National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Department of
Biomedical Engineering

# DESIGN OF MEDICAL INFORMATION SYSTEMS

## Working program of basic discipline (Syllabus)

| Requisites for basic discipline | |
|---|---|
| **Level of higher education** | ***First (bachelor's)*** |
| **Branch of knowledge** | *16 Chemical engineering and bioengineering* |
| **Specialty** | *163 Biomedical Engineering* |
| **Educational program** | *Medical Engineering* |
| **Discipline status** | *Elective discipline* |
| **Form of study** | *full-time* |
| **Year of preparation, semester** | *4th course, autumn semester* |
| **The scope of discipline** | *4 ECTS credits / 120 hours*<br>*(Lectures – 18 hours, Practical classes – 36 hours, Independent study – 66 hours)* |
| **Semester control / Control measures** | *Pass/fail test, term paper, modular test* |
| **Lessons schedule** | *https://schedule.kpi.ua/* |
| **Language of instruction** | *Ukrainian* |
| **Information about course leader / teachers** | *PhD in Engineering, Associate Professor, Associate Professor of the Department of Biomedical Engineering Oksana K. Biloshytska, e-mail: biloshytska.oksana@lll.kpi.ua* |
| **Course placement** | *Sikorsky Distance Learning Platform – Course: Design of Medical Information Systems (Course code: fa38og)* |

## Curriculum of the discipline

### 1. Course Description, Purpose, Subject Area, and Learning Outcomes

*The main objective of the academic discipline "Design of Medical Information Systems" is to develop in higher education students a systemic understanding of the principles of development, functioning, and evolution of medical information systems, as well as to acquire theoretical knowledge and practical skills in the analysis, design, standardization, and implementation of information systems in the healthcare sector, taking into account modern requirements of electronic health, medical standards, and the software life cycle.*

*The study of the discipline provides higher education students with:*

- *an understanding of the role of medical information systems in improving the efficiency of healthcare institution management and the quality of medical care;*
- *the ability to analyze business processes of medical organizations and formalize requirements for medical information systems;*
- *skills in designing the architecture and software of medical information systems in accordance with interoperability standards;*
- *preparation for professional activity in the field of development, implementation, and maintenance of medical information and telemedicine systems.*

*As a result of studying the academic discipline (educational component) "Design of Medical Information Systems", students should acquire the following* ***general competencies:***

*GC1. Ability for abstract thinking, analysis, and synthesis to solve complex engineering and interdisciplinary tasks.*

*GC2. Ability to apply knowledge of information technologies and software engineering in professional activities.*

*GC3. Ability to work in a team and communicate effectively with specialists from various fields, in particular healthcare professionals and IT specialists.*

*GC4. Ability for continuous learning and mastering modern technologies and standards in the field of biomedical engineering and electronic health.*

*After completing the academic discipline (educational component) "Design of Medical Information Systems", students should possess the following* ***special (professional) competencies****:*

*PC1. Ability to analyze and model the functioning processes of medical information systems taking into account the specifics of the medical field.*

*PC2. Ability to design the architecture and software of medical information systems in accordance with the requirements of standards and regulatory documents.*

*PC3. Ability to apply requirements analysis methods, business process modeling, and CASE technologies in the design of medical information systems.*

*PC4. Ability to use medical and information standards to ensure compatibility, security, and reliability of electronic medical data exchange.*

*The* ***program learning outcomes*** *resulting from the study of the academic discipline (educational component) "Design of Medical Information Systems" are:*

*PLO1. Explain the principles of construction, classification, and functional capabilities of medical information systems and electronic health systems.*

*PLO2. Analyze business processes of healthcare institutions, and formulate and document requirements for medical information systems.*

*PLO3. Design the architecture and core components of medical information systems using modern technologies and standards.*

*PLO4. Apply software life cycle methods, CASE tools, and software development technologies in the development and modernization of medical information systems.*

***Contribution to the Educational Program Competencies***

*This course also contributes to the development of competencies and learning outcomes defined in the educational program approved by Rector's Order No. NON/434/24 dated June 10, 2024.*

***Integral Competency:*** *The ability to solve complex, specialized problems and practical problems in biomedical engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the complexity and non-strict terms..*

***General Competencies***

*GC01 – Ability to apply knowledge in practical situations.*

*GC02 – Knowledge and understanding of the subject area and professional activity.*

*GC04 – Skills in using information and communication technologies.*

*GC06 – Ability to search for, process, and analyze information from various sources.*

*GC07 – Ability to generate new ideas (creativity).*

*GC08 – Ability to make reasoned decisions.*

***Professional Competencies***

*PC01 – Ability to apply engineering software packages for research, analysis, processing, and presentation of results, as well as for automated design of medical devices and systems.*

*PC03 – Ability to study and apply new methods and tools for analysis, modeling, design, and optimization of medical devices and systems.*

*PC11 – Ability to develop, plan, and conduct experiments using specified technical and biomedical techniques, applying mathematical methods in the analysis and modeling of the functioning of living organisms, systems, and processes in biology and medicine, computer processing, analysis, and synthesis*

*of the obtained results..*

***Program Learning Outcomes***

*PLO 05 - Be able to use databases, mathematical and software tools for data processing and computer modeling of biotechnical systems.*

*PLO 20 - Knowledge and application of research methods in biomedical engineering, methods and tools for organizing and processing experimental data, statistical methods for modeling and simulating processes and systems of physical and biological nature, modern programming technologies and supporting tools, methods for designing digital and microprocessor-based medical systems.*

***Teaching Methods***

*Lectures are conducted using explanatory-illustrative methods, problem-based teaching, and interactive methods aimed at establishing dialogue with students.*
*Practical classes employ:*

1. *Reproductive method for consolidating theoretical knowledge and applying it to practical tasks.*
2. *Partially exploratory (heuristic) method to develop problem-solving strategies.*
3. *Interactive method to engage students in solving tasks and discussing theoretical foundations.*
4. *Presentation and discussion of results using problem-based and interactive approaches.*
5. *Mathematical modeling during practical sessions.*

