СПбГЭТУ «ЛЭТИ»
ПЕРВЫЙ ЭЛЕКТРОТЕХНИЧЕСКИЙ

MINISTRY OF EDUCATION AND SCIENCE OF RUSSIA
federal state autonomous educational institution of higher education
"St. Petersburg State Electrotechnical University" LETI "named after. IN AND. Ulyanov (Lenin)" (St. Petersburg Electrotechnical University "LETI")

I approve:

Vice-Rector for Research

_____ Tupik V.A.

"____" _____ 2022

WORKING PROGRAMM

disciplines

"System Analysis, Management and Information Processing"

for the preparation of graduate students in a scientific specialty

3.2.1. – System analysis, management and information processing

Saint Petersburg

2022

DISCIPLINE STRUCTURE

Supporting Faculty:	FKTI
Supporting department:	IP
Well	4
Semester	8

Types of occupations

Lectures

Independent work

Type of intermediate certification

Exam (semester)	8

Developer	Sovetov B. Ya.
Head of dep. of IP	Tsekhanovsky V.V.
Head of DDPS	Tumarkin A.V.

DISCIPLINE ABSTRACT
"SYSTEM ANALYSIS, MANAGEMENT AND INFORMATION PROCESSING"

Provides studyproblems of development and application of methods of system analysis of complex applied research objects; information processing; modeling, optimization, improvement of management and decision-making, in order to increase the efficiency of the functioning of research objects.Alsothe principles of human impact on research objects, human control of research objects using modern methods of information processing are considered.

SUBJECT SUMMARY
"SYSTEM ANALYSIS, MANAGEMENT AND INFORMATION PROCESSING"

The course coversengages in the problems of development and application of methods of analysis of the systems of the difficult applied objects of research; treatments of information; designs, optimizations, improvements of management and making decision, with the purpose of increase of efficiency of functioning of research objects.also,involves the principles of human impact on the objects of research, management, human objects of study, using modern methods of information processing.

GOALS AND OBJECTIVES OF THE DISCIPLINE

1. Learning principlesdevelopment and application of methods for system analysis of complex applied objects, targeted human impact on objects of study, ways to improve management and decision-making in order to increase the efficiency of functioning of research objects.

2.Formation of the ability to conduct theoretical analysis, computer modeling and experimental researchVtasks of system analysis, management and processing of information in research objects, including optimization issues, improving the reliability and quality of objects, special mathematical and software solutions for research problems.

3. Mastering the skills of independent work with literature;fundamental, theoretical, applied knowledge andmethodological means of experimental software-computational research.

THE CONTENT OF THE DISCIPLINE

Introduction

The content, purpose and significance of the discipline in the preparation of graduate students, its relationship with other disciplines and the preparation of a PhD thesis. general characteristicsapplication of methods of system analysis of complex applied objects for the development, design, modeling, research, reasonable choice of applied solutions; analysis, management and processing of information in the objects of study.

Topic 1. Fundamentals of system analysis and management.

History and essence of system analysis, management and information processing. Typical tasks: diagnostic, predictive; definition of interaction strategies; object research; designing decision-making models, interaction of objects. General and specific methods: analytical, statistical, graphic, structural, expert, heuristic. Methods of choice, decision making, decomposition and aggregation. Analysis of the structure of the information system; analysis of the state, formation of goals and criteria; target decomposition; development and selection of strategies, ways, alternatives for solving problems; identification and analysis of significant factors of resource and process needs; building system models.

Topic 2. Methods and methodology of system analysis.

Methodological principles of system analysis and management. Typical tasks: diagnostic, predictive, determination of interaction strategies, research of an object, designing models of decision making and organizational interaction. simulation models. Structured, unstructured, formalized models. Target decomposition; development and selection of strategies, ways, alternatives for solving problems of management and information processing; identification and analysis of significant factors of resource and process needs; building system models; processing of simulation results.

Topic 3. System modeling.

Examples of objects requiring a systematic approach to modeling. Statement of problems of system modeling: system and its parts, decomposition, aggregation, coordination. Subsystem models. Classical methods for analyzing models of subsystems,

processes in subsystems and systems consisting of many subsystems. Methods of stability analysis, quality assessment and synthesis of large systems. Problems and methods for reducing the dimension of models of large systems, methods for removing variables, the theory of rigid systems. Examples of objects for a systematic approach to modeling.

