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

Department of Geoengineering

Underground Enterprises Reconstruction

Working program of the academic discipline (Syllabus)

Details of the academic discipline	
Level of higher education	***Second (master's)***
Branch of knowledge	*18 Production and technologies*
Specialty	*184 Mining*
Educational program	*Geoengineering*
Discipline status	*Normative*
Form of education	*Intramural (day)*
Year of training, semester	*1st year, autumn semester*
Scope of the discipline	*3.5 credits/105 hours (lectures - 27 hours, practical - 27 hours, independent work - 51 hours)*
Semester control/ control measures	*Exam/Modular control work/Computational and graphic work*
Lessons schedule	*http://roz.kpi.ua*
Language of teaching	*English*
Information about head of the course / teachers	*Lecturer: Doctor of Technical Sciences, Professor Kostiantyn Tkachuk, kkttkk297@gmail.com* *Practical / Seminar: Doctor of Technical Sciences, Professor Kostiantyn Tkachuk, kkttkk297@gmail.com*
Placement of the course	*https://classroom.google.com*

Program of educational discipline

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

A specialist who can apply acquired theoretical knowledge to determine the technical condition of structures and buildings, design reinforcement and repair of structures, geotechnical reconstruction.

The purpose *of teaching the educational discipline "Underground Enterprises Reconstruction" is to provide students with a basis for studying the main directions of development of the theory and practice of the reconstruction of the underground space of cities, to improve the ability to act in a new situation related to work in the specialty and the ability to generate new ideas in the field of mining; to develop and implement innovative products and measures to improve and increase the technical level of mining systems and technologies, ensuring their competitiveness; use basic knowledge of fundamental sciences to the extent necessary for mastering general professional disciplines and the ability to assess the technical condition of structures in accordance with the reliability and durability of structures.*

The subject *of study of the discipline is the technical condition of structures and buildings, strengthening and repair of structures, geotechnical reconstruction.*

Program competencies

3K1. The ability to act in a new situation related to work by profession and the ability to generate new ideas in the field of mining.
CK3. Ability to develop and implement innovative products and measures to improve and increase the technical level of mining systems and technologies, ensuring their competitiveness.

CK6. The ability to perform design works of special construction methods, mineral development facilities, take special measures for the reconstruction of underground structures and mining enterprises.

Program learning results.

PH1. To act in a new situation related to work by profession and the ability to generate new ideas in the field of mining.
PH8. Develop and implement innovative products and measures to improve and increase the technical level of mining systems and technologies, ensuring their competitiveness.
PH11. Carry out design works for special construction methods, mineral development facilities, take special measures for the reconstruction of underground structures and mining enterprises.

to know: *modern scientific approaches to the reconstruction of underground enterprises at various stages of design and basic concepts about the reliability and durability of structures, mechanisms of corrosion of materials and the destruction of underground structures and buildings;*

to be able: *to evaluate the technical condition of structures in accordance with the reliability and durability of structures; to determine the technical condition of stone, reinforced concrete and metal structures; to carry out calculations and construction of stone and reinforced concrete structures.*

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

Pre-requisites: Based on the studied educational components of the first (bachelor) level of higher education.

Post-requisites: is a formative discipline for mastering the educational component "Special methods of construction" and a final discipline in the formation of a master of mining profile when writing a master's thesis or qualification work.

3. Content of the academic discipline

Topic 1. Basic concepts about the reliability and durability of buildings
Topic 2. Corrosion mechanism of materials and structures
Topic 3. Mechanisms of destruction of underground structures and buildings
Modular control work (MCW) 1 on 1-3 topics
Topic 4. Determination of the technical condition of structures and buildings
Topic 5. Design of reinforcement and repair of structures
Topic 6. Geotechnical reconstructions
Modular control work (MCW) 1 on 4-6 topics
Computational and graphic work (CGW)
Exam

4. Educational materials and resources

Basic literature:

