Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Department of system programming and specialized computer systems

MODELING AND DESIGN OF INFORMATION SYSTEMS

Syllabus

Details of the academic discipline	
Level of higher education	*Second (master's)*
Branch of knowledge	*12 Information technologies*
Specialty	*121 Software engineering*
Educational program	*Software Engineering of Multimedia and Information Retrieval Systems*
Discipline status	*Normative*
Form of education	*Daytime*
Year of training, semester	*1 year of training, 1 semester*
Scope of the discipline	*36 hours for lectures, 18 hours for practicals, 66 hours for self-study*
Semester control/ control measures	*Exam, modular control work, calendar control*
Lessons schedule	*According to the schedule for the autumn semester of the current academic year (http://roz.kpi.ua/)*
Language of teaching	*English*
Information about	*Lectures:*
head of the course / teachers	http://fpm.kpi.ua/archive/dir.do?sys_id=obj_14804

Program of educational discipline

1. Description of the educational discipline, its purpose, subject of study and learning outcomes

Today, the use of information systems (IS) permeates the entire life of society. Modern IT allows you to accumulate, organize and integrate large amounts of data related to various aspects of human life, and to provide operational access to this data for various types of users and provide them with information for effective decision-making.

The general informatization of production, management and service organizations is changing the very approach to the use of IS. From a means of accumulating data about their activities, IS turns into a tool for improving the efficiency of management and service provision by organizations, institutions and industries. It accelerates the process of analytical data processing and provides comprehensive information for decision-making and service provision, and the viability of organizations increases due to the improvement of the efficiency of decisions and the quality and efficiency of services produced on the basis of information provided by IS, and the possibility of prompt communication with effective persons of the surrounding environment ;

No enterprise, organization or institution today can exist without effective IS.

Modern IT has a complex multi-level organization. It is based on integrated and distributed relational and object databases, integrated and distributed object-oriented software components and means of remote access to information.

The main problems of IS construction, the solutions of which will ensure their effective functioning in the future, are the definition of:

- *the model of the subject environment, which will be reproduced in IS;*
- *methods of data organization that will ensure the maintenance of adequacy, integrity and consistency of data of the subject environment reproduced in IS;*
- *methods of building application software for work with IS, which will provide the possibility of its further transformation and scaling with changes in the needs of IS data processing.*

The goal of the discipline *is the formation of students' ability to model, design and develop corporate-scale enterprise information systems integrated into business processes at all levels of management of modern enterprises and organizations.*

The subject of the academic discipline *is the paradigm of integrated end-to-end modeling and design of corporate information systems from analysis and modeling of business processes to software implementations with open architecture.*

The study of the discipline "Modeling and design of information systems" contributes to the formation of the following competencies in students.

Competencies, the formation of which is facilitated by this discipline:

PC 01	*Ability to analyze subject areas, form, classify software requirements.*
PC 02	*Ability to develop and implement scientific and / or applied projects in the field of software engineering.*
PC 03	*Ability to design software architecture, model the operation of individual subsystems and modules.*
PC 08	*Ability to develop and coordinate processes, stages and iterations of the software life cycle based on the application of modern models, methods and technologies of software development.*
PC 10	*Ability to plan and perform research in software engineering.*
PC 14	*Ability to implement and maintain information systems.*
PC 17	*Ability to apply software engineering methodologies in practice.*

The formation of these competencies ensures the achievement of the following program learning outcomes:

PLO 02	*Evaluate and choose effective methods and models of software development, implementation, support and relevant processes management at all stages of the life cycle.*
PLO 03	*Build and research models of information processes in the application field.*
PLO 04	*Identify information needs and classify data for software design.*
PLO 06	*Develop and evaluate software design strategies; substantiate, analyze and evaluate options for design solutions in terms of the final software product quality, resource constraints and other factors.*
PLO 07	*Analyze, evaluate and apply at the system level modern software and hardware platforms to solve complex problems of software engineering.*
PLO 08	*Develop and modify software architecture to meet customer requirements.*
PLO 10	*Modify existing and develop new algorithmic solutions for detailed software design.*
PLO 11	*Ensure quality at all stages of the software life cycle, including the use of relevant models and assessment methods, as well as automated software testing and verification tools.*
PLO 13	*Configure software, manage its changes and develop software documentation at all stages of the life cycle.*
PLO 15	*Carry out software reengineering in accordance with customer requirements.*
PLO 17	*Collect, analyze, evaluate the information needed to solve scientific and applied problems, using scientific and technical literature, databases and other sources.*
PLO 18	*Develop mathematical and software for research in software engineering.*
PLO 20	*Plan and perform research in the software engineering area, choose methods and tools,*

	analyze the results, justify the conclusions.
PLO 21	*Know the theoretical foundations underlying research methods of information systems and software, research methodologies and computational experiments.*
PLO 26	*Know and be able to apply in practice specialized templates for designing information retrieval systems.*