*Students independently study literature and software tools for analysis and forecasting of medical data. In some cases, coursework may evolve into research activities.*

## 2. Prerequisites and Course Position in the Curriculum

*The academic discipline "Design of Medical Information Systems" belongs to the cycle of elective educational components. Its study requires:*

*– **knowledge:** basic concepts of computer science and information technologies; fundamentals of programming and software engineering; principles of computer systems and networks architecture; fundamentals of databases and information modeling; general understanding of the healthcare system and the organization of medical institutions; elements of mathematical modeling and data analysis;*

*– **skills (abilities):** ability to analyze applied problems and formulate technical requirements; ability to use software tools for information processing; ability to read and interpret technical and regulatory documentation; ability to apply algorithmic thinking to solve engineering problems; ability to work with information resources and specialized software;*

*– **practical skills:** operation of a personal computer and standard software; basic use of programming languages or development environments; construction of simple data and process models; teamwork during the execution of educational and project-based tasks; independent study of educational and scientific-technical literature.*

## 3. Course Content

*Main sections and topics to be covered during the course:*

***Section 1. General principles of formation and development of medical information systems.***

*Topic 1.1. Basic concepts of medical information systems.*
*Topic 1.2. Classification of functions of medical information systems.*

***Section 2. Electronic health.***

*Topic 2.1. Structural elements of medical information systems.*
*Topic 2.2. Automated workplaces.*

*Topic 2.3. Standardization of electronic exchange of medical documents.*
*Topic 2.4. Telemedicine technologies.*

***Section 3. Management systems of medical organization activities***

*Topic 3.1. Decision support in medicine.*
*Topic 3.2. Intelligent information systems in medicine.*

***Section 4. General issues of the theory of information systems (IS) design.***

*Topic 4.1. Basic concepts of information systems design technology.*
*Topic 4.2. Software life cycle of information systems.*
*Topic 4.3. Organization of information systems design.*
*Topic 4.4. Information systems architecture.*
*Topic 4.5. Methodological aspects of software design.*
*Topic 4.6. Business process modeling and requirements specification in information systems design.*
*Topic 4.7. Software analysis and design.*
*Topic 4.8. Software development technologies.*
*Topic 4.9. Computer-aided information systems design based on CASE technologies.*
*Topic 4.10. Features of modern projects.*

***Section 5. General issues of the theory of medical information systems design***

*Topic 5.1. Business processes in medical institutions.*
*Topic 5.2. Interface standards in medical information systems.*
*Topic 5.3. Medical information standards.*

## 4. Training materials and resources

***Basic literature:***


1. *Білошицька, О. К. Проєктування медичних інформаційних систем. Практичні роботи [Електронний ресурс] : навч. посіб. для здобувачів першого (бакалаврського) рівня вищої освіти за освітньою програмою «Медична інженерія» спеціальності 163 «Біомедична інженерія» / О. К. Білошицька ; КПІ ім. Ігоря Сікорського. – Електронні текстові дані (1 файл: 3,9 Мбайт). – Київ : КПІ ім. Ігоря Сікорського, 2021. – 84 с. – Назва з екрана. Доступ: https://ela.kpi.ua/handle/123456789/47978*
2. *Проектування інформаційних систем: Загальні питання теорії проектування ІС. Конспект лекцій [Електронний ресурс]: навчальний посібник для студентів спеціальності 122 «Комп'ютерні науки» / КПІ ім. Ігоря Сікорського; уклад. О.С.Коваленко, Л. М. Добровська. – Київ: КПІ ім. Ігоря Сікорського, 2020. – 192 с. Доступ: https://ela.kpi.ua/handle/123456789/33651*
3. *Ізмайлова, О. В. Проектування інформаційних систем : навч. посібник : для студ. галузі знань 12 "Інформаційні технології" / О. В. Ізмайлова ; Київ. нац. ун-т буд-ва і архіт. - Київ : КНУБА, 2022. - 87 с. https://repositary.knuba.edu.ua/handle/123456789/11350*
4. *Проєктування інформаційних систем : конспект лекцій / укладачі : Малик І.В., Кириченко О.Л., Філіпчук О.І., Горбатенко М.Ю. Чернівці : Чернів. нац. ун-т ім. Ю.Федьковича, 2024. 176 с. https://archer.chnu.edu.ua/xmlui/handle/123456789/11571*
5. *Проектування інформаційної інфраструктури медичних та телемедичних систем / Г. В. Табунщик, Т.І. Каплієнко, О.А Петрова, О.В. Шитікова. Вид. ПП "Євро-Волинь", Житомир, – 2021. – 198 с. https://eir.zp.edu.ua/server/api/core/bitstreams/661729df-18ee-41da-874d-dbce0b7596c7/content*


***Additional literature:***

1. *Інформаційні технології в медицині. E-health / за ред. В. Г. Кнігавка. – Харків : ХНМУ, 2019. – 72 с. https://repo.knmu.edu.ua/server/api/core/bitstreams/0c686624-9356-49fb-a64d-d7d711311dfb/content*
2. *Проектування інформаційних систем: навчальний посібник / В.С. Авраменко, А.С. Авраменко. – Черкаси: Черкаський національний університет ім. Б. Хмельницького, 2017. – 434 с.: https://files.znu.edu.ua/files/Bibliobooks/Inshi72/0053479.pdf*
3. *Медична інформаційна система «Доктор Елекс»: основи роботи: Навчальний посібник / під. ред. І. Березовської, Ю. Триуса. – Львів: Ліга Прес, 2018. – 186 с https://er.chdtu.edu.ua/bitstream/ChSTU/3448/1/%D0%9F%D0%BE%D1%81%D1%96%D0%B1%D0%BD%D0%B8%D0%BA%20%D0%9C%D0%86%D0%A1%20%D0%94%D0%95%20%D0%BE%D1%81%D0%BD%D0%BE%D0%B2%D0%B8%20%D1%80%D0%BE%D0%B1%D0%BE%D1%82%D0%B8%20%D0%A2%D1%80%D0%B8%D1%83%D1%81%20%D0%AE%20%D0%92%202018.pdf*

