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

Department of automation electrical engineering and mechatronic complexes

TECHNICAL RISKS

Level of higher education	***Second (master's)***
Branch of knowledge	*14 Electrical engineering*
Specialty	*141 Electric Power Engineering, Electrotechnics and Electromechanics*
Program of Educational	*Engineering of Intellectual Electrotechnical and Mechatronic Complexes*
Status of Discipline	*selective*
Form of education	*Full-time*
Year of training, semester	*5th year, spring semester*
Scope of the discipline	*5.0 credits, 150 hours*
Semester control/ control measures	*Exam*
Lessons schedule	*One lecture every week and one practical session every two weeks*
Language of teaching	*English*
Information about head of the course / teachers	Lecturer: doctor of technical sciences, professor. Oleh Terentiev. Practical: d. t. n., professor. Oleh Terentiev. Contacts [1] E:mail, oltr_1@ukr.net, mob Tel. 098 081 9192
Placement of the course	A link to a remote resource (Google classroom, module, тощо) https://classroom.google.com/c/MzA2MDcwMjU0MjM2?cjc=6zpjw73

Working program of the academic discipline (Syllabus)
Program of educational discipline

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

"Why should a future specialist learn this particular discipline?". The discipline examines the basic principles of building electrical engineering systems for the construction and operation of underground and surface structures. Students analyze and study the main properties, characteristics, and engineering methods of calculating parameters and designing automated electrical and mechatronic systems.

The purpose of the educational discipline is to manage industrial and environmental safety based on the analysis, assessment and prevention of risky situations in production. Training of students on the basics of the theory of technical risks, computer modeling, design and operation of electromechanical equipment.

The subject of studying the discipline is the safe operation of electrical and mechatronic systems and their equipment, prevention and elimination of the causes and consequences of emergency situations, the theory of safe operation, consideration of possible causes and prevention of emergency situations in production.

E-mail address of the teacher or other contacts for feedback, it is possible to indicate reception hours or hours for communication in the case of indicating contact telephone numbers. For the syllabus of a discipline taught by many teachers (for example, history, philosophy, etc.), you can refer to the site page where the contact information of teachers for the relevant groups, faculties, institutes is presented.

The discipline lays the foundations for the formation of the student's knowledge, skills and experience in the use of modern electronic computing equipment for risk analysis and management of risk situations at work, assessment of possible consequences of accidents at work. And also evaluate and choose a technical solution option with the minimum probability of a risky situation.

The study of the risk situation of the questions is based on Technical Mechanics, Hydraulics and hydraulic drive, Physics. Adjacent disciplines are: Electric drive, Automation of technological processes. Nonlinear problems and identification of mechatronic systems, Microprocessor devices in energy-intensive production facilities.

As a result of studying the "Technical Risks" discipline, students have the ability to receive competencies:

- (K02) to search, process and analyze information from various sources;
- (K07) to learn and master modern knowledge;
- (K08) to identify and assess risks;
- (K11) to solve practical problems using automated design and calculation systems;
- (K23) to develop working project and technical documentation with verification of compliance of development projects and technical documentation with standards, technical conditions and other normative documents;
- (K24) to solve complex specialized tasks and practical problems related to the development of automatic control systems;
- (K25) to evaluate accumulated experience.

Ability to apply the methods of automatic control theory, system analysis and numerical methods to develop mathematical models of electrotechnical and mechatronic complexes, analyze the quality of their functioning using the latest computer technologies.

Ability:

- (PR06) to use application software and microprocessor technology to solve practical problems in professional activities;
- (PR08) choose and apply suitable methods for the analysis and synthesis of electromechanical and mechatronic complexes with specified indicators;
- (PR17) to solve complex specialized problems in the design and maintenance of electromechanical systems, electrical equipment of power stations, substations, systems and networks;
- (PR20) apply optimization methods in the design of electrotechnical and mechatronic systems and complexes;
- (PR21) use, calculate and research digital and nonlinear regulators of technological processes, using modern electrotechnical equipment.