Topic 4. Applied aspects of system analysis

Examples of the application of the methodology for designing information systems for industry-specific tasks. Organizational forms and practical methods of scientific substantiation of decisions. Description of the system and system objects. Construction and choice of system architecture. Industry system management. Decision making in information system management. Decision monitoring systems.

Topic 5. Mathematical foundations of system analysis.

Operations research models, decision making models, game models. Basic Principles of Operations Research. Typical tasks. Goals and stages of operational research. Classification of optimization problems. Statement of the problem in deterministic and stochastic cases. Probability theory and probabilistic models. Probabilistic-statistical models. Conditions for the use of probabilistic models. Probabilistic models of the type of random events, quantities, vectors and functions; their main functional and numerical characteristics, rules, transformations. Limit theorems of probability theory.

Topic 6. Mathematical and applied statistics and statistical models. Methods for obtaining, analyzing and processing expert information.

Basic definitions and concepts of statistics. Fundamentals of the theory of evaluation. Nonparametric and parametric estimation methods. Theory of correlation, regression, factorial, variance and spectral analyzes on sample data. Basic concepts and methods for testing parametric and non-parametric, simple and complex hypotheses. Expert evaluation of objects. Methods of individual and group expert assessment: ranking, standardization, Delphi, etc. Assessment of experts' competence. The use of concordance and rank correlation coefficients in the examination. Quality indicators and analysis of expert assessments: inaccuracy, inconsistency, inconsistency.

Topic 7. Fuzzy models and conclusions. chaotic models. fractal patterns

Fuzzy sets and concepts. Basic definitions and concepts. Typical membership functions and basic operations on fuzzy sets. Fuzzy relations and operations on them. Fuzzy and linguistic variables. Fuzzy statements and fuzzy models of systems. Deterministic chaos. Chaotic dynamics. The concept of an attractor and a bifurcation point. Wave processes of dynamical systems. Oscillations in nonlinear systems. Elements of the theory of catastrophes. The concept of models of fractional dimension, fractal dimension. Dimension measures of manifold and space: Besikovich, Hausdorff, information, correlation, Lyapunov.

Topic 8. Methods of intellectual support in making managerial decisions.

The concept of a decision maker. Elements of the theory of choice. Basic formal structure. voting theory. Decision-making procedures. Weakly structured problems. WITHdecision support systems. Technology of system analysis in solving complex problems. Decision-making procedure. Definition of criteria for achieving goals. Buildingmodelsto find and justify solutions. Interactive recognition of situations and objects.

Conclusion

Methods for assessing the efficiency, quality and reliability of complex systems.The quality of the information system. Quantitative characteristics and indicators of efficiency, quality and reliability of complex systems, system failure; recoverable, non-recoverable, maintained, unattended systems. Prospects for the development of methods for system analysis of complex applied objects for the development, design, modeling, research, reasonable choice of applied solutions; analysis, management and information processing. New fields of application of methods of system analysis of complex applied objects.

If the discipline is implemented in groups with a small number, classes in individual sections can take the form of orientation lectures, the issuance and explanation of the task on the topic, and the current control can take place in the form of presentation and defense of the completed task by the postgraduate student.

General recommendations for the completion of individual tasks are available to the graduate student in printed or electronic form (on the University website), or the graduate student can receive recommendations from the teacher responsible for the discipline during consultation hours. The task is formulated taking into account the topics of the PhD student's dissertation research within the framework of the discipline under study.

EDUCATIONAL AND METHODOLOGICAL SUPPORT OF DISCIPLINE

Methodological recommendations for the implementation of the discipline

Methodological recommendations for teachers:

Before starting to teach the discipline, the teacher must:

– know the goals and objectives of teaching the discipline;

– imagine what knowledge, skills and abilities a graduate student should acquire in the process of studying this discipline;

– to clearly understand in the formation of what results of mastering the postgraduate program the discipline is involved.

If the curriculum for the discipline provides for an exam, it is recommended to conduct it in the form of an individual conversation with a graduate student on the questions formulated in the funds of the discipline's assessment tools, using questions from various sections of the discipline, thereby ensuring a more complete test of the graduate student's knowledge.

In his activities, the teacher must be guided by local regulations governing educational activities in educational programs for the training of highly qualified personnel at the university.