**Educational content**

**5. Methods of mastering the discipline (educational component)**

| *No.* | *Lecture Title and Key Topics (teaching and learning methods, independent study tasks)* | *General, Professional Competencies and Program Learning Outcomes* |
|---|---|---|
| ***Lecture 1*** | ***Introduction to medical information systems.***<br>*Concept and purpose of medical information systems; the role of MIS in the healthcare system; classification of MIS functions; main directions of development of medical information systems.*<br><br>***Didactic tools:*** *multimedia presentation; structural schemes of MIS; examples of real systems.*<br>***Independent work:*** *study of basic MIS terminology; preparation of a short summary on the classification of medical information systems.* | *GC1, GC4; PC1; PLO1* |
| ***Lecture 2*** | ***Electronic healthcare system and structural elements of MIS.***<br>*Concept of electronic health; eHealth architecture; components of medical information systems; interaction of subsystems; the role of national and local MIS.*<br><br>***Didactic tools:*** *presentation; schematic models of eHealth; demonstration of information flows.*<br>***Independent work:*** *analysis of the structure of the national eHealth system; preparation of a scheme of interaction between MIS components.* | *GC1, GC2; PC1, PC4; PLO1, PLO3* |
| ***Lecture 3*** | ***Automated workplaces and telemedicine technologies.***<br>*Concept of automated workplaces in MIS; types of automated workplaces for medical personnel; telemedicine and its models; information flows in telemedicine systems.*<br><br>***Didactic tools:*** *presentation; examples of automated workplace interfaces; video demonstration of telemedicine services.*<br>***Independent work:*** *analysis of the functions of a physician's automated workplace; preparation of examples of telemedicine applications.* | *GC2, GC3; PC1, PC2; PLO1, PLO3* |
| ***Lecture 4*** | ***Fundamentals of information systems design. Software life cycle.*** | *GC1, GC4;* |

| No. | Lecture Title and Key Topics (teaching and learning methods, independent study tasks) | General, Professional Competencies and Program Learning Outcomes |
|---|---|---|
| | *Basic concepts of information systems design; stages of the software life cycle; life cycle models; organization of the design process.*<br><br>***Didactic tools:*** *presentation; software life cycle diagrams; examples of project documentation.*<br>***Independent work:*** *study of software life cycle models; preparation of a comparative table of models.* | *PC2;*<br>*PLO3, PLO4* |
| ***Lecture 5*** | ***Business process modeling in medical information systems: IDEF0 and BPMN.***<br>*Concept of a business process; IDEF0 methodology; BPMN standard; use of models in MIS design.*<br><br>***Didactic tools:*** *presentation; examples of IDEF0 and BPMN diagrams; demonstration of CASE tools.*<br>***Independent work:*** *development of a simple business process model of a medical institution; analysis of diagram examples.* | *GC1, GC2;*<br>*PC3;*<br>*PLO2, PLO4* |
| ***Lecture 6*** | ***CASE technologies and DFD diagrams in MIS design.***<br>*Concept of CASE technologies; data flow diagrams (DFD); application of CASE tools in medical information systems; requirements specification.*<br><br>***Didactic tools:*** *presentation; examples of DFD diagrams; demonstration of a CASE environment.*<br>***Independent work:*** *analysis of DFD diagrams; preparation of a description of MIS information flows.* | *GC2;*<br>*PC2, PC3;*<br>*PLO2, PLO4* |
| ***Lecture 7*** | ***Architecture of medical information systems. Cloud technologies and information security.***<br>*Architectural approaches to MIS; use of cloud technologies; information security threats; principles of medical data protection.*<br><br>***Didactic tools:*** *presentation; architectural diagrams; examples of information security solutions.*<br>***Independent work:*** *analysis of advantages and risks of cloud-based MIS; study of fundamentals of medical data protection.* | *GC2, GC4;*<br>*PC2, PC4;*<br>*PLO3* |
| ***Lecture 8*** | ***Intelligent information systems and artificial intelligence in medicine.***<br>*Concept of intelligent information systems; application of artificial intelligence in medicine; machine learning in MIS; limitations and ethical aspects.*<br><br>***Didactic tools:*** *presentation; examples of medical AI systems; video demonstrations.*<br>***Independent work:*** *analysis of examples of AI applications in medicine; preparation of a short review.* | *GC1, GC4;*<br>*PC1;*<br>*PLO1* |
| ***Lecture 9*** | ***Expert systems, UML diagrams, and MIS project management.***<br>*Expert systems and decision support systems; UML diagrams in software* | *GC3, GC4;*<br>*PC2, PC3;* |

| No. | Lecture Title and Key Topics (teaching and learning methods, independent study tasks) | General, Professional Competencies and Program Learning Outcomes |
|---|---|---|
| | *design; Gantt chart; features of modern IT projects in medicine.*<br><br>***Didactic tools:*** *presentation; examples of UML and Gantt diagrams; project case studies.*<br>***Independent work:*** *analysis of UML diagrams; familiarization with project planning tools.* | *PLO3, PLO4* |