1. *Underground Engineering for Sustainable Urban Development. URL: https://www.pdfdrive.com/underground-engineering-for-sustainable-urban-development-e157631027.html*
2. *Engineering Geology for Underground Rocks. URL: https://www.pdfdrive.com/engineering-geology-for-underground-rocks-e30629835.html*
3. *Hencher S. Practical Rock Mechanics. URL: https://www.pdfdrive.com/practical-rock-mechanics-e186096352.html*
4. *Underground Engineering: Planning, Design, Construction and Operation of the Underground Space. URL: https://civilnode.com/download-book/10232812648649/underground-engineering-planning-design-construction-and-operation-of-the-underground-space*
5. *Handbook on Tunnels and Underground Works. URL: https://www.taylorfrancis.com/books/edit/10.1201/9781003256175/handbook-tunnels-*

underground-works-renato-casale-daniele-peila-andrea-pigorini-enrico-maria-pizzarotti-emilio-bilotta-claudio-giulio-di-prisco-salvatore-miliziano

6. *Underground Construction (Tunneling). URL: https://www.osha.gov/sites/default/files/publications/osha3115.pdf*

Educational content

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

Names of sections and topics	*Number of hours*			
	Total	*including*		
		Lectures	*Practical (seminar)*	*Independent work of student*
1	2	3	4	5
***Topic 1.** Basic concepts about the reliability and durability of buildings*	***6***	***4***	***2***	
***Topic 2.** Corrosion mechanism of materials and structures*	*6*	*4*	*2*	
***Topic 3.** Mechanisms of destruction of underground structures and buildings*	***6***	***2***	***4***	
***Modular control work** on 1-3 topics*	*2*			*2*
***Topic 4.** Determination of the technical condition of structures and buildings*	***10***	***6***	***4***	
***Topic 5.** Design of reinforcement and repair of structures*	*19*	*6*	*13*	
***Topic 6.** Geotechnical reconstructions*	***9***	***5***	***2***	***2***
***Modular control work** on 4-6 topics*	*2*			*2*
Computational and graphic work	***15***			***15***
Exam	*30*			*30*
Total hours	***105***	***27***	***27***	***51***

The name of the topic of the lecture and a list of main questions
Topic 1. Basic concepts about the reliability and durability of buildings
Lecture 1. Life cycle of buildings. The main stages of the life cycle: design, construction, overhaul, reconstruction, liquidation. Normative base.
Lecture 2. Technological and technical operation of buildings. Efficiency of technical operation of buildings. Basic procedures of technical operation of structures: supervision, care, repair. Reliability and durability of buildings. Operational qualities of buildings. Reliability, maintainability of buildings. Classes of buildings by capital and purpose. Standardization of durability of buildings. Physical and moral deterioration of buildings.
Topic 2. Corrosion mechanism of materials and structures
Lecture 3. Corrosion of metal structures and methods of their protection against corrosion. Types and mechanism of metal corrosion. Factors of metal corrosion. Methods of forecasting metal corrosion. Protection of metal structures from atmospheric corrosion. Protection of metal structures from soil corrosion.