Methodological recommendations for independent work of graduate students:

The study of each discipline should be accompanied by independent work of a graduate student with literature sources and Internet information resources recommended by teachers in all sections of the discipline.

A number of issues to be studied as part of the discipline are quite well developed in the educational literature, presented in scientific papers, collections of papers, articles, and on the Internet. These questions can be transferred to graduate students for independent study. Such work is built on the basis of tasks prepared by the teacher with a list of questions to which the student must find answers in the process of self-study. Both whole topics and individual questions can be studied independently as part of the topics indicated by the teacher, but not fully disclosed by him. To consolidate the material, notes are taken, abstracts, essays are prepared or reports are made. The degree

of mastering independently studied materials is necessarily checked by control measures using the fund of evaluation tools for the discipline.

A special place should be given to counseling as one of the forms of training and control of independent work. Counseling involves a specially organized interaction between the teacher and graduate students, it is assumed that the consultant either knows a ready-made solution that he can prescribe to the consulted person, or he owns methods of activity that indicate the way to solve the problem.

List of basic and additional educational literature,

necessary for mastering the discipline

No.	Title, bibliographic description	Number of copies in the Bible (at the cafe)
1	Sovetov B.Ya., Dubenetsky V.A., Tsekhanovsky V.V., Shekhovtsov O.I. Theory of information processes and systems: textbook. for universities in the direction of training "Information systems" / ed. B.Ya. Soviet. – M.: Academy, 2010. – 428 p.	50 (10+el.)
2	Sovetov B.Ya., Tsekhanovsky V.V., Chertovskoy V.D. Intelligent systems and technologies: textbook. for universities in the direction of preparation 230400 "Information systems and technologies". – M.: Academy, 2013. – 317 p.	22 (10+el.)
3	Sovetov B.Ya. Yakovlev S.A. Modeling systems: textbook. for universities in the areas of "Informatics and Computer Engineering" and "Information. systems" / Saint-Petersburg state. Electrotechnical University. IN AND. Ulyanov (Lenin) "LETI". – 7th ed. – M.: Yurayt, 2013. – 342 p.	41 (10+el.)
4	Sovetov B.Ya., Tsekhanovsky V.V., Chertovskoy V.D. Databases: theory and practice: textbook. for universities in the areas of "Informatics and Comput. technique" and "Information. systems" / – 2nd ed. – M.: Yurayt, 2012. – 462 p.	32 (10+el.)

List of information and telecommunication network resources

"Internet" used in the development of the discipline

No.	Email address
1	http:// www.infom.ru
2	http://www.resources.com

Information technologies (operating systems, software for general and specialized purposes, as well as information reference systems) and the material and technical base used in the implementation of the educational process in the discipline comply with federal state requirements.

Specific forms and procedures for current knowledge control and intermediate certification, including a list of examination questions (Appendix 1), as well as guidelines for students on independent work when mastering disciplines, are brought to the attention of students in the first lesson.

Annex 1

List of exam questions by discipline

"System Analysis, Management and Information Processing"

1. Paradigms of the systems approach. cybernetic paradigm. functional systems. Purposefulness. Feedback. Homeostasis. Sustainability. Complexity. Control. Information.
2. Target instrumental paradigm. Goal achievement. Optimality and improvement. Problem of choice. Dimension. Complexity. Universal solver. Making decisions. Simulation modeling.
3. synergetic paradigm. Instability. Nonlinearity. Accident. Evolution. Chaos. Self-organization. Order. structures. Complexity. Dynamic systems. Newtonian mechanics. conservative systems. Integrable and non-integrable systems. Resonances. New mechanics. Statistical dynamics. Peculiarities. Catastrophes. Bifurcations. Fractals. dissipative systems. Dynamics of irreversible nonequilibrium processes.
4. systemic paradigm. Knowledge of the essence of systems. Systemology of the phenomenal. Complexity. Reduction of the complex. System reconstructions.
5. Apparatus for system analysis. Methods of nonlinear dynamics. asymptotic methods. Tikhonov systems. Computational experiment of nonlinear dynamics.
6. Methods of complex reduction and reconstruction of systems. Computational technologies for system reconstructions.
7. Operations research. Organizational management. Network optimization. Dynamic optimization. Stochastic optimization.
8. Probabilistic modeling apparatus. Statistical modeling methods. Monte Carlo method. regenerative method. Entropy Modeling. System dynamics. Genetic modeling. Neural modeling.
9. Game theory. utility theory. Preferences. Expert analysis. Group choice. Choice under fuzzy data. Choice in conditions of information deficit.
10. Analysis of conflicts and risks. Decisions in the conditions of the conflict.
11. Structural analysis. situational analysis.
12. Basic concepts of control theory. The concept of management and control systems. Information and management principles. Mathematical modelscontrol systems.