| No. | Title of the class and list of key issues (teaching aids, independent study tasks) | GC, PC and PLO according to the Educational Program |
|---|---|---|
| ***Practical class 1*** | ***Practical work No. 1. Familiarization with the functionality of medical information systems.***<br><br>***Key issues:*** *analysis of the MIS interface; main modules and functions; information flows.*<br>***Teaching aids:*** *MIS demonstration; training user accounts; instructional materials.*<br>***Independent study:*** *analysis of the functionality of a selected MIS; preparation of a short description of its modules.* | *GC1, GC2; PC1; PLO1* |
| ***Practical class 2*** | ***Defense of Practical work No. 1.***<br><br>***Key issues:*** *presentation of MIS analysis results; discussion of functional capabilities.*<br>***Teaching aids:*** *oral assessment; presentation materials.*<br>***Independent study:*** *revision of the report based on defense feedback.* | *GC3; PC1; PLO1* |
| ***Practical class 3*** | ***Practical work No. 2. Development of a medical document model using the IDEF0 notation.***<br><br>***Key issues:*** *fundamentals of functional modeling; construction of context and decomposition diagrams.*<br>***Teaching aids:*** *CASE tools; examples of IDEF0 diagrams; methodological guidelines.*<br>***Independent study:*** *development of an IDEF0 model of a medical document.* | *GC1, GC2; PC3; PLO2, PLO4* |
| ***Practical class 4*** | ***Defense of Practical work No. 2.***<br><br>***Key issues:*** *analysis of the correctness of IDEF0 diagrams; justification of design decisions.*<br>***Teaching aids:*** *discussion; diagram demonstration.*<br>***Independent study:*** *refinement of the model based on defense results.* | *GC3; PC3; PLO2* |
| ***Practical class 5*** | ***Practical work No. 3. Data flow modeling (DFD).*** | *GC1, GC2; PC2, PC3; PLO2* |

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|---|---|---|
| | ***Key issues:*** *identification of data sources and sinks; construction of context and detailed DFD diagrams.*<br>***Teaching aids:*** *CASE tools; DFD examples; training templates.*<br>***Independent study:*** *development of a DFD for a selected MIS process.* | |
| ***Practical class 6*** | ***Defense of Practical work No. 3.***<br><br>***Key issues:*** *evaluation of completeness and logical consistency of data flows.*<br>***Teaching aids:*** *oral defense; diagram analysis.*<br>***Independent study:*** *refinement of the DFD diagram.* | *GC3; PC2; PLO2* |
| ***Practical class 7*** | ***Practical work No. 4. Workflow diagram using BPMN notation****.*<br><br>***Key issues:*** *BPMN elements; modeling of clinical and administrative processes.*<br>***Teaching aids:*** *BPMN editors; diagram examples; methodological recommendations.*<br>***Independent study:*** *development of a BPMN diagram of a medical process.* | *GC1, GC2; PC3; PLO2, PLO4* |
| ***Practical class 8*** | ***Defense of Practical work No. 4.***<br><br>***Key issues:*** *analysis of BPMN model compliance with the real process.*<br>***Teaching aids:*** *presentation of results; discussion.*<br>***Independent study:*** *refinement of the BPMN diagram.* | *GC3; PC3; PLO2* |
| ***Practical class 9*** | ***Practical work No. 5. UML diagrams in MIS design.***<br><br>***Key issues:*** *Use Case, Class, and Sequence diagrams; relationship between UML and system requirements.*<br>***Teaching aids:*** *UML editors; model examples.*<br>***Independent study:*** *development of UML diagrams for an MIS.* | *GC1, GC2; PC2; PLO3* |
| ***Practical class 10*** | ***Defense of Practical work No. 5.***<br><br>***Key issues:*** *analysis of UML diagram completeness; compliance with requirements.*<br>***Teaching aids:*** *oral defense; model demonstration.*<br>***Independent study:*** *refinement of UML diagrams.* | *GC3; PC2; PLO3* |
| ***Practical class 11*** | ***Practical work No. 6. Gantt chart in business process modeling.***<br><br>***Key issues:*** *MIS project planning; resources and timelines; life cycle stages.*<br>***Teaching aids:*** *project planning software; diagram templates.*<br>***Independent study:*** *development of a Gantt chart for an MIS project.* | *GC2; PC2; PLO4* |
| ***Practical class 12*** | ***Defense of Practical work No. 6.***<br><br>***Key issues:*** *evaluation of planning logic and timeline realism.*<br>***Teaching aids:*** *discussion; diagram analysis.*<br>***Independent study:*** *refinement of the project plan.* | *GC3; PC2; PLO4* |
| ***Practical class 13*** | ***Practical work No. 7. Mind maps for information structuring.***<br><br>***Key issues:*** *development of mind maps; structuring MIS requirements and functions.* | *GC1, GC4; PC1; PLO1* |

| | | |
|---|---|---|
| | ***Teaching aids:*** *mind mapping software; examples.*<br>***Independent study:*** *creation of a mind map for an MIS.* | |
| ***Practical class 14*** | ***Defense of Practical work No. 7.***<br><br>***Key issues:*** *analysis of logical structure and completeness of the mind map.*<br>***Teaching aids:*** *presentation of results.*<br>***Independent study:*** *refinement of the mind map.* | *GC3; PC1; PLO1* |
| ***Practical class 15*** | ***Submission of the report.***<br>***Practical work No. 8. Agile systems in business processes.***<br><br>***Key issues:*** *Agile fundamentals; Scrum and Kanban; application in MIS projects.*<br>***Teaching aids:*** *presentation; Agile board examples; software tools.*<br>***Independent study:*** *analysis of Agile applicability in MIS.* | *GC2, GC4; PC2; PLO4* |
| ***Practical class 16*** | ***Defense of Practical work No. 8.***<br><br>***Key issues:*** *discussion of advantages and limitations of Agile in healthcare.*<br>***Teaching aids:*** *discussion; presentations.*<br>***Independent study:*** *preparation of generalized conclusions.* | *GC3; PC2; PLO4* |
| ***Practical class 17*** | ***Modular Control Work.***<br><br>***Key issues:*** *assessment of knowledge and practical skills in MIS modeling and design.*<br>***Teaching aids:*** *test and practical tasks.* | *GC1; PC1–PC3; PLO1–PLO4* |
| ***Practical class 18*** | ***Generalization and systematization of course material.***<br><br>***Key issues:*** *analysis of completed works; knowledge integration; preparation for final assessment.*<br>***Teaching aids:*** *discussion; summary diagrams.*<br>***Independent study:*** *revision of course materials.* | *GC1–GC4; PC1–PC4; PLO1–PLO4* |