2. Pre-requisites and post-requisites of the discipline (place in the structural and logical scheme of training according to the relevant educational program)

To successfully master the discipline "Modeling and design of information systems" it is necessary and sufficient to have thorough knowledge and skills within the educational and professional program of the first (bachelor's) level of higher education "Software engineering of multimedia and information search systems".

The theoretical knowledge and practical skills obtained during the study of the discipline "Modeling and design of information systems" ensure the successful completion of course projects and master's theses in the specialty 121 Software engineering.

3. Content of the academic discipline

Topic 1. MODERN CORPORATE INFORMATION SYSTEMS
Topic 2. METHODOLOGY OF MODELING THE SUBJECT ENVIRONMENT
Topic 3. DATABASE DESIGN METHODOLOGY
Topic 4. METHODOLOGIES OF OBJECT ANALYSIS AND IS DESIGN
Topic 5. COMPARATIVE ANALYSIS OF THE RELATIONAL AND OBJECT DATA MODELS
Topic 6. JDBC DATA ACCESS TECHNOLOGY
Topic 7. TECHNOLOGY OF OBJECT-RELATIONAL DATA DISPLAY. OBJECT-RELATIONAL DISPLAY OF DATA IN JAVA PERSISTENCE API TECHNOLOGY
Topic 8. MANAGEMENT AND MANIPULATION OF JPA ENTITIES
Topic 9. ARCHITECTURE OF INFORMATION SYSTEMS
Topic 10. DISTRIBUTED DB
Topic 11. TECHNOLOGIES FOR CREATING WEB APPLICATIONS OF INFORMATION SYSTEMS

4. Educational materials and resources

Basic literature:

1. *Авраменко В.С., Авраменко А.С. Проектування інформаційних систем: навчальний посібник. – Черкаси: Черкаський національний університет ім. Б. Хмельницького, 2017. – 434 с.*
2. *Литвин В.В., Пасічник В.В., Шаховська Н.Б. Проектування інформаційних систем. Навчальний посібник. – Львів: Видавництво Магнолія, 2006. – 380 с.*
3. *Руденко В.Д. Бази даних в інформаційних системах К.: Фенікс, 2010,- 235 с.*
4. *Проектування інформаційних систем: Загальні питання теорії проектування ІС (конспект лекцій) [Електронний ресурс]: навч. посіб. для студ. спеціальності 122 «Комп'ютерні науки» / КПІ ім. Ігоря Сікорського; уклад.: О. С. Коваленко, Л. М. Добровська. – Електронні текстові дані (1 файл: 2,02 Мбайт). – Київ : КПІ ім. Ігоря Сікорського, 2020. – 192с.*

Additional literature:

5. *O'Brien, J A. Introduction to information systems: essentials for the e-business enterprise. McGraw-Hill, Boston, 2003- 320 p.*
6. *Bacon, C. James; Fitzgerald, Brian (2001-04-01). "A systemic framework for the field of information systems". ACM SIGMIS Database: The DATABASE for Advances in Information Systems. 32 (2): 46–67.*

7. *Rainer, R. Kelly Jr, and Casey G. Cegielski. Introduction to Information System: Support and Transforming Business Fourth Edition. New Jersey: John Wiley and Sons, Inc., 2012. Print.*
8. *David T. Bourgeois, Biola University, James L. Smith. Information Systems for Business and Beyond. O'Reilly, 2019 – 640 p.*
9. *Efrem G. Mallach. Information Systems. O'Reilly, 2015 – 570 p.*

Electronic resources:

10. *Web-портал ФПМ. Архів матеріалів. Тека "Павловський". – Режим доступу: http://fpm.kpi.ua/archive/dir.do?sys_id=obj_14804*
11. *Електронний кампус НТУУ «КПІ ім. Ігоря Сікорського». Матеріали з дисципліни "Проектування корпоративних інформаційних систем". – Режим доступу: http://login.kpi.ua/*
12. *http://docs.oracle.com/javaee/1.4/tutorial/doc/*
13. *http://www.ibm.com/developerworks/rational/library/05/0816_Louis/*

Educational content

5. Methods of mastering an educational discipline (educational component)

5.1 Lecture classes

Materials for studying the discipline are available in electronic form on the website of the faculty (http://fpm.kpi.ua/archive/dir.do?sys_id=obj_14804) and in the "Electronic Campus" environment. The content is available to the student from anywhere on the Internet.

