**МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ**
**ХАРКІВСЬКИЙ НАЦІОНАЛЬНИЙ ЕКОНОМІЧНИЙ УНІВЕРСИТЕТ**
**ІМЕНІ СЕМЕНА КУЗНЕЦЯ**

**ЗАТВЕРДЖЕНО**
на засіданні кафедри
обліку і бізнес-консалтингу
Протокол № 6 від 20.12.2024 р.

**ПОГОДЖЕНО**
Проректор з навчально-методичної роботи
Каріна НЕМАШКАЛО

# СИСТЕМИ ТА СИСТЕМНЕ МИСЛЕННЯ
**робоча програма навчальної дисципліни (РПНД)**

| | |
|---|---|
| Галузь знань | **Всі** |
| Спеціальність | **Всі** |
| Освітній рівень | **Третій (освітньо-науковий)** |
| Освітня програма | **Всі** |

| | |
|---|---|
| Статус дисципліни | **вибіркова** |
| Мова викладання, навчання та оцінювання | **англійська** |

Розробник:
д.е.н., проф. Андрій ПИЛИПЕНКО

Завідувач кафедри
обліку і бізнес-консалтингу Андрій ПИЛИПЕНКО

**Харків**
**2025**

**MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE**
**SIMON KUZNETS KHARKIV NATIONAL UNIVERSITY OF ECONOMICS**

**APPROVED**
at the meeting of accounting and business consulting department
Protocol № 6 of 20.12. 2024

**AGREED**
Vice-rector for educational and methodological work
Karina NEMASHKALO

# SYSTEMS AND SYSTEMS THINKING
**Program of the course**

| | |
|---|---|
| Field of knowledge | **All** |
| Specialty | **All** |
| Study cycle | **Third (educational and research)** |
| Study programme | **All** |

| | |
|---|---|
| Course status | **elective** |
| Language | **English** |

Developer:
DSc (Economy), prof. Andriy PYLYPENKO

Head of Accounting and Business-Consulting department Andriy PYLYPENKO

**Kharkiv**
**2025**

# INTRODUCTION

Preparing a dissertation requires a PhD candidate to demonstrate self-determination, achieve self-realization, and, most importantly, generate novel ideas to address complex problems within their chosen field of research. As a result, doctoral students at the third (educational and research) level must develop the ability to perceive issues holistically, recognize interconnected scenarios driven by intricate cause-and-effect relationships, and identify key components of a given problem. This necessitates the ability to maintain cognitive focus on both analytical and synthetic processes when examining complex phenomena. The integration of analysis and synthesis is essential for producing research outcomes that demonstrate scientific novelty and hold theoretical, methodological, and practical significance in socio-economic contexts. Achieving this integration requires adopting a systems approach, which, in turn, demands a shift in the researcher's cognitive framework. Furthermore, doctoral education entails an understanding of paradigm shifts, requiring a systemic perspective and the ability to analyze and transform underlying paradigmatic structures.

Systems are an inherent part of human existence, and modern scientific inquiry can no longer rely solely on the traditional view of systems as mere interactions among their subsystems that give rise to emergent and synergistic properties. Ph.D. candidates must be proficient in advanced methodologies and tools for studying complex systems, particularly those defined by international standards such as ISO 42010, ISO 15288, and ISO 15926, as well as the Systems Engineering Body of Knowledge (SEBoK). Collectively, these frameworks establish a new understanding of systems thinking - one that recognizes the agency of systems and emphasizes their study through the lens of stakeholder needs and interests. Every system must be examined for its role within a broader supersystem, critical constraints, progression through various life cycle stages, and the tangible value it generates. Consequently, researchers must develop a cognitive framework that integrates these components to meet all system requirements. The development of systems thinking should not be left to passive exposure through a variety of related courses; instead, it must be cultivated deliberately. This course, "Systems and Systems Thinking," serves as the foundation for this intellectual discipline.

The **primary objective of this course** is to develop students' ability to analyze and address complex challenges in socioeconomic systems while providing them with practical tools for designing, synthesizing, and managing such systems throughout their life cycle.

**Learning Outcomes.** Upon successful completion of this course, students will be able to:

develop a conceptual understanding of complex socioeconomic systems and apply cognitive strategies to manage system complexity.

master ontological, conceptual, and architectural modeling techniques to analyze system dynamics.

apply systems thinking in entrepreneurial, managerial, and strategic decision-making contexts.

develop expertise in managing communication processes within projects aimed at designing and implementing complex socioeconomic systems.

acquire the skills necessary to design and sustain effective systems, ensuring their long-term efficiency and functionality.

