Subject code: P.3(2)	**Subject name:** System Engineering		
Study load: 4 ECTS	**Load of contact hours:** 50	**Study semester:** Spring	**Assessment:** Exam
Objectives:	The purpose of the course is to study a systematic approach as the basis of engineering thinking.		
Course outline:	Topics covered: 1. What is systems engineering and the role of systems engineer 2. The concept of the system 3. The concept of a life cycle 4. The basic system engineering standard 5. System Definition Practices - Requirements 6. System Definition Practices - Architecture 7. Systems of systems. Organizational engineering 8. System Implementation Practices 9. System Engineering Software 10. Planning the life cycle of software systems Contact lessons will be divided into two parts: lectures&practicals and system engineering workshops with individual tasks.		
Learning Outcomes:	At the end of the course, the student should have a holistic view of systems engineering as an interdisciplinary field of technical sciences, focused on the problems of creating effective, integrated systems suitable to meet the identified requirements. The student should be able to identify stakeholders, formulate and analyze system requirements, and develop system architecture using simple examples.		
Assessment Methods:	Assessment of student knowledge is based on the results of checking two self-written essays. The first is about a simple household system, the second is about a software system. Essay topics are selected by the student on their own and agreed with the teacher.		
Teacher(s):	Sergey Makhortov		
Prerequisite subject(s):	Preliminary knowledge of computer science, programming, discrete and probabilistic models, models and decision-making methods is required.		
Compulsory Literature:	Kosyakov A. System Engineering. Principles and practice / A. Kosyakov, W. Sweet, S. Seymour, S. Beamer. - Per. from English V. Batovrin. - M .: DMK Press, 2014 .-- 636 p. Shamie K. Systems Engineering for Dummies: IBM Limited Edition. Per. from English / K. Chamie. - John Wiley & Sons, Inc. - 2014 .-- 69 s.		
Replacement Literature:	Levenchuk A.I. System engineering thinking. Textbook [Electronic resource] / TechInvestLab .. - M, 2015. - 302 p. URL:		

<table>
<tr><td></td><td>http://techinvestlab.ru/files/systems_engineering_thinking/systems_engineering_thinking_2015.pdf.</td></tr>
<tr><td>Participation requirements:</td><td>Lower limit of lectures attendance is 80%, each essay must be presented by end of the course.</td></tr>
<tr><td>Independent work:</td><td>1. Essays on the household system
2. Essay on the software system</td></tr>
<tr><td>Grading criteria scale or the minimal level necessary for passing the subject:</td><td>Points distribution:

<table><tr><td>Failed</td><td>< 50 points</td></tr><tr><td>Passed, grade 3</td><td>50-69 points</td></tr><tr><td>Passed, grade 4</td><td>70-89 points</td></tr><tr><td>Passed, grade 5</td><td>>=90 points</td></tr></table>
Ongoing assessment:
Home system essay: 50 points
Essay on the software system: 50 points</td></tr>
<tr><td>Information about the course:</td><td>Room ___, on ___ at ___</td></tr>
<tr><td>1) Date 1</td><td>Lecture 1. The subject of the study of systems engineering and the role of systems engineer.
Subject of the study of systems engineering, it differs from the engineers in the field of engineering and management. The role of a system engineer, the differences between a system engineer and a project manager and engineers by profession. The relationship and differences of systems engineering, engineering and research.</td></tr>
<tr><td rowspan="2">2) Date 2</td><td>Lecture 2. The concept of the system.
The counterintuitiveness of a systematic approach. The concept of the system. Parties concerned. Function and design. Hamburger Chart. The mechanism, architecture, modularity of the system. Holarchy. Targeted and supporting systems, systems in the operational environment.</td></tr>
<tr><td>Practical 2
Strengthening knowledge based on examples.</td></tr>
<tr><td>3) Date 3</td><td>Lecture 3. The life cycle of the system.
Life cycle concept. Incremental resource allocation (ICM). Lifecycle management, features of PLM systems. Life cycle from the point of view of a system engineer, project manager, engineer by profession. Types of life cycles. Formalisms of life cycle representation. Typicality and diversity of life cycles.</td></tr>
<tr><td rowspan="2">4) Date 4</td><td>Lecture 4. The main standard of systems engineering.
Capital projects. Complex Life Cycle Notation. Summary of ISO 15288 (Systems Engineering Life Cycle Practices). Four main groups of practices. Differentiation of areas of system engineer and project manager. The life cycle of systems engineering practices.</td></tr>
<tr><td>Practical 4
Strengthening knowledge based on examples.</td></tr>
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5) Date 5	**Lecture 5.** ***System definition practices – requirements.*** The cost of errors. The basic principle of decision making. Ontology of requirements, types of requirements. Structure engineering requirements. The work of an engineer according to requirements. Requirement languages. Standards ISO 29148, ISO 15926. Link engineering requirements with architecture.
6) Date 6	**Lecture 6.** ***System Definition Practices - Architecture.*** Dependence of architecture on requirements. An example of building an architecture. Work and competencies of a system architect. Systems architecture engineering, ISO 42010 standard. Architectural descriptions, description methods and description groups. Synthetic and projection approaches. Architectural practices. ArchiMate language, its purpose, advantages and disadvantages.
	Practical 6 Strengthening knowledge based on examples.
7) Date 7	**Lecture 7.** ***Systems of systems. Organizational Engineering.*** Key issues, features of systems systems, evolution. Classification of systems systems, examples. Organization as a system. Organizational architecture and its ontology. Levels and the problem of their integration. DEMO methodology and other methodologies. Situational engineering of methods as a methodology of organizational architecture. Standards ISO 24744 and OMG SPEM 2.0.
8) Date 8	**Lecture 8.** ***System implementation practices.*** Planning and manufacturing the system. System integration and its role. Ways of implementation. Verification and validation, V-diagram. Targeted engineering and engineering justification. Standard ISO 15026. The choice of the type of life cycle. Errors in the interaction of managers and engineers. ICM method, its rationale, features and benefits. The problem of integrating life cycle data and the ISO 15926 standard.
	Practical 8 Strengthening knowledge based on examples.
9) Date 9	**Lecture 9.** ***Systems Engineering Software.*** Application of systems engineering to the creation of complex software systems. Systems Software Engineering (SwSE). SwSE and software engineering, SwSE and project management. SwSE functions. Requirements analysis. Software design. Process planning. Process control. Verification, validation and testing.
10) Date 10	**SE Workshop 1.** ***System concept.***
11) Date 11	**SE Workshop 2.** ***System life cycle.***
12) Date 12	**SE Workshop 3.** ***The main standard of systems engineering.***
13) Date 13	**SE Workshop 4.** ***System Definition Practices - Requirements.***
14) Date 14	**SE Workshop 5.** ***System Definition Practices - Architecture.***
15) Date 15	**SE Workshop 6.** ***Systems of systems. Organizational Engineering.***
16) Date 16	**SE Workshop 7.** ***Practical implementation of the system.***
17) Date 17	**Assessment**