## 6. Student Independent Study

*Preparation for classroom activities – 45 hours*
*Preparation for the modular control test – 4 hours*
*Completion of the individual semester assignment – 11 hours*
*Preparation for the pass/fail test – 6 hours*

***Types of Student Activities and Estimated Time Allocation***

| ***Type of student activity*** | ***Estimated time (hours)*** |
|---|---|
| *Preparation for 1 hour of lectures* | *0.5* |
| *Preparation for 1 hour of practical classes* | *1.0* |
| *Preparation for the modular control test* | *4* |
| *Preparation for the pass/fail test* | *6* |
| *Individual semester assignment (term paper / report)* | *11* |

*One of the main forms of semester assessment during the study of the course **"Design of Medical Information Systems"** is the preparation of a **term paper (report)**. The term paper is completed during*

*the semester, formatted according to the established requirements, and submitted for assessment during the **15th practical class**.*

*A term paper is a **scientific and technical document** that contains comprehensive and systematized information on a selected topic. It involves the presentation of material based on specially selected literature and independently conducted research. A student may prepare a term paper **only on a topic approved by the instructor**.*

***General requirements for the term paper:***

- *clarity and logical consistency of the presentation;*
- *persuasiveness of arguments;*
- *conciseness and precision of formulations that exclude ambiguous interpretation;*
- *specificity in presenting research results;*
- *justification of recommendations and proposals.*

***The term paper must address:***

- *the relevance of the topic and its correspondence to the current state of science, technology, and production-related issues;*
- *justification of the chosen research direction and problem-solving methods, including their comparative evaluation;*
- *analysis and generalization of existing research results;*
- *development of a general research methodology;*
- *the nature and content of performed theoretical studies and calculations, research methods applied;*
- *justification of the need for experimental studies, principles of operation of developed software tools, their characteristics, evaluation of calculation errors, and obtained experimental data;*
- *assessment of the completeness of solving the stated problem;*
- *evaluation of the reliability of obtained results and their comparison with analogous results;*
- *scientific and practical value of the completed work.*

***Structure of the term paper:***

*title page; table of contents; list of symbols, abbreviations, and terms (if necessary); introduction; main body; conclusions; list of references; appendices (if necessary).*

***Approximate list of term paper topics:***

1. *Medical information systems in the structure of the modern healthcare system.*
2. *Classification and functional capabilities of medical information systems.*
3. *Electronic health (eHealth): concept, architecture, and development prospects.*
4. *Structural components of medical information systems and their interaction.*
5. *Automated workplaces of medical personnel: functions and requirements.*
6. *Telemedicine technologies and their role in ensuring accessibility of medical care.*
7. *Software life cycle of medical information systems.*
8. *Architectural approaches to the design of medical information systems.*
9. *Modeling of business processes of medical institutions in the design of medical information systems.*
10. *IDEF0 methodology in functional modeling of medical processes.*
11. *BPMN notation as a tool for modeling clinical and administrative processes.*
12. *CASE technologies in the design of medical information systems.*
13. *UML diagrams in the analysis and design of medical information systems software.*
14. *Cloud technologies in healthcare: advantages, risks, and limitations.*
15. *Protection of medical information in medical information systems.*
16. *Intelligent information systems and artificial intelligence in medicine.*
17. *Expert systems and decision support systems in medicine.*
18. *Project management of medical information systems: traditional and Agile approaches.*
19. *Application of the Gantt chart in planning projects of medical information systems.*
20. *The role of medical information standards in ensuring interoperability of medical information*

*systems.*

***Title page requirements:***

*The title page of the term paper must include: the name of the university; the name of the faculty; the name of the department; the name of the specialty; the name of the educational program; the name of the course; the title of the term paper; the student's first and last name; year of study; academic group number; and the year of completion.*

*Following the title page, a list of abbreviations (if necessary) and a detailed table of contents must be provided. The table of contents should clearly identify the introduction, sections of the main body (main topics to be considered), subsections (if necessary), conclusions, and the list of references. Page numbers indicating the beginning of each section must be aligned on the right. Each section must begin on a new page.*

*The total length of the term paper, depending on the selected topic, may range from **25 to 40 pages of the main text** (subject to agreement with the instructor). The length is determined by the student's ability to concisely and comprehensively explain and analyze the obtained information.*

***Mandatory requirements:***

*All sources of information must be clearly referenced. All numerical data, facts, scientific opinions, quotations, and formulas must include references in the form **[2]**, where the number corresponds to the source in the reference list at the end of the paper. Tables, schemes, graphs, diagrams, and other visual materials must be used.*

*The list of references must contain **at least 10 sources** and be formatted according to the **APA citation style**. All sources must have been published within the **last 5 years**. Preference is given to **foreign (international) sources**. If information is obtained from the Internet, the author, title of the article, and the website address must be indicated, as for printed sources.*

***Assessment criteria:***

*The term paper is evaluated based on the following criteria: logical structure of the outline; completeness and depth of topic coverage; reliability of obtained data; inclusion of practical materials; correctness of conclusions and final results; quality of formatting; justification of the student's own viewpoint in the conclusions.*

***Submission deadline:***

*The final deadline for submitting the term paper for assessment is the **15th practical class**.*

*The term paper is **not checked for plagiarism**, but it must comply with the principles of **academic integrity**. In cases of academic misconduct, the paper is annulled and not assessed.*

## Policy and Assessment

### 7. Course Policy (Educational Component)

***Attendance***

*Attendance at **practical classes is mandatory**, as these classes include short in-class assessments / test tasks, as well as the completion and defense of practical works. A student is required to be present for the **entire duration of the class**, from the beginning to the end, and to actively participate in the learning process.*