13. Linear Modelscontrol systems: input-output models, input-state output models. Systems of equations in the form of a state space. Linear models of discrete control systems. Nonlinear models of control systems.
14. Models of the environment and the extended system. Model Uncertaintycontrol systems.
15. Tasks and methods of analysis of control systems. Stability analysis: stability under initial conditions, input-output stability. Stability criteria for linear stationary systems. Method of Lyapunov functions.
16. Controllability and observability of control systems. Algebraic Criteria for Controllability and Observability.
17. Analysis of impulse control systems. Analysis of linear systems under random influences. Invariance and sensitivity of control systems.
18. Analysis of equilibrium modes and behavior of systems on the phase plane. Investigation of periodic regimes by the method of harmonic balance.
19. General information about the synthesis of control systems. Problems and methods of synthesis of control systems. Analytical design of regulators.
20. The problem of synthesizing a state observer. Luenberger Observer. Features of constructing a state observer for nonlinear control systems.
21. Synthesis of invariant control systems. Synthesis of tracking systems.
22. Structural and parametric synthesis of control systems.
23. Random process and its main characteristics in control systems under random influences. Closed system under random influences.
24. Methods for calculating the dispersion of a random signal of the system. Using the ideal white noise model. The concept of a shaping filter.
25. Synthesis of linear control systems under random influences. Wiener-Hopf integral equation, determination of the optimal Wiener filter. Filter with finite memory. Kalman-Bucy filter.
26. Nonlinear systems under random influences. The passage of a random signal through a nonlinear link. Statistical linearization of a nonlinear link.
27. Optimality conditions for processes in dynamical systems. Variational Methods in Optimal Control Problems.
28. The maximum principle in optimal control systems. Systems are optimal in terms of speed. Optimization of dynamical systems by quadratic criterion.

29. Analytical design of regulators. Generalized work functionality. Analytical design of aggregated controllers.
30. Optimal systems with incomplete measurement of the state vector.
31. Tasks and methods of adaptive control. Statement of the problem of synthesis of adaptive systems. Classes of adaptability.
32. Direct and identification principles for constructing adaptive automatic systems. Deterministic and stochastic adaptation algorithms.
33. Synthesis of continuous adaptive systems. Discrete adaptive control systems (DACS). DASU with customizable object model and gradient adaptation algorithm.
34. Adaptation algorithms: acceleration, stochastic environment.
35. Information: types, its properties and measurement. Information process in technical systems and its organization. Problems of information transformation. Information processes: basic concepts and their classification. Models of the processes of transfer, processing, accumulation, presentation of information and knowledge.
36. A systematic approach to the organization of information processes: a reference model for the interaction of open systems, goals, objectives and methods of multilevel organization of information processes.
37. The main stages of applied statistical analysis. Dependency analysis: correlation analysis of quantitative and qualitative features. Models and methods of regression analysis. Time series analysis: models and forecasting.
38. Pattern recognition and typology of objects. Downsizing. Classification in the presence of training samples (discriminant analysis). Classification without training: parametric and non-parametric (cluster analysis) cases. Qualimetry. Causal analysis. Opportunity analysis.
39. The concept of information technology. Structure of basic information technology. Technology of distributed transformation of information. multimedia technologies. interface technologies.
40. Technologies of artificial intelligence. Technologies of interactive computer graphics.
41. Geoinformation technologies. Technologies of adaptive modeling. Help-learning technologies.
42. Technologies for protecting information from unauthorized access.

43. Knowledge, their representation and use in intelligent systems. Expert systems in problems of control and information processing. Knowledge-oriented and interactive recognition of situations and objects.
44. Artificial neural networks, architecture, learning algorithms. Multilayer neural networks and their use in problems of classification, clustering, identification and control. Neural network control in robotics, in dynamic nonlinear systems.
45. Fuzzy data and fuzzy logic. Information processing, decision-making and control systems with fuzzy data and/or logic.