Lecture 4. Corrosion of concrete, reinforced concrete and stone structures. The essence and types of corrosion of concrete. Corrosion of fittings. Indicators of frost resistance and water resistance of concrete. Methods of assessing the corrosiveness of the environment. Ways to protect concrete and reinforced concrete structures from corrosion. Primary protection against corrosion. Secondary protection against corrosion. Peculiarities of corrosion of stone structures.
Topic 3. Mechanisms of destruction of underground structures and buildings
Lecture 5. Deterioration of foundations and destruction of their foundations. Consequences of soaking the foundations. Subsidence of soils. Soil swelling. Frost heaving of soils. Sufosis subsidence of foundations. Subsidence of territories as a result of artificial lowering of groundwater. Construction in densely built-up conditions. Landslide areas. Change of loads and calculation schemes. Corrosion of the material of foundation structures.
Topic 4. Determination of the technical condition of structures and buildings
Lecture 6. Peculiarities of searches, surveys, design and execution of works during the reconstruction of buildings of existing enterprises. The need to determine the technical condition of structures and buildings before starting the design of reconstruction measures. Licensing of such works. Normative base. Combining design and construction. Design and production documentation. ***MCW-1***
Lecture 7. Deformations of structures and buildings and their measurement. Determination of strength and deformation characteristics of materials during examinations. Types of mechanical damage and their normalization.
Lecture 8. Determination of strength and deformation characteristics of materials during examinations. Types of mechanical damage and their normalization. Determination of actual loads. Characteristics of an aggressive environment.
Tasks for independent student work (ISW). Categories of technical condition of structures and methods of their determination.
Topic 5. Design of reinforcement and repair of structures
Lecture 9. General design rules for strengthening and repairing structures. Normative base for repair and strengthening of structures.
Lecture 10. Reinforcement of stone structures.
Lecture 11. Design solutions, technology of work performance.
Topic 6. Geotechnical reconstructions
Lecture 12. Methods of reconstruction of foundations and bases. Expansion of foundations. Moving the building onto piles.
Lecture 13. Transferring the building to a solid slab. Injection of the base of the building. Reinforcement of the base of the building. Restoration of waterproofing of buildings. ***MCW-2***
Lecture 14. Methods of strengthening foundation structures: injection, clips, shirts, extensions.

№	***Practical classes and a list of basic question***
1	Practical lesson № 1. Study of normative documents on the examination, determination and certification of the technical condition of buildings and structuresю Studying the rules of inspections and determining the technical condition of stone, concrete and reinforced concrete structures. Studying the rules of inspection and determining the technical condition of metal and wooden structures.
2	Practical lesson № 2. Studying the rules of inspections and determining the technical condition of waterproofing structures and anti-corrosion coatings. Studying the features of inspections and determining the technical condition of underground structures: tunnels, deep-laying collectors, pumping stations, basements. Study of regulatory and methodical documents on non-destructive methods of determining the strength of concrete structures.
3	Practical lesson № 3-5. Reinforcement of a reinforced concrete beam with an elastic support.

4	Practical lesson № 6-8. Reinforcement of a reinforced concrete column with a metal clip.
5	Practical lesson № 9-11. Reinforcement of the bolt with a sprengel screed.
6	Practical lesson № 12-14. Reinforcement of the crossbar with a horizontally tensioned screed. **Protection of CGW.**

6. Independent work of the student

The student's independent work (SIW), for which 51 hours are allocated, includes: study of educational material, preparation for classroom classes, performance of practical works (PW) and CGW*.*

The educational plan provides Individual tasks: to be completed by the student of the CGW*, for which 15 hours of independent work are allocated.*

Policy and control

6. Policy of academic discipline (educational component)

The system of requirements for the student.

- ***Attending classes is an integral part*** *of learning the material. The student's rating is formed through active participation in practical classes, namely in solving practical tasks and individual homework.*
- ***Students must adhere to the rules of behavior*** *in classes, in accordance with the Regulation on the organization of the educational process at Igor Sikorsky Kyiv Polytechnic Institute (https://kpi.ua/regulations) and the Principles of academic integrity or moral and ethical standards of conduct (https://kpi.ua/academicintegrity), in accordance with the normative legal documents of the University and the Rules of Study and Conduct of Igor Sikorsky Kyiv Polytechnic Institute, which are presented on the website at the University and at the link: https://pbf.kpi.ua/ua/2017/09/04/rules/. In case of violation of the rules of behavior in classes, in accordance with the Regulation on the organization of the educational process of Igor Sikorsky Kyiv Polytechnic Institute, Principles of academic integrity or moral and ethical standards of conduct, non-fulfillment of conditions of admission to semester control, deadlines for completing tasks for improper reasons, the student may be assigned the grade: "Removed". At the lecture, the teacher uses his own presentation material; uses Google Class to teach the material of the current lecture, additional resources, etc.; the teacher opens access to a certain Google Class directory for resetting electronic* CGW *and answers to MCW.*