*Attendance at **lectures is not mandatory**.*

*In case of justified absence (illness, official circumstances), the student must inform the instructor in advance or as soon as possible and **make up for the missed class** in accordance with the established procedure.*

***Rules of Conduct During Classes***

*Students are required to adhere to the principles of **academic ethics** and mutual respect toward the instructor and other students.*

*Active participation is encouraged during classes, including answering questions, participating in discussions, and completing learning tasks.*

*If necessary, students may prepare short oral or written presentations, reports, or analytical texts related to the course topics.*

*Mobile phones and other personal communication devices must be switched off or set to silent mode.*

*The use of laptops, tablets, and mobile devices is permitted **exclusively for educational purposes**, such as completing practical tasks, searching for materials on relevant educational platforms, in open-access sources, or working with educational datasets.*

***Missed Assessment Activities***

*Missed assessment activities (defense of practical works) must be completed during subsequent classes, provided that the task planned for the current class has been completed, or during scheduled consultations.*

*Missing the **modular control test** or short in-class assessments / test tasks is **not permitted**. A term paper submitted **after the established deadline** is **not assessed**.*

***Rules for the Defense of Practical Works***

*A practical work is considered completed provided that the results are submitted on time and **successfully defended orally**.*

*The defense of a practical work includes: explanation of problem-solving methods; interpretation of obtained results; and answering the instructor's questions.*

*Works completed in violation of the principles of **academic integrity** (plagiarism, copying, use of others' results without proper referencing) are **not admitted for defense and are not assessed**.*

***Deadline and Retake Policy***

*All types of academic work (practical works, term paper, modular control test) must be completed within the deadlines specified in the syllabus.*

*Late submission of assignments without a valid reason may result in **refusal to assess the work**.*

*In the presence of justified reasons, a student has the right to **individually agree on a new submission deadline** with the instructor.*

*Retaking assessment activities is carried out in accordance with the regulations, orders, and instructions of **Igor Sikorsky Kyiv Polytechnic Institute**.*

***Bonus Points***

*Bonus points may be awarded for creative academic activities related to the course (e.g., participation in academic competitions, conferences, scientific contests, preparation of reviews of scientific works or publications, etc.). These bonus points **do not form part of the standard grading scale**.*

*The total number of bonus points **may not exceed 10 points**, and the overall student rating **may not exceed 100 points**.*

***Academic Integrity***

*The policy and principles of academic integrity are defined in **Section 3 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"**. More details are available at: https://kpi.ua/code*

***Ethical Standards of Conduct***

*The standards of ethical conduct for students and staff are defined in **Section 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"**. More details are available at: https://kpi.ua/code*

***Procedure for Appealing Assessment Results***

*Students have the right to raise any issues related to assessment procedures and may expect them to be reviewed in accordance with predefined procedures.*

*A student has the right to appeal the results of an assessment activity in accordance with the approved **Regulation on Appeals at Igor Sikorsky Kyiv Polytechnic Institute** (approved by Order No. NON/128/2021 dated May 20, 2021): https://osvita.kpi.ua/index.php/node/182*

***Inclusive Education***

*The course **"Design of Medical Information Systems"** may be delivered to most students with special educational needs, except for students with severe visual impairments that prevent them from performing tasks using personal computers, laptops, and/or other technical devices.*

***Distance Learning***

*Distance learning is conducted via the **"Sikorsky" Distance Learning Platform**.*

*Distance learning through additional online courses on specific topics is allowed subject to agreement with students. If only a small number of students express a desire to complete an online course on a particular topic, studying the material through such courses is permitted; however, students must complete **all assignments предусмотрені by the course syllabus**.*

*The list of available courses is proposed by the instructor after students express their interest, as the pool of available courses is updated almost monthly.*

*The student must provide a document confirming completion of the online course (in case of completing the full course) or submit completed practical tasks from the online course. Upon successful completion of an oral interview with the instructor on the studied topics, the student may receive grades for the assessment activities предусмотрені for the relevant topics (short assessments / test tasks, practical works).*

*Practical works and the term paper are completed during students' **independent study in a distance-learning format**, with the possibility of consultations with the instructor via email or social networks.*

***Instruction in a Foreign Language***

*Instruction in English is provided **only for international students**.*

*At the request of students, studying course materials through English-language online courses corresponding to the topics of specific classes is permitted.*

## 8. Types of Assessment and the Rating-Based Grading System (RGS)

*The assessment system is focused on awarding points for student engagement and for completing tasks aimed at developing practical skills and competencies.*

***Assessment System (Continuous Assessment)***

| No. | Assessment component | % | Weight (points) | Quantity | Total |
|---|---|---|---|---|---|
| 1 | Short in-class assessments / test tasks | 18 | 2 | 9 | 18 |
| 2 | Completion and defense of practical works | 56 | 7 | 8 | 56 |
| 3 | Modular control test | 12 | 12 | 1 | 12 |
| 4 | Term paper (report) | 14 | 14 | 1 | 14 |
| 5 | Pass/Fail assessment work[1] | 86 | 86 | 1 | 86 |

| | | | | | |
|---|---|---|---|---|---|
| | ***Total*** | ***100*** | | | ***100*** |

*[1] The result is counted toward the overall rating together with the term paper grade if the student has earned fewer than 60 points during the semester or wishes to improve the final grade.*

*Failure to complete a continuous assessment activity **in synchronous mode without a valid reason** is graded **0 points**.*

***Rules for Assessing the Completion and Defense of Practical Works***

- *Each practical work is graded on a **7-point rating scale**.*
- *The **maximum score** for one practical work is **7 points**.*
- *The **minimum passing threshold** is **at least 60%** of the maximum score, which corresponds to **5 points**.*
- *A result below the threshold (**less than 5 points**) is considered **unsatisfactory** and is graded **0 points**.*