Lectures on the discipline are conducted using modern multimedia presentation technologies.

№ з/п	*Type of training session*	*Description of the training session*
1	*Lecture 1. General aspects of IS modeling and design*	*Historical information about the evolution of database technology from local to client-server and distributed.* *Course subject. Basic concepts and definitions.* *Tasks on SRS: item 6 #1.*
2	*Computer workshop 1. Modeling business processes and data flows of enterprises in the AFPM BPWin package*	*Assignment: structural diagrams in IDEF0, DFD, IDEF3 notation*
3	*Lecture 2. Definition and purpose of IS*	*Task on SRS: item 6 #2.*
4	*Lecture 3. Principles and criteria of construction and operation of IS*	*Prerequisites for the emergence of IS. IS requirements. Types of IS.*
5	*Computer workshop 2. Designing a conceptual and physical database model in the AFDM ERWin package*	*Task: Construction of logical and physical data models in IDEF1x notation.*
6	*Lecture 4. Structural analysis and IS modeling methodologies*	*Assignment on SRS: p. 6 No. 5.*
7	*Lecture 5. IDEF methodology and its models*	*Levels of modeling the subject environment. Methodologies of structural analysis and modeling of PKIS. SADT methodology.*

8	*Computer workshop 3. UML design of IS use diagrams, classes and sequence diagrams*	*Tasks on SRS: p. 6 No. 6, 32.*
9	*Lecture 6. UML object-oriented analysis and design methodology*	*Methodology of functional IDEF0. IDEF3 methodology for describing the logic of interaction of information flows. DFD methodology for document flow description. Basic concepts. Functions. Connections. Inputs and outputs. Diagrams.*
10	*Lecture 7. The concept of database design*	*Tasks on SRS: item 6 #7.*
11	*Computer workshop 4. Implementation of object-relational mapping of database tables into entity classes and entity classes in a database table by means of JPA by means of JPA (part 1)*	*Task: Construction of IS usage diagrams, classes and sequence diagrams.*
12	*Lecture 8. Conceptual database design using the entity-relationship method. ER diagrams*	*Tasks on SRS: item 6 #8.*
13	*Lecture 9. Logical database design. Normal forms of relations*	*Diagrams of use cases, classes, sequences.*
14	*Computer workshop 4. Implementation of object-relational mapping of database tables into entity classes and entity classes in a database table by means of JPA by means of JPA (part 2)*	*Task: Create a software application in which entity classes are created from database tables.*
15	*Lecture 10. Strongly and weakly normalized data models*	*Task on SRS: item 6 No. 14.*
16	*Lecture 11. JDBC data access technology*	*Data denormalization. OLTP and DSS systems. Data warehouses and OLAP. Characteristics of OLTP systems. The main differences between OLAP and OLTP systems. Codd rules for OLAP systems. Types of OLAP systems, their advantages and disadvantages. MOLAP, ROLAP and HOLAP systems. Modeling multidimensional cubes on the relational data model.*
17	*Computer workshop 5. Designing software systems using DAO and DAOFactory templates (part 1)*	*Assignment on SRS: item 6 No. 15.*

18	*Lecture 12. Comparative analysis of relational and object data models*	*Architecture of interaction of Java applications with a database. JDBC drivers. Select data from a data source. Non-parametric and parametric data sampling queries.*
19	*Lecture 13. Object-relational display of data in Java Persistence API technology*	*Assignment on SRS: item 6 No. 16.*
20	*Computer workshop 5. Designing software systems using DAO and DAOFactory patterns (part 2)*	*Task: Create a software application in which DAO classes, DAO class interfaces and DAOFactory are added to entity classes.*
21	*Lecture 14. Management and manipulation of JPA entities Assignment on SRS: item 6 #17.*	*Assignment on SRS: item 6 #17.*
22	*Lecture 15. EntityManager Components of relational and object data models. Structural, associative, manipulative and holistic components*	*Components of relational and object data models. Structural, associative, manipulative and holistic components*
23	*Computer workshop 6. Designing software systems using DAO and Dependency Ejection patterns, GenericDAO and DomainSuperClass Assignment on SRS: item 6 #18.*	*Assignment on SRS: item 6 #18.*
24	*Lecture 16. JPQL - the language of requests to JPA-entities JPA entities and their representation. Entity fields. Primary keys and entity identity. Automatic generation of primary keys. Associative relationships between entities.*	*JPA entities and their representation. Entity fields. Primary keys and entity identity. Automatic generation of primary keys. Associative relationships between entities.*
25	*Lecture 17. Interfaces Query and TypedQuery Task on SRS: item 6 #19.*	*Task on SRS: item 6 #19.*
26	*Computer workshop 7. Designing software systems using templates Task: Develop DAO classes according to the GenericDAO and DomainSuperClass templates.*	*Task: Develop DAO classes according to the GenericDAO and DomainSuperClass templates.* *Assignment on SRS: item 6 #26.*
Modular control work		