  Practical work: *students carry out and complete tasks.*
- ***CGW:*** *students carry out and complete assignments. Points for the CGW are taken into account only if there is an electronic report and a printed CGW.*
- ***Modular control works*** *are performed in lectures without the use of aids (mobile phones, tablets, etc.); the result is forwarded in a file to the appropriate Google Class directory. If the control measures (protection of CGW + credit) are missed for valid reasons (illness or important life circumstances), the student is given the opportunity to additionally complete the control task during the next week.*
- ***Incentive points*** *are awarded for: active participation in lectures; preparation of reviews of scientific works; presentations on one of the proposed topics of the discipline, etc.*
- ***Penalty points:*** *not provided.*
- ***The policy of deadlines and rescheduling*** *is formed in accordance with the approved schedule of the educational process at the University (https://kpi.ua/year) and the Regulation on current, calendar and semester control of study results at Igor Sikorsky Kyiv Polytechnic Institute (https://kpi.ua/document_control). The schedule of deadlines and rescheduling in the academic*

discipline is presented in the Electronic Campus (https://ecampus.kpi.ua/) and in the dean's office of the faculty.

- ***The policy on academic integrity*** *by students provides, in particular: independent performance of educational tasks, current and final tasks, control of learning results (for persons with special educational needs, this requirement is applied taking into account their individual needs and capabilities); references to sources of information in case of use of ideas, developments, statements, information; compliance with the legislation on copyright and related rights; provision of reliable information about the results of one's own (scientific, creative) activity, used research methods and sources of information.*

7. Types of control and rating system for evaluating learning outcomes (RSE)

Current control: MCW, CGW.
Calendar control: is carried out twice a semester as a monitoring of the current state of fulfillment of the syllabus requirements.
The condition for a positive first and second calendar control is to obtain at least 50% of the maximum rating possible at the time of the corresponding intermediate control.
Semester control: exam.
Conditions for admission to the semester control: semester rating of more than 36 points and protection the CGW.

1. The rating of a student in a discipline consists of the points he receives for:
1) practical classes;
2) Calculation and graphic work;
3) modular control work;
4) the answer to the exam.

System of rating (weighted) points and evaluation criteria
The student's rating in the discipline consists of the following points:
1. Work in practical classes.
The weighted point is 1. The maximum number of points in all practical classes is equal to: 1 point × 8 = 8 points
2. Calculation and graphic work.
The weighted score is 20.: 20 points×1=20 points
- "excellent" complete answer (at least 95% of the required information) – 19-20 points;
- "very good", complete answer with minor inaccuracies - 18-17 points;
- "good", sufficiently complete answer with minor inaccuracies (at least 75% of the required information) - 16-15 points;
- "satisfactory", incomplete answer (at least 65% of the required information) - 14-13 points;
- "sufficiently", sufficient answer (at least 60% of the required information) - 12 points;
3. Modular control.
The weighted point is 16. The maximum number of points for all control works is equal to: 16 points × 2 = 32 points:
- "excellent" complete answer (at least 95% of the required information) – 15-16 points;
- "very good", complete answer with minor inaccuracies - 13-14 points;
- "good", sufficiently complete answer with minor inaccuracies (at least 75% of the required information) - 12 points;
- "satisfactory", incomplete answer (at least 65% of the required information) - 11-10 points;

- " sufficiently", sufficient answer (at least 60% of the required information) - 9 points;
4. Exam – 40 points.
Answers are evaluated in 10 (15) points according to the following criteria:
- "excellent", complete answer, at least 95% of the required information (complete, error-free solution of the task) - 9-10 (13-15) points;
- "very good", sufficiently complete answer, at least 85% of the required information or minor inaccuracies (complete solution of the task with minor inaccuracies) - 8-9 (12-13) points;
- "good", sufficiently complete answer, at least 75% of the required information or minor inaccuracies (complete solution of the task with minor inaccuracies) - 7-8 (10-12) points;
- "satisfactory", incomplete answer, at least 65% of the required information and some errors (the task was completed with certain shortcomings) - 6-7 (9-10) points;
- " sufficiently", incomplete answer, at least 60% of the required information and some errors (the task was completed with certain shortcomings) - 5-6 (7-8) points;
- "unsatisfactory", the answer does not meet the conditions for "satisfactory" - 0 points.
Bonus points for:
- performance of tasks to improve didactic materials in the discipline is awarded from 5 to 10 incentive points.