***Criteria for Assessing a Practical Work***

| ***Criterion*** | ***Maximum points*** |
|---|---|
| *Correctness of calculations and modeling* | *3* |
| *Justification of selected methods and models* | *2* |
| *Analysis and interpretation of results* | *1* |
| *Oral defense and answers to questions* | *1* |
| ***Total*** | ***7*** |

***Conditions for Passing a Practical Work***

- *A practical work is considered passed if the student scores **5–7 points**.*
- *If **0 points** are awarded, the work **cannot be revised or re-defended** during the academic debt remediation period.*
- *Works completed in violation of **academic integrity principles** are **not accepted** and are graded **0 points**.*

***Rules for Assessing the Term Paper***

- *The term paper is graded on a **14-point rating scale**.*
- *The **maximum score** for the term paper is **14 points**.*
- *The **minimum passing threshold** is **at least 60%**, which corresponds to **9 points**.*
- *A term paper graded **below 9 points** is considered **not passed** and is graded **0 points**.*

***Criteria for Assessing the Term Paper***

| ***Criterion*** | ***Maximum points*** |
|---|---|
| *Relevance to the topic and completeness of coverage* | *4* |
| *Correct application of mathematical models and methods* | *4* |
| *Independence of analysis and soundness of conclusions* | *5* |
| *Quality of formatting and compliance with academic integrity* | *1* |
| ***Total*** | ***14*** |

***Conditions for Passing the Term Paper***

- *A term paper is considered passed if the student scores **9–14 points**.*
- *If **0 points** are awarded, the student must **revise the paper and resubmit it** before the start of the academic debt remediation period.*
- *Detection of plagiarism or other violations of **academic integrity** results in a grade of **0 points**.*

***Pass/Fail Assessment and Application of the Rating System***

*Students who have met all eligibility requirements for the pass/fail assessment and have accumulated **60 or more points** receive the corresponding rating grade **without completing an additional semester assessment**.*

*For students who have met all eligibility requirements but have a rating score **below 60 points**, as well as for those who wish to **improve their rating**, the instructor conducts a semester assessment during the examination week in the form of a **pass/fail test or an oral interview**.*

*After completing the pass/fail assessment:*

- *if the score obtained in the pass/fail assessment is **higher** than the accumulated rating, the student receives the **pass/fail assessment score**;*
- *if the score obtained is **lower** than the accumulated rating, a **"strict" Rating-Based Grading System** is applied: the student's previous rating (excluding points for the individual semester assignment) is annulled, and the final grade is determined **solely based on the pass/fail assessment result**.*

*This approach fosters a **responsible attitude** toward the decision to undertake the pass/fail assessment, encourages students to **critically evaluate their level of preparedness**, and motivates thorough preparation for the final assessment.*

***Calendar Control (CC)***

*Calendar Control (CC) is conducted **twice per semester** as a monitoring tool to assess the current status of compliance with the syllabus requirements.*

*The purpose of Calendar Control is to **improve the quality of student learning** and to **monitor students' adherence to the academic schedule**.*

***Calendar Control Criteria***

| Criterion | First CC | Second CC |
|---|---|---|
| **Timing of calendar control** | Week 7 | Week 13 |
| **Conditions for obtaining a positive result** | | |
| Current rating | ≥ 13 points | ≥ 31 points |
| Completion of practical works: PW No. 1–3 | + | + |
| Completion of practical works: PW No. 4–7 | – | + |
| Short in-class assessments / test tasks: minimum for any 2 lectures | + | – |
| Short in-class assessments / test tasks: minimum for any 6 lectures | – | + |
| Modular control test (graded) | – | – |
| Term paper (graded) | – | – |

*In case of detection of **academic misconduct** during the learning process, the corresponding assessment activity **is not credited**.*

***Semester Assessment: Pass/Fail Test***

***Eligibility Requirements for Semester Assessment***

*Admission to the semester assessment (pass/fail test) requires **no outstanding academic debts** in practical works and the individual semester assignment (term paper), as well as **completion of the modular control test**.*

***Mandatory Eligibility Requirements***

| No. | Requirement | Criterion |
|---|---|---|
| 1 | Current rating | RD ≥ 40 |
| 2 | Positive grade for the term paper | More than 9 points |
| 3 | All practical works completed and defended | More than 40 points |
| 4 | Modular control test completed | More than 7 points |

***Optional Eligibility Requirements***

1. *Positive results in the **first and second Calendar Controls**.*
2. *Attendance of lecture classes.*

***Conversion of Rating Points to Grades (University Grading Scale)***

| Number of points | University grade |
|---|---|
| 95–100 | Excellent |
| 85–94 | Very good |
| 75–84 | Good |
| 65–74 | Satisfactory |
| 60–64 | Pass |
| Less than 60 | Fail |

## 9. Additional Course Information (Educational Component)

*The list of questions for preparation for the **modular control test** as well as for preparation for the **pass/fail assessment** is provided in **Appendix 1**.*

*Distance learning through the completion of additional **online courses** on specific topics is permitted subject to agreement with students. In cases where only a limited number of students express a desire to complete an online course on a particular topic, studying the material through such courses is allowed; however, students are required to complete **all assignments by the course syllabus**.*

*The list of recommended courses is proposed by the instructor after students express their interest, as the pool of available courses is updated almost monthly.*

*The student must provide a document confirming completion of the distance course (in the case of completing the full course) or submit completed practical assignments from the distance course. Upon successful completion of an **oral interview with the instructor** on the studied topics, the student may receive grades for the assessment activities provided for the relevant topics (short in-class assessments / test tasks, practical works).*

*In the event of the introduction of an **asynchronous learning mode**, the deadlines for completing assessment activities may be adjusted.*

***Course Syllabus***

*The course syllabus was prepared by Associate Professor of the Department of Biomedical Engineering, PhD in Engineering, Associate Professor Oksana Biloshytska*