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

The study of the discipline "Technical risks" is based on the following courses: Physics, Hydraulics and hydraulic drive, technical mechanics. They provide the basic knowledge and skills that the student needs (requirements for the level of training) to successfully master the discipline (for example, "basic level of English language proficiency not lower than A2"). Related disciplines are: Electromechanics, Automation of technological processes

3. Content of the academic discipline

The educational discipline "Technical risks" consists of 18 lectures, 9 practical classes, a test and a test.

4. Educational materials and resources

Basic educational literature

1. Asveld, L., & Roeser, S. (Eds.). (2012). The ethics of technological risk. Routledge.

2. Klijnstra, J., Zhang, X., van der Putten, S., & Röckmann, C. (2017). Technical risks of offshore structures (pp. 115-127). Springer International Publishing.

3. Lock, D. (2020). Project management. Routledge.

4. Schwalbe, K. (2009). Introduction to project management. Boston: Course Technology Cengage Learning.

Auxiliary educational literature:

5. Hopkin, P. (2018). Fundamentals of risk management: understanding, evaluating and implementing effective risk management. Kogan Page Publishers.

6. Glendon, A. I., Clarke, S., & McKenna, E. (2016). Human safety and risk management. Crc Press.

7. Loosemore, M. (2006). Risk management in projects. Taylor & Francis.

Educational content

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

Lecture classes

№ з/п	Titles of lecture topics and a list of main questions (references to the literature)
1	**Lecture No. 1. Technical risks** Introduction

	1.1. Systematization and analysis of possible risk events 1.2. Technical risks are defined Self-test questions for Lecture No. 1 List of reference sources for Lecture No. 1 Literature 1,2,3
2	**Lecture No. 2. Analysis of scientific research and publications** 2.1. Analysis of recent research and publications 2.2. Liability for non-payment of consumed electricity Self-test questions for Lecture No. 2 List of references to Lecture No. 2 Literature 1,2,3. Express control
3	**Lecture No. 3. Risk analysis at production facilities** 3.1. Analysis of the risk of accidents at dangerous production facilities 3.2. Risk analysis procedure 3.3. Implementation of the ISO 31000:2009 series of standards Self-test questions for Lecture No. 3 List of sources of reference to Lecture No. 3 Literature 1,2 3. Control work
4	**Lecture No. 4. Categories of failure to work** 4.1. Analysis of types and sequences of failures 4.2. Analysis of types and consequences of failures Self-test questions for Lecture No. 4 List of sources of reference to Lecture No. 4 Appendix A. Building an event tree Example 4.1. Building an event tree The list of sources refers to Appendix A Literature 1,2,3. Express counter
5	**Lecture No. 5. Peculiarities of risks in the power industry** 5.1. Types of risks of energy complexes 5.2. Peculiarities of risks in the state's electric power industry 5.3. Peculiarities of risk management in electric power Self-test questions for Lecture No. 5 Literature 1-3,5,6. Calculation robot
6	**Lecture No. 6. Technical risks in the power industry** 6.1. External and internal energy risks 6.2. The main reasons for the appearance of technical risks Self-test questions for Lecture No. 6 List of sources of reference to Lecture No. 6 Literature 1-4 Express control
7	**Lecture No. 7. Risks of electric power projects** 7.1 Management of risk event development scenarios 7.2 Analysis of studies on technical risk management 7.3. Technical risks Self-test questions for Lecture No. 7 List of references to Lecture No. 7 Literature 1-3, 5-8. Work calculations
8	**Lecture No. 8. Methods of quantitative risk analysis** 8.1. Bayes formula - hypothesis theorem 8.2. Establishing the risk of purchasing low-quality components 8.3. Implementation of the production task through the "Probability Tree" Self-test questions for Lecture No. 8 List of sources of reference to Lecture No. 8

	Options for Self-Test and Control Tasks Literature 1-3,5,6. Express control
9	**Lecture No. 9. The risk of lost profit in production** 9.1. Normative document ISO 31000 9.2. Risk of lost profits 9.3. Quantification of the risk of lost benefit 9.4. Factors affecting production downtime Tasks for the digital calculation of risks Self-test questions for Lecture No. 9 List of sources of reference to Lecture No. 9 Literature 1-3,5,6. Express control
10	**Lecture No. 10. The effect of voltage asymmetry on power plant resource consumption** 10.1. The effect of voltage asymmetry on the operation of electrical equipment 10.2. Coefficients of voltage asymmetry in the power grid of Ukraine 10.3. Categories of dangerous production facilities Conclusions Self-test questions for Lecture No. 10 List of reference sources for Lecture No. 10 Literature 1-3