Calculation of the rating scale (R):
The sum of the weighted points of control measures during the semester is:

$$R_C = 8 + 20 + 32 = 60 \text{ points.}$$

The examination component of the scale is equal to 40% of R, namely:

$$R_E = R_C \frac{0,4}{1-0,4} = 60 \frac{0,4}{1-0,4} = 40 \text{ points.}$$

Thus, the rating scale for the discipline is: $R = R_C + R_E = 60 + 40 = 100$ *points.*

<u>For extramural education</u>.
Current control: MCW (32 points), CGW (28 points), exam (40 points). Structure of MCW and CGW, requirements for them and evaluation criteria:
MCW (32 points):
- "excellent" full answer (at least 95% of the required information) - 30-32 points;
- "very good", complete answer with minor inaccuracies - 26-29 points;
- "good", sufficiently complete answer with minor inaccuracies (at least 75% of the required information) - 23-25 points;
- "satisfactory", incomplete answer (at least 65% of the required information) - 20-22 points;
- "sufficiently", sufficient answer (at least 60% of the required information) - 18-19 points.
CGW (28 points):
- "excellent" complete answer (at least 95% of the required information) - 27-28 points;
- "very good", complete answer with minor inaccuracies - 24-26 points;
- "good", sufficiently complete answer with minor inaccuracies (at least 75% of the required information) - 21-23 points;
- "satisfactory", incomplete answer (at least 65% of the required information) - 18-20 points;
- "enough", sufficient answer (at least 60% of the required information) - 16-17 points.

The sum of the weighted points of control measures during the semester is:

$$R_C = 32 + 28 = 60 \text{ points.}$$

The exam is conducted in the same way as for full-time education.

Bonus points for:

- performance of tasks to improve didactic materials in the discipline is awarded from 5 to 10 incentive points.

The examination component of the scale is equal to 40% of R, namely:

$$R_E = R_C \frac{0,4}{1-0,4} = 60 \frac{0,4}{1-0,4} = 40 \text{ points.}$$

Thus, the rating scale for the discipline is: $R = R_C + R_E = 60 + 40 = 100$ *points.*

In order for the student to receive the appropriate grades (ECTS and traditional), his rating grade R is translated according to the table:

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

Number of points	***Estimate***
100-95	Excellent
94-85	Very Good
84-75	Good
74-65	Satisfactory
64-60	Sufficiently
Less than 60	Unsatisfactorily
Admission conditions not met	Not allowed

8. Additional information on the discipline (educational component)

Questions for the modular control work on 1-3 topics

1. The life cycle of structures.
2. The main stages of the life cycle: design, construction, overhaul, reconstruction, liquidation. Normative base.
3. Technological and technical operation of structures.
4. Efficiency of technical operation of buildings.
5. Basic procedures of technical operation of structures: supervision, care, repair.
6. Reliability and durability of buildings.
6. Operational qualities of buildings. Reliability, maintainability of buildings.
7. Classes of buildings by capital and purpose.
8. Standardization of durability of buildings.
9. Physical and moral deterioration of structures.
10. The influence of the air environment on buildings and the consequences of this influence.
11. The influence of atmospheric moisture on buildings and the consequences of this influence.
12. The influence of groundwater on buildings and the consequences of this influence.
13. The influence of negative temperature and stray currents on buildings and the consequences of these influences.
14. Seismic effects, biogenic effects on buildings and consequences of these effects.
15. Effects of man-made processes on structures and consequences of this influence. Man-made accidents.
16. Corrosion of metal structures and methods of their protection against corrosion.
17. Types and mechanism of metal corrosion. Factors of metal corrosion.
18. Methods of predicting corrosion of metals.
19. Protection of metal structures from atmospheric corrosion.
20. Protection of metal structures from soil corrosion.