**The object of the course**: The challenges associated with developing and evolving complex socioeconomic systems across their life cycle stages.

**The subject of the course**: The fundamental principles, methodologies, and challenges involved in synthesizing target systems as defined by the research domain of the doctoral dissertation. This includes both theoretical and practical aspects of system architecture development.

The learning outcomes and competencies formed by the course are defined in table 1.

*Table 1*

**Learning outcomes and competencies formed by the course**

| Learning outcomes | Competences |
|---|---|
| Demonstrate knowledge of the principles and techniques of systems thinking and recognize its potential for practical application. | Proficiency in implementing systems thinking frameworks to design and optimize successful systems |
| Identify key focus areas when defining requirements for a socio-economic system | Advanced skills in stakeholder communication and project coordination within complex systems development |
| Develop ontological and conceptual models within the research domain | Expertise in constructing and validating domain-specific conceptual frameworks |
| Conduct architectural modeling of complex socio-economic system development and allocate specific system development tasks across its lifecycle stages | Advanced capabilities in complex systems architecture design and lifecycle management |
| Formalize complex system development projects in terms of high-level functional objects, establish relationships between these objects, and manage system constraints | Advanced analytical competency in decomposition and integration of complex socio-economic systems |
| Apply systems thinking models in an enterprise's entrepreneurial, managerial, and strategic decision-making. | Practical mastery of systems theory principles and systematic thinking methodologies |

## COURSE CONTENT

### Content module 1. Fundamental principles of system modeling and development of system thinking

**Topic 1. The systems theory evolution and the genesis of system thinking**

**1.1. Modern Systems Thinking: Foundations and Applications.** Cognitive frameworks in modern management: systems thinking, critical thinking, visual thinking, and analytical thinking. Assessment frameworks and cognitive components in systematic problem-solving. Core principles and methodologies in systems thinking development

**1.2. Theoretical Foundations of Systems Approach.** Historical development and evolution of systems theory. Comparative analysis of reductionism, holism, and systems thinking approaches. Fundamental principles and theoretical constructs in systems theory. Integration of strategic and systems thinking in modern management. Contemporary paradigms in systems theory. Theoretical framework of open and closed systems dynamics.

**1.3. Applied Systems Thinking in Contemporary Business.** Analysis and management of business ecosystems and complex systems networks. Integration of systems architecture with business process engineering. Value creation through systematic thinking approaches. Systemic approach to business and entrepreneurship. Integration of design thinking with systems approach. Contemporary applications of systems thinking in business contexts. Evolution of thinking paradigms and cognitive modeling.

**Topic 2. Ontology and communication in system thinking**

**2.1. Ontological Frameworks in Research Methodology.** Advanced semantics and pragmatics. Ontological modeling fundamentals: framework development and model architecture principles. Domain concept mapping and relationship analysis. Enterprise knowledge architecture: data structure optimization and role-based communication frameworks. Advanced explanatory modeling techniques.

**2.2. Causal Analysis and Knowledge Representation.** Graph-based knowledge modeling: advanced knowledge graph implementation and object classification methodologies. Automated system ontology integration. Semantic modeling frameworks: advanced inference rules and performance metric modeling. Reference architecture development. Collaborative cognition and stakeholder integration.

**2.3. Stakeholder Dynamics and Communication Framework.** Advanced pragmatic communication analysis. Information quality management: reliability assessment frameworks and validity verification methodologies. Communication channel optimization. Communication gap analysis and goal alignment.

**Topic 3. Identification of system levels and the target system for research**

**3.1. Emergence Theory and System Hierarchy.** Advanced systems modeling principles. Hierarchical system analysis. System implementation frameworks. Target system architecture. Supersystem integration analysis. Complex systems architecture: systems-of-systems implementation and production network optimization. Cross-functional process integration. System functionality framework. Role-based system architecture.

**3.2. Target System Development Framework.** Advanced target system conceptualization. Real-world implementation strategies. Documentation methodology. Network integration optimization. Supersystem alignment strategies.

**3.3. Advanced System Modeling Frameworks.** Functional analysis methodology: modular synthesis techniques and integration optimization. System architecture principles. Requirements engineering: needs assessment and constraint analysis. Multi-perspective system documentation. Holistic integration approaches. Alternative composition strategies. Boundary definition methodology.

**Topic 4. Architecture and contexts of system description**

**4.1. Requirements Engineering in Systems Development.** Advanced description methodologies. Multi-model integration frameworks. Requirements management: validation frameworks and verification methodologies. Configuration optimization. Practice integration strategies.

**4.2. Advanced Systems Engineering.** Technological leadership framework. Methodology implementation. System development strategies.