11	**Lecture No. 11. Investigation of the consequences of technological violations in the operation of power plants** 11.1. Types of accidents and violations of the production cycle 11.2. Methodological features of calculating the spread of emissions into the atmosphere Self-test questions for Lecture No. 11 List of references to Lecture No. 11 Literature 1,2,3. Express control
12	**Lecture No. 12. Signs of energy company violations** 12.1. Accidents of the first category 12.2. Accidents of the second category 12.3. Refusals of the first category 12.4. Refusals of the second category List of reference sources for Lecture No. 12 Literature 1-4. Express control
13	**Lecture No. 13. Determination of underproduction of electrical energy** 13.1. Signs of accidents and violations 13.2. Determination of underproduction of electric and thermal energy 13.3. The main tasks of investigating and recording violations Self-test questions for Lecture No. 13 List of references to Lecture No. 13 Literature 1,2,3.
14	**Lecture No. 14. Analysis of the risk of theft or damage to the transformer** 14.1. Components of risk in electric power 14.2. Discrete and continuous risk assessment models 14.3. Risk of loss from theft of the transformer Self-test questions for Lecture No. 14 List of references to Lecture No. 14 Literature 1-8. Express control
15	**Lecture No. 15. Assessment of production risk** 15.1. Assessment of production risk

	15.2. Man-made accident risk indicator 15.3. Representation of production risk in monetary terms Self-test questions for Lecture No. 15 List of references to Lecture No. 15 Literature 1,6. Express control
16	**Lecture No. 16. Design calculation of technical system reliability** 16.1. Probability of fault-free operation of the system 16.2. Reliability calculation procedure Self-test questions for Lecture No. 16 Appendix A Calculation for lecture #16 Literature 1. Express control.
17	**Lecture No. 17. Loss of work capacity at work** 17.1. Clarification regarding the appointment and implementation of insurance payments 17.2. Insurance payments Example 17.1. Literacy 1,2 Express counter.
18	**Lecture No. 18. Calculation of annual payments based on a sick leave** 18.1. Information about the industrial potential of the Donetsk region of Ukraine. Open editions 18.2. Quantitative calculation of annual payments based on sick leave List of sources of reference to Lecture No. 18 **Final class. Test**

Practical training

The purpose of practical classes in the discipline "Technical risks" is to acquire knowledge, skills and consolidate experience in assessing operational risks when conducting scientific research and implementing innovative developments, taking into account current regulatory and legal acts.

In the course of practical work, students practice in determining, substantiating, analyzing, comparing possible risk situations when designing installations, choosing the main and auxiliary equipment, determining the actual mode of operation and performance indicators of the equipment; research and determination of the efficiency of electromechanical equipment operating modes.

The main tasks of the cycle of practical classes are the development of a technical risk plan for the creation and implementation of mechatronic equipment. Study of the risks of developing new equipment and technology of production processes.

6. Independent work of a student/graduate student

The student's independent work involves:
preparation for classroom classes - 60 hours;
preparation for the modular control work - 2 hours;
implementation of RGR - 10 hours;
preparation for the exam - 24 hours

The indicated types of independent work (preparation for classroom, calculations based on primary data obtained in laboratory classes, solving problems,

writing an essay, performing calculation work, performing homework control work, etc.) and the time allotted for it.

Tasks that are assigned to practical classes

Practical lesson № 1	Project risks
Practical lesson № 2	Risk of loss of working capacity
Practical lesson № 3	Calculation of lost profit
Practical lesson № 4	Calculation of accident risk zones
Practical lesson № 5	Risks of accidents on power lines
Practical lesson № 6	Risk of accidents at warehouses, chemical facilities
Practical lesson № 7	Determination of the quantitative risk of a mechatronic system
Practical lesson № 8	The risk of death of a worker at work
Practical lesson № 9	Risk of participation in hostilities

In the course of practical work, students practice in determining, substantiating, analyzing, comparing possible risk situations when designing installations, choosing the main and auxiliary equipment, determining the actual mode of operation and performance indicators of the equipment; research and determination of the efficiency of electromechanical equipment operating modes.

