of questions for the exam.

12. RECOMMENDED READING

1. Gunderloy M., Automating Microsoft Access with VBA = Mike Gunderloy, Susan Sales Harkins; Automating Microsoft Access with VBA / Translated from English by S.A. Khramov. M, SpB, K: Williams, 2006. 416 p.

2. Date C. Introduction to Database Systems. Translated from English. 6th edition. Kyiv: Williams, 1999. 848 p.

3. Ensor Dave. Ian Stevenson. Oracle Design: Translated from English. K.: BHV Publishing Group, 2000. – 560 p.

4. Makarova M.V., Karnaukhova H.V., Zapara S.V. Informatics and computer technology: study guide / edited by M.V. Makarova. 3rd edition, revised and supplemented. Sumy: University book, 2008. 665 p.

5. Pasichnyk V.V., Shakhovska N.B. Data storages: study guide / edited by V.V. Pasichnyk. Lviv: Magnolia 2006, 2008. 492 p.

6. Rudenko V.D. Databases in information systems: study guide / edited by V.Y. Bykov. K.: Phoenix, 2010. 240 p.

7. Hernandez M.D., J.L. Viescas. SQL Queries for Mere Mortals: A Hands-On Guide to Data Manipulation in SQL: Translated from English. – M.: Lori, 2003. – 458 p.

8. Huzhva V.M. Information systems and technologies at enterprises: study guide. K. : KNEU, 2001. 400 p.

9. Kauchmen Jason S., Mariseti Sudhir N. OSA Oracl 9x Associate DBA. Database administrator training: Translated from English. M.: Lori, 2006. 680 p.

10. Luger George F. Artificial Intelligence: Strategies and Methods for Solving Complex Problems: Translated from English. M.: Williams, 2003. 864 p.

13. Falovskyi O. O., Nesterenko O. V. Basics of database design and using: Tutorial. Section I. Kyiv: Tropea. 2023. 83 p.

Internet resources

1. Additional materials and software tools for developing intelligent systems. - Available at: http://www.pearsoneduc/ com/computing

2. Software system design methods. - Available at: http://www.sdm.viptop.ru/articles/booch/'

3. MySQL DBMS. - Available at: www.mysql.com

4. PostgreSQL DBMS. - Available at: www.postgresql.org