**4.3. Enterprise Architecture Development.** Decision-making optimization. Configuration management frameworks. Organizational design methodology: process optimization and unit integration. Architecture decision framework. Implementation methodologies: TOGAF integration and BIZBOK implementation. Zachman framework adoption. Enterprise architecture optimization. Service-oriented framework development.

**Topic 5. Modeling the lifecycle of a system**

**5.1. Contemporary Lifecycle Management Paradigms.** Advanced concepts in system lifecycle management. Project lifecycle integration frameworks. Evolution of lifecycle understanding in modern systems thinking. Lifecycle stage progression monitoring and control. Contemporary lifecycle management methodologies.

**5.2. System Lifecycle Modeling.** Comparative analysis of lifecycle models. 4D extensionalism and BORO methodology applications. Operational phase system modeling. Advanced lifecycle modeling frameworks.

**5.3. Lifecycle Management Implementation.** Integrated lifecycle management systems. Stage-gate and iterative lifecycle models. Agile lifecycle management methodologies. Work breakdown structure across lifecycle stages. Lifecycle optimization strategies.

**Content Module 2. Practical Application of System Thinking Tools**

**Topic 6. Formulation of a system development project**

**6.1. Systems Development Project Framework.** OMG Essence standard implementation. High-level functional objects for lifecycle tracking. Project monitoring and control mechanisms.

**6.2. System Development and Evolution Framework.** Key focus areas in systems development projects. System maturity models and frameworks. Systems development project management methodologies. Development stage progression management.

**6.3. System Creation Framework Implementation.** OMG Essence adaptation strategies (capability implementation, project role definition, system modeling frameworks, physical system implementation, team structure and dynamics, methodologies and tools) to research domain adaptation strategies

**Topic 7. System dynamics and causal loop diagram**

**7.1. Complex Dynamic Systems Analysis.** Causal loop diagram implementation. Ontological and conceptual model integration. Feedback loop analysis. Increasing returns law. Growth accelerator mechanisms.

**7.2. System Dynamics Methodology.** Cognitive modeling and graph theory. System dynamics principles. System behavior typology. System dynamics modeling tools. Agent-based modeling of socio-economic systems.

**7.3. Applied System Dynamics.** Structural complexity representation levels. System complexity reduction strategies. Senge's system archetypes. Supersystem dynamics forecasting. Homeostasis and equilibrium analysis. System dynamics leverage points. System trap identification. Development scenario modeling.

**Topic 8. Theory of constraints and system approach to continuous improvement**

**8.1. Theory of Constraints: Advanced Framework.** System objective optimization. Stakeholder role integration. Critical constraint identification methodology. Constraint theory variables analysis. Advanced constraint management frameworks.

**8.2. Logical Tools in Constraint Theory.** Conflict resolution methodologies. Logical proposition validation frameworks. Five focusing steps implementation. Global vs. local system effectiveness metrics. Complex system improvement strategies. Advanced optimization techniques.

**8.3. System Improvement Implementation.** Current and future reality tree construction. Conflict resolution diagram development. Group dynamics optimization. Systematic improvement frameworks.

**Topic 9. System management and entrepreneurship**

**9.1. Systems Approach in Management.** Systems thinking in decision support. Integrated systems management. Systemic marketing frameworks. Organizational development and systems leadership. Supply chain integration. Practice decomposition methodologies. Advanced management frameworks.

**9.2. Reflective Management and Project Governance.** Practice-system

alignment methodologies. Reflective management implementation. System-reflective marketing strategies. Ontological management frameworks. Enterprise management system ontology. Advanced governance models.

**9.3. Causality in Systems Management.** Bayesian theorem applications. Causal inference frameworks. Digital twin implementation in socio-economic systems. Case management methodologies. Information systems for systems thinking. Advanced analytical frameworks.

**Topic 10. Applying system thinking in the strategic process**

**10.1. Systemic Approach to Strategic Process.** Engineering aspects of strategy. Strategy vs. strategizing differentiation. Strategic thinking models. Innovator's dilemma framework. Strategy as socio-economic system architecture. Advanced strategic planning methodologies.

**10.2. Strategic Modeling and Implementation.** Architectural strategy modeling. Strategy formalization communications. Continuous development strategy. Strategic cycle implementation. Organizational strategic culture. Strategic practice frameworks. Socio-economic systems strategic design. Advanced strategic planning tools.

**10.3. Strategic Documentation and System Archetypes.** Enterprise activity strategy documentation. Goal-setting modeling frameworks. Business model formalization. Strategic process performance management. Advanced strategic implementation tools. Strategic archetype documentation.