Policy and control

7. Policy of academic discipline (educational component)

At the time of the class, both lecture and practical, the student must have **Discord** or the **Zoom** application installed on the device from which he works (in the case of distance learning), and the course "Technical risks" on the "Sikorsky" platform must be opened (access code to the course is provided at the first lesson according to the schedule). Syllabus; lecture material; tasks for each practical session; variants of modular control work; tests to be completed after lectures; methodical recommendations for practical work and calculation and graphic work; variants of the credit test are posted on the "Sikorsky" platform and in the "KPI Electronic Campus" system.

The main tasks of the cycle of practical classes are the development of a technical risk plan for the creation and implementation of mechatronic equipment. Study of the risks of developing new equipment and technology of production processes.

The study of the academic discipline "Technical risks" requires the student of higher education:

- observance of educational and academic ethics;
- compliance with the schedule of the educational process;
- be balanced, attentive in classes;
- systematically study theoretical material;
- compliance with the schedule of protection of practical and laboratory works. The applicant's answer must demonstrate signs of independent performance of the assigned task, absence of signs of repetition and plagiarism.

If the student of higher education was absent from the lecture, then he should practice this lecture at another time (with another group, at a consultation).

If the student of higher education was absent from practical and laboratory classes, he should complete these classes at another time (with another group, at a consultation).

During the "Technical Risks" course, students must adhere to the general moral principles and rules of ethical behavior specified in the Code of Honor of the National Technical University of Ukraine "Igor Sikorski Kyiv Polytechnic Institute".

The deadlines for each task are specified in the "Technical Risks" course on the "Sikorsky" platform.

Everyone is obliged to comply with the requirements of the Regulations on the Academic Plagiarism Prevention System at the National Technical University of Ukraine "Igor Sikorski Kyiv Polytechnic Institute".

For participation in the All-Ukrainian Olympiad (competition of scientific works), a student is awarded 5 (I round) or 10 (II round) points. For writing an article and its publication, the student is awarded 10 points (a publication included in Scopus or Web of Science) or 6 points (a specialized publication of Ukraine). 3

points for publication of report abstracts at a scientific conference. The total amount of incentive points cannot exceed 10 points.

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

Current control: tasks within the framework of the practical lesson (total 9 × 4 points = 36 points), MKR (conducted directly in the practical lesson, in the presence of the teacher, 10 points), RGR (14 points). MKR is performed in the form of a test. The student performs the test directly during the lecture, 5-10 minutes before its end. At the end of the lesson, the test is closed and cannot be rewritten or completed at home. The test contains ten questions and several answers to each of them, one of which is correct. Each correct answer is valued at 1 point.

Tasks within the framework of a practical lesson are evaluated in 4 points according to the following criteria:

 "excellent" - a complete answer (at least 90 % of the required information), relevant justifications and a personal opinion are provided - 4 points;

 "good" - a sufficiently complete answer (at least 75 % of the required information), which is completed in accordance with the requirements for the "skills" level or contains minor inaccuracies – 3-2 points;

 "satisfactory" - an incomplete answer (at least 60 % of the required information), completed in accordance with the requirements for the "stereotype" level and containing some errors - 1 points;

 "unsatisfactory" - unsatisfactory answer - 0 points.

RGR is estimated at 14 points according to the following criteria:

 "excellent" - a complete answer (at least 90% of the required information), relevant justifications and a personal opinion are provided - 14 - 12 points;

 "good" - a sufficiently complete answer (at least 75 % of the required information), which is completed in accordance with the requirements for the "skills" level or contains minor inaccuracies - 11 - 8 points;

 "satisfactory" - an incomplete answer (at least 60 % of the required information), completed in accordance with the requirements for the "stereotype" level and containing some errors - 7 - 5 points;

 "unsatisfactory" - unsatisfactory answer - 0 points.

The requirements for writing the RGR are provided in the form of methodological recommendations and are posted on the "Sikorsky" platform and in the "KPI Electronic Campus" system.