21. Corrosion of concrete, reinforced concrete and stone structures.
22. The essence and types of corrosion of concrete.
23. Corrosion of fittings.
24. Indicators of frost resistance and water resistance of concrete.
25. Methods of assessing the corrosiveness of the environment.
26. Ways to protect concrete and reinforced concrete structures from corrosion. Primary protection against corrosion.
27. Ways to protect concrete and reinforced concrete structures from corrosion. Secondary protection against corrosion.
28. Peculiarities of corrosion of stone structures.

Questions for the modular control work on 4-6 topics

1. Types and mechanism of biological destruction.
2. Destructive fungi, destructive insects and worms.
3. Methods of protection and methods of restoration and strengthening of wooden structures.
4. Demolition of foundations and destruction of their basics.
5. Consequences of soaking the bases.
6. Subsidence of soils. Soil swelling.
7. Frost heaving of soils. Sufosis subsidence of foundations.
8. Subsidence of territories as a result of artificial lowering of groundwater.
9. Construction in densely built-up conditions. Landslide areas.
10. Change of loads and calculation schemes. Corrosion of the material of foundation structures.
11. Humidification and watering of structures and buildings.
12. Methods of protection against wetting and watering. Selection of protective materials.
13. Protective coatings, waterproofing, ventilation, drainage.
14. Elimination of humidity in underground rooms.
15. Causes of wear of tunnel fasteners and methods of their protection against corrosion.
16. Determination of the technical condition of structures and buildings.
17. Inspection of building structures.
18. Design and production documentation when determining the technical condition of structures and buildings.
19. Peculiarities of searches, surveys, design and execution of works during the reconstruction of buildings of existing enterprises.
20. Deformations of structures and buildings and their measurement. Types of mechanical damage and their normalization.
21. Determination of strength and deformation characteristics of materials during examinations.
22. The method of determining strength with Fizdel's hammer and Kashkarov's reference hammer.
23. Method of determination of strength by rebound and plastic deformation, optical method.
24. The method of determining the strength by tearing and chipping the rib of the structure.
25. Radiation method of determination of strength and thermal method.
26. Determination of actual loads.
27. Categories of technical condition of structures and methods of their determination.
28. General rules for designing, strengthening and repairing structures.
29. Reinforcement of reinforced concrete and stone structures: selection of methods and schemes of reinforcement. Design requirements.
30. Reinforcement schemes of reinforced concrete and stone structures.
31. Initial data and recommended classes of fittings and materials for reinforcing reinforced concrete and stone structures.

32. Calculations of the load-bearing capacity of brickwork when reinforced with metal, reinforced concrete, and plaster brackets. Design of the clip.
33. Calculation of the strength of reinforced concrete bending elements strengthened by the installation of additional reinforcement in the stretched zone.
34. Calculation of the strength of reinforced concrete bending elements reinforced by the installation of sheet reinforcement in the stretched zone.
35. Calculation of the strength of normal cross-sections of flexural reinforced concrete elements strengthened by the expansion of the compressed zone.
36. Methods of reconstruction of foundations and foundations. Expansion of foundations.
37. Methods of reconstruction of foundations and basics. Moving the building onto piles.
38. Methods of reconstruction of foundations and basics. Transferring the building to a solid slab.
39. Methods of reconstruction of foundations and basics. Injection of the base of the building.
40. Methods of reconstruction of foundations and basics. Reinforcement of the base of the building. Restoration of waterproofing of buildings.
41. Reinforcement of foundation structures by means of injection.
42. Reinforcement of foundation structures with the help of a clip.
43. The method of strengthening foundation structures by arranging a shirt.
44. Strengthening of foundation structures by means of extension.
45. Methods of repairing tunnel fasteners.

Working program of the academic discipline (syllabus):

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Approved by the Department of Geoengineering (protocol № 17 of June 17, 2022)

Agreed by the Methodical Commission of the Educational and Scientific Institute of Energy Saving and Energy Management (protocol № 12 of June 24, 2022)