The list of practical classes (seminars) of the course is given in Table 2

*Table 2*

**List of practical classes and tasks**

| Topics and tasks | Content |
|---|---|
| Topic 1. The systems theory evolution and the genesis of system thinking | Practical Assignments 1. Developing an Effective Idea Organization System Using the Zettelkasten Method: Enhancing thinking through writing |
| Topic 2. Ontology and communication in system thinking | Practical Assignments 2. Defining the Research Domain: Applying the Design and Engineering Methodology for Organizations (DEMO) to structure and describe the research domain |
| Topic 3. Identification of system levels and the target system for research | Practical Assignments 3. Identifying the Target System and Its Structure: Defining the target system within the scope of the Ph.D. dissertation research |
| Topic 4. Architecture and contexts of system description | Practical Assignments 4. Developing Architectural Descriptions of the Target System: Creating system architecture descriptions aligned with the Ph.D. research topic |
| Topic 5. Modeling the lifecycle of a system | Practical Assignments 5. Formalizing Life Cycle Practices of the Target System and Its Development Systems: Structuring and documenting system life cycle processes in accordance with the dissertation research theme |
| Topic 6. Formulation of a | Practical Assignments 6. Designing a Systematic Development |

| | |
|---|---|
| system development project | Plan for the Target System: Creating a structured system model for the development project of the selected target system |
| Topic 7. System dynamics and causal loop diagram | Practical Assignments 7. Identifying and Visualizing Cause-and-Effect Relationships: Mapping causal links between key concepts in the research domain of the dissertation |
| Topic 8. Theory of constraints and system approach to continuous improvement | Practical Assignments 8. Applying Thinking Processes from the Theory of Constraints: Developing and analyzing the Current Reality Tree, Conflict Resolution Diagram, Future Reality Tree, Transition Tree, and Transformation Plan |
| Topic 9. System management and entrepreneurship | Practical Assignments 9. Incorporating Bayesian Probability in Decision-Making Models: Constructing strategy and tactics trees for informed decision-making |
| Topic 10. Applying system thinking in the strategic process | Practical Assignments 10. Formalizing Strategy with Wardley Maps: Applying Wardley mapping concepts to strategic planning and modeling strategy in Archimate. |

List of independent work of students of higher education on this course is given in table 3.

*Table 3*

**List of independent work**

| Topic and task | Content |
|---|---|
| Topic 1. The systems theory evolution and the genesis of system thinking | Assignments 1. Fundamentals of Organizing a Personal Knowledge Base (External Exocortex): Utilizing Obsidian, Notion, and The Brain for knowledge management |
| Topic 2. Ontology and communication in system thinking | Assignments 2. Review of Ontological Modeling Tools in Systems Thinking: Exploring automation tools for ontological knowledge engineering in Protégé |
| Topic 3. Identification of system levels and the target system for research | Assignments 3. Exploring the Archimate Architecture Modeling Language: Using the open-source Archi tool to formalize the doctoral candidate's target system |
| Topic 4. Architecture and contexts of system description | Assignments 4. Tabular Modeling of System Architecture: Implementing low-code table-based modeling in platforms like Coda.io and Notion.so, integrating functional, modular, spatial, and cost-based system descriptions |
| Topic 5. Modeling the lifecycle of a system | Assignments 5. Developing an Architectural Model of System Practices: Using enterprise architecture modeling tools in Archi to design and analyze system practices. |
| Topic 6. Formulation of a system development project | Assignments 6. Establishing a System for Tracking State Changes: Monitoring state transitions of high-level functional objects using specialized software. |
| Topic 7. System dynamics and causal loop diagram | Assignments 7. Review of Additional Materials on Causal Loop Diagrams: Modeling system dynamics in online environments such as InsightMaker and SilicoAI (https://insightmaker.com, www.silicoai.com), visualizing system behaviors . |
| Topic 8. Theory of constraints and system approach to continuous improvement | Assignments 8. Mastering Thinking Process Modeling Software: Applying Theory of Constraints (TOC) tools in Flying Logic |
| Topic 9. System management and entrepreneurship | Assignments 9. Learning Probabilistic Decision-Making Models: Utilizing Netica for Bayesian network modeling in |

| | |
|---|---|
| | decision-making processes |
| Topic 10. Applying system thinking in the strategic process | Assignments 10. Developing Strategic Roadmaps for Target System Development: Using specialized software to map strategic evolution and transformation |

The number of the academic hours of lectures, practical classes, as well as mandatory independent work of applicants for higher education on each topic is presented in the work syllabus (technological card) of the course.