Calendar control: conducted twice a semester as a monitoring of the current status of meeting the syllabus requirements. The condition for a positive first and second calendar control is to obtain at least 50% of the maximum possible rating at the time of the corresponding calendar control.

Semester control: exam. Conditions for admission to the semester control: completed and credited practical, MKR.

Students who have fulfilled all the conditions for admission to the test and have a rating of 60 and more points, they receive a grade corresponding to the obtained rating without additional tests.

The sum of the rating points received by the student during the semester is transferred to the final score evaluations according to the table.

Calculation of the rating scale (RS):

RC(max) = 9*4 + 1*10+1*14 = 60 points

RC(min) = 7*4 + 1*5+1*7 = 30 points

The exam paper is valued at 40 points. The control task of this work is composed of two theoretical questions from the list provided in the appendix to the syllabus.

Each question and task is evaluated in 20 points according to the following criteria:

- "excellent" - a complete answer (at least 90% of the required information), the relevant ones are provided

justification and personal view - 20 - 18 points;

- "good" - a sufficiently complete answer (at least 75% of the required information) that

performed in accordance with the requirements for the "skills" level or contains minor inaccuracies - 17 - 14 points;

- "satisfactory" - incomplete answer (at least 60% of the required information), completed

according to the requirements for the "stereotype" level and contains some errors - 13 - 10 points;

- "unsatisfactory" - unsatisfactory answer - 0 points.

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

Number of points	Evaluation
100-95	Excellent
94-85	Very good
84-75	Good
74-65	Satisfactory
64-60	is enough
Less than 60 Unsatisfactory	Unsatisfactorily
Admission conditions not met Not admitted	Unsatisfactorily

9. Additional information on the discipline (educational component)

Control questions on discipline "TECHNICAL RISKS"

1. Concept of risks of technical projects
2. Risk qualification system
3. Basic concepts of risk
4. Classification of risks
5. Brief description of individual risk categories
6. Basic concepts of risk theory
7. Concept of risks of technical projects
8. Basic concepts of risk theory
9. Initial identification of risks
10. Analysis of the causes of risks
11. Components of risk situations
12. Project risk management.
13. Prevention of losses from risky situations
14. Project risk management plan
15. Stages of the risk management plan
16. Allocation of resources to overcome risks
17. Prevention of losses from risky situations
18. Planning steps to prevent losses from risky situations
19. Allocation of resources to overcome risks
20. Planning activities and strategies for project quality management
21. Project quality management strategy
22. Planning activities and strategies for project quality management
23. Typical design errors related to product quality
24. Inadequacy of response to system errors (manufacturer errors)
25. Inadequacy of response to system errors (manufacturer errors)
26. Organization of obligations during design
27. Types of project commitments
28. Types of internal project obligations
29. Documentary recording of project obligations
30. Graph of obligations.
31. Qualitative and quantitative risk analysis
32. Analysis and risk assessment of technical projects
33. Quantitative risk analysis
34. Project sensitivity analysis
35. Analysis of project development scenarios
36. Method of simulation modeling
37. Characteristics of individual risk categories
38. Methods of assessing operational risks
39. Value-At-Risk (VaR) risk assessment method
40. Features of risk assessment methods
41. Relevance of management and choice of risk assessment method
43. Features of Value-At-Risk (VaR) risk assessment
44. Method of historical modeling
45. Using the Value-At-Risk (VaR) risk assessment method
46. Justification of the feasibility of using the VaR method
47. Semi variation and semi quadratic deviation when using the method
48. Use of the VaR method with asymmetric distribution of indicators
49. The risk of system inoperability due to failure of its element

50. Taking into account the risk and uncertainty of investment projects
51. Establishing the risk of purchasing low-quality components
52. Assessment of the risk of production cycle violations
53. Risk of building collapse from a gas explosion
54. Calculation of the amount at risk. VAR method
55. The method of paired comparisons when evaluating options (2 hours)
56. Analysis of the risks of implementing physical methods of water purification

Working program of the academic discipline (syllabus):

Compiled by the professor of the department of AEMK. Prof. O. Terentiev
Approved by the Department of AEMK (protocol No. 17 dated May 31, 2023)
Agreed by the Methodical Commission of the NNIEE (protocol No.9 dated June 22, 2023)