6. Independent work of a student/graduate student

Independent work involves preparing for classroom classes, setting up the software environment for performing laboratory work, developing software components necessary for building an IS prototype, and components of an IS software application.

The student's independent work includes the performance of individual tasks on the subject assigned to laboratory work, as well as the processing of theoretical material based on the provided lecture texts and additional literature, including on topics assigned to independent study (according to Table 1). All educational materials (presentations of lectures, practical classes, methodological instructions for performing laboratory work) are placed in electronic form at http://fpm.kpi.ua/archive/dir.do?sys_id=obj_14804, as well as in the "Electronic Campus" environment.

Educational content is available from anywhere on the Internet.

Table 1. Topics submitted for independent study

№ з/п	Topic name	Number of hours	literature
1.	Preparation for the lecture 1	1	1-3
2.	Preparation for computer workshop No. 1	1	9; 10
3.	Preparation for lecture 2	1	1-3
4.	Preparation for the lecture 3	1	4; 8
5.	Preparation for computer workshop No. 2	1	9; 10
6.	Preparation for the lecture 4	1	5-7
7.	Preparation for the lecture 5	1	2; 5; 8
8.	Preparation for computer workshop No. 3	1	9; 10
9.	Preparation for the lecture 6	1	1; 3; 6
10.	Preparation for the lecture 7	1	2; 5
11.	Preparation for computer workshop #4 (part 1)	1	4, 7; 11
12.	Preparation for the lecture 8	1	2; 6
13.	Preparation for the lecture 9	1	3-6
14.	Preparation for computer workshop No. 4 (part 2)	1	4, 7; 11
15.	Preparation for lecture 10	1	1; 2; 3
16.	Preparation for lecture 11	1	2-4
17.	Preparation for computer workshop No. 5 (part 1)	1	9; 10
18.	Preparation for lecture 12	1	4; 5
19.	Preparation for lecture 13	1	7-9
20.	Preparation for computer workshop No. 5 (part 2)	1	9; 10
21.	Preparation for lecture 14	1	1; 6
22.	Preparation for lecture 15	1	5; 8

23.	*Preparation for computer workshop No. 6*	*1*	*9; 10*
24.	*Preparation for lecture 16*	*1*	*3; 7*
25.	*Preparation for lecture 17*	*1*	*4; 7*
26.	*Preparation for computer workshop No. 7*	*1*	*9; 10*
27.	*Preparation for modular control work*	*4*	*1-12*
28.	*Preparation for the exam*	*36*	*1-12*

Policy and control

7. Policy of academic discipline (educational component)

The system of requirements that the teacher sets for the student/graduate student is indicated:

- *rules of behavior in classes: activity and respect for those present.*
- *adherence to the policy of academic integrity.*
- *attending laboratory classes is mandatory;*
- *the student sends laboratory reports to the teacher, who gives him an assessment and assigns a grade based on the results of the defense;*
- *the defense of laboratory work involves answering the questions with illustrations on the relevant fragments of the report;*
- *incentive points are awarded on the condition of early submission of the work for defense for each week preceding the established deadline for the defense of the work;*
- *penalty points are accrued for providing work performed in full for each week that exceeds the established term of work protection;*
- *retaking of exams is carried out in accordance with the schedules drawn up by the dean's office;*
- *the academic integrity policy prohibits submission of laboratory reports not performed independently*

8. Types of control and rating system for evaluating learning outcomes (RSO)

Current control: express survey.
Calendar control: is carried out twice a semester as a monitoring of the current state of fulfillment of the syllabus requirements.
Semester control: exam.
Conditions for admission to semester control: enrollment of all laboratory work.
The rating based on the results of studying the discipline includes:

1. *Points for performance and defense of laboratory work (computer workshops).*

   During the semester, students perform 7 laboratory works (computer workshops).
   The maximum number of points for each laboratory work: 6 points.
   Points are awarded for:
   - *quality of laboratory work from 0 to 2 points;*
   - *answer during the defense of laboratory work from 0 to 2 points*
   - *timely submission of work for defense from 0 to 2 points*

   Total (maximum number of points) 6 points

   Criteria for evaluating the quality of laboratory work
   - *the work is done qualitatively, in full - 2 points;*
   - *the work is done qualitatively, in full, but has shortcomings - 1 point;*
   - *the work is completed in full, but contains minor errors - 0 points;*

Evaluation criteria for answers to questions:

- *the answer is complete, well-argued - 2 points;*
- *the answer is generally correct, but has shortcomings -1 point;*
- *the answer has minor errors - 0 points;*

Criteria for evaluating the timeliness of the submission of laboratory work to the defense:

- *the work is submitted for defense no later than the specified deadline - 2 points;*
- *work submitted for defense 1 week later than the specified deadline - 1 point;*
- *the work is submitted for defense more than 1 week later than the specified deadline – 0 points.*

The maximum number of points for the performance and defense of laboratory works (computer workshops):

6 points × 7 lab. works = 42 points

2. *The assignment for the modular test consists of 1 theoretical and 1 practical question. The answer to each question is evaluated by 4 points.*

   Evaluation criteria for each test question:

   - *the answer is correct, complete, well-argued - 4 points;*
   - *in general, the answer is correct, but it has shortcomings of 2-3 points;*
   - *there are significant errors in the answer 1 point;*
   - *there is no answer or the answer is incorrect 0 points -.*

   The maximum number of points for a modular control work:

   4 points × 2 questions = 8 points.

3. *Points for the answer on the exam*

   The examination ticket consists of 5 questions. The answer to each question is evaluated by 10 points.
   Evaluation criteria for each question of the examination paper:

   - *the answer is correct, complete, well-argued - 10 points;*
   - *the answer is correct, detailed, but not very well argued - 9 points;*
   - *in general, the answer is correct, but has shortcomings - 6-8 points;*
   - *there are minor errors in the answer - 4-5 points;*
   - *there are significant errors in the answer - 1-3 points;*
   - *no answer or the answer is incorrect - 0 points.*

   The maximum number of points for an answer on the exam:

   10 points × 5 questions = 50 points

4. *Calculation of the rating scale (R).*

   The semester component of the RS rating scale = 50 points, it is defined as the sum of points received for the performance and defense of laboratory work and the results of modular control.
   Examination component of the RE rating scale = 50 points.

   The rating scale for the discipline is equal to:

   R = РЛР + РМКР+ RE = 42 points + 8 points + 50 points = 100 points.

5. *Calendar control: conducted twice a semester as a monitoring of the current status of meeting the syllabus requirements.*

   At the first certification (8th week), the student receives "credited" if his current rating is at least 12 points (50% of the maximum number of points a student can receive before the first certification).

At the second certification (14th week), the student receives "passed" if his current rating is at least 24 points (50% of the maximum number of points a student can receive before the second certification).

6. *Conditions for admission to the exam and determining the grade*

A necessary condition for a student's admission to the exam is the completion and defense of all laboratory work and the student's semester rating (RS) of at least 60% of the RS, i.e. not less than 30 points. Otherwise, the student must do additional work and improve his rating.
The total rating of the RD student is defined as the sum of the semester rating of the RS student and the RE points received on the exam. The grade (ECTS and traditional) is assigned according to the RD value according to the table of correspondence of rating points to grades on the university scale

Table of correspondence of rating points to grades on the university scale:

Scores	*Rating*
100-95	*Perfectly*
94-85	*Very good*
84-75	*Fine*
74-65	*Satisfactorily*
64-60	*Enough*
Less than 60	*Unsatisfactorily*
Less than 25 or not completed (not protected) all laboratory work	*Not allowed*

9. Additional information on the discipline (educational component)

- *it is possible to enroll certificates of completion of remote or online courses on the relevant subject;*

Working program of the academic discipline (syllabus):

Compiled by V.I. Pavlovskyi, associate professor, candidate of technical sciences, associate professor

Adopted by Computer Systems Software Department (protocol № 12 from 26.04.23)

Approved by the Faculty Board of Methodology (protocol № 10 from 26.05.23)