***Approved by** the Department of Biomedical Engineering (protocol № 16 of June 21, 2024)*

***Approved by** the Methodical Commission of the Faculty of Biomedical Engineering (protocol № 9 of June 26, 2024)*

## *List of Questions for Preparation for the Modular Control Test*

*and for the Pass/Fail Assessment*

1. *Characterize the general requirements imposed on all medical information systems (MIS) in Ukraine.*
2. *Characterize the general capabilities of medical information systems.*
3. *Which modules (automated workplaces, AWP) does each MIS consist of, and what is their purpose?*
4. *Which technologies are used for the operation of MIS (cloud technologies, artificial intelligence, internal telecommunication networks of healthcare institutions, combinations thereof, etc.)?*
5. *Identify the available functions of the electronic registry.*
6. *Describe the appointment scheduling capabilities via the MIS website.*
7. *Describe the appointment scheduling capabilities via a mobile application.*
8. *Describe other possible ways for patient appointment scheduling, such as self-service terminals, call centers, etc.*
9. *Describe and characterize the available functions for working with electronic medical records in MIS.*
10. *Characterize the process of completing and signing a patient declaration with a physician.*
11. *Describe the process of issuing electronic referrals and prescriptions.*
12. *Characterize the inpatient department module. What functions are available in the inpatient MIS?*
13. *Provide a comparative description of the modules used by diagnostic services (radiology, ultrasound, functional diagnostics) and laboratories.*
14. *What key functions of diagnostic services should be considered when selecting an MIS?*
15. *Specify which technologies and standards are used in the operation of diagnostic service modules (DICOM, HL7, etc.).*
16. *Characterize the possibilities of using MIS in telemedicine consultations. What functions are available?*
17. *Characterize the administrative module of MIS. What functions does it include?*
18. *What additional functions are available in MIS?*
19. *Describe the application of information technologies in the healthcare sector of Ukraine.*
20. *Present the advantages and disadvantages of using MIS in Ukraine (in general).*
21. *What general requirements exist for the functioning of MIS in healthcare institutions?*
22. *What requirements exist for the structure and functioning of MIS?*
23. *What key medical documents can be generated using a specific MIS?*
24. *What is the essence of the system approach to software design? Name two principles that allow assessing the mutual influence of system components on each other.*
25. *Define the concept of an information system (IS) and its components. Name the main properties of IS and the types of IS support.*
26. *What is the purpose of software design?*
27. *Identify the main criteria for the classification of information systems (types of IS).*
28. *Identify the features and challenges of modern large-scale software system projects. What are the causes of project failures, and what are possible solutions?*
29. *What is the software life cycle?*
30. *What regulates the software life cycle?*
31. *Name the groups of processes included in the software life cycle. Which processes belong to each group? Which processes, in your opinion, are most frequently used in real projects, which are used less often, and why?*

32. *Which stages are included in the software development process?*
33. *What is the relationship between stages and processes of the software life cycle?*
34. *Identify: 1) the stages and phases of the information system design process based on the waterfall model; 2) the fundamental characteristics of the waterfall model. What are the advantages and disadvantages of the waterfall model?*
35. *What are the fundamental characteristics of the iterative model? What are its advantages and disadvantages?*
36. *How can an increase in the maturity level of software development processes be achieved?*
37. *What role do requirements management and software configuration management processes play in increasing the maturity level?*
38. *Name the components of the technical specification for an information system.*
39. *Explain the essence of the concept of "typical design" and name the methods of typical design. Identify the main requirements imposed on the selected typical design of an information system. Name the criteria used to classify information system design methods.*
40. *Identify the types of computer-aided design tools.*
41. *Identify the requirements imposed on domain models.*
42. *Name the main methodologies of modern information system design.*
43. *What does "rapid software development" mean?*
44. *Define the concept of "software development technology" and characterize the system of concepts that describe it. Which concepts are the most important? Identify the capabilities of software development technologies.*
45. *What requirements are imposed on modern software development technologies, and which are the most important, and why?*
46. *Characterize the principles and scope of application of the Rational Unified Process (RUP) methodology.*

## *Program Learning Outcomes (Extended Form)*

*As a result of studying the course **"Design of Medical Information Systems"**, students will be able to achieve the following learning outcomes:*

| ***Learning outcomes*** | | ***Alignment of learning outcomes with competencies according to the Educational Program*** | |
|---|---|---|---|
| | | ***General competencies (soft skills)*** | ***Professional (specialized) competencies*** |
| ***PLO1*** | *Explain the principles of development, classification, and functional capabilities of medical information systems and electronic health systems.* | ***GC1** – Ability for abstract thinking, analysis, and synthesis; **GC4** – Ability for continuous learning and mastering modern technologies and standards.* | ***PC1** – Ability to analyze and model the functioning processes of medical information systems taking into account the specifics of the medical field.* |
| ***PLO2*** | *Analyze business processes of medical institutions, and formulate and document requirements for medical information systems.* | ***GC1** – Ability for abstract thinking, analysis, and synthesis; **GC3** – Ability to work in a team and communicate effectively with specialists from various fields.* | ***PC3** – Ability to apply requirements analysis methods, business process modeling, and CASE technologies in the design of medical information systems.* |
| ***PLO3*** | *Design the architecture and core components of medical information systems using modern technologies and standards.* | ***GC2** – Ability to apply knowledge of information technologies and software engineering in professional activities; **GC3** – Ability to work in a team and communicate effectively with specialists from various fields.* | ***PC2** – Ability to design the architecture and software of medical information systems in accordance with standards and regulatory requirements.* |
| ***PLO4*** | *Apply software life cycle methods, CASE tools, and software development technologies in the development and modernization of medical information systems.* | ***GC2** – Ability to apply knowledge of information technologies and software engineering; **GC4** – Ability for continuous learning and mastering modern technologies and standards.* | ***PC3** – Ability to apply requirements analysis methods and CASE technologies; **PC4** – Ability to use medical and information standards to ensure compatibility, security, and reliability of electronic medical data exchange.* |