## TEACHING METHODS

In the process of teaching the course to obtain certain learning outcomes, intensify the educational process, it is envisaged to use such teaching methods as:

Verbal (lecture (Topic 1-3), problem lecture (Topic 4-10).

Visual (demonstration (Topic 1-10)).

Practical (practical work (Topic 1 – 6), essay (Topic 9-10), case method (Topic 7-8)

## FORMS AND METHODS OF EVALUATION

The University uses a 100-point cumulative system for assessing the learning outcomes of higher education applicants.

**Current control** is carried out during lectures, practical seminars and aims to check the level of preparedness of the applicant for a specific job and is estimated by the sum of points scored. The maximum amount is 100 points; The minimum amount is 60 points.

**The final assessment** is conducted as semester control, which takes the form of a pass/fail evaluation (credit). The final grade is determined by summing the points earned from all forms of continuous assessment throughout the course.

The following assessment components are used during the course: practical exercises – 40 points; written test – 30 points; essay – 30 points

Semester control: Grading

More detailed information on the assessment system is provided in technological card of the course

## RECOMMENDED LITERATURE

### Main

1. Величко О.М., Гордієнко Т.Б. Основи системного аналізу і прийняття оптимальних рішень. К.: Олді+, 2021. 672 с.

2. Ґріффітс К., Кості М. Посібник із креативного мислення. К.: Ранок, 2020. 288 с.

3. Максименко М., Меерович М., Шрагина Л. Системне мислення: формування і розвиток. К.: Києво-Могилянська академія, 2020. 251 с.

4. Пушкар О. І. Методологія та організація наукових досліджень [Електронний ресурс]: навч. посіб. Харків : ХНЕУ ім. С. Кузнеця, 2020. 866 с. (URL: http://www.repository.hneu.edu.ua/handle/123456789/23346)

5. Guide to the Systems Engineering Body of Knowledge (SEBoK) : ed. R.J.

Cloutier. Hoboken, NJ: The Trustees of the Stevens Institute of Technology, 2021. 1155 p.

**Additional**

6. Бьюзен Т. Мапа думок. Докладний посібник із вивчення і застосування найпотужнішого інструмента мислення у світі. Львів. Видавництво старого лева, 2021. 224 с.

7. Гриффитс К., Кости М. Посібник із креативного мислення. К.: Фабула, 2020, 288 с.

8. Пилипенко А. А., Тирінов А.В. Системна парадигма організації бухгалтерського обліку в умовах четвертої промислової революції. *Бізнес Інформ*. 2022. № 5. С. 92-99. (URL: http://www.repository.hneu.edu.ua/handle/123456789/28046)

9. Сучасні інформаційні технології та системи [Електронний ресурс] : монографія / Н. Г. Акса. Гризун, О. В. Щербаков та ін. ; за заг. ред. д-ра екон. наук, професора В. С. Пономаренка. Харків : ХНЕУ ім. С. Кузнеця, 2022. 271 с. (URL: http://www.repository.hneu.edu.ua/handle/123456789/29233)

10. Темплар Р. Правила мислення. Персональна інструкція на шляху до кмітливості, мудрості й щастя. К.: КМ-БУКС, 2022. 236 с.

11. Чепелюк М. І. Інструментарій стратегічного управління в контексті сучасних концепцій та трендів світового економічного розвитку : монографія. Харків : ФОП Лібуркіна Л. М., 2021. 396 с. (URL: http://www.repository.hneu.edu.ua/handle/123456789/26372)

12. DeLisi P.S. Strategic Leadership and Systems Thinking. New York: Routlege, 2020. 165p.

13. Qudrat-Ullah H. Managing Complex Tasks with Systems Thinking (Understanding Complex Systems). Switzerland: Springer, 2023. 479 p. URL: https://link.springer.com/book/10.1007/978-3-031-40635-5

14. McCuen R.H. Critical Thinking, Idea Innovation, and Creativity. London: CRC Press, 2023. 332 p.

15. Snyder K.J., Snyder K.M. Systems Thinking for Sustainable Schooling : A Mindshift for Educators to Lead and Achieve Quality Schools. New York: Rowman & Littlefield Publishers, 2023. 157 p.

16. Wierda G. Mastering ArchiMate. Instruction to the ArchiMate enterprise architecture modeling language. The Netherlands: R&A, 2021. 236 p.

**Information resources**

17. The Object Management Group. URL: https://www.omg.org

18. International Council on Systems Engineering. URL: https://www.incose.org/

19. Сторінка курсу на платформі Moodle (персональна навчальна система). – Режим доступу: https://pns.hneu.edu.ua/course/view.php?id=9271