Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Department of Geoengineering

Designing of opencast mining enterprises

Work program of the discipline (Syllabus)

Details of the Disciplines

Level of higher education	***Second (Educational and scientific)***
Branch of knowledge	*18. Production and technology*
Specialty	*184 Mining*
Educational program	*Geoengineering. Certificate program - Resource-saving technologies of subsoil use*
Discipline status	*Selective*
Discipline scope	*Full-time (day)/full-time (evening)/correspondence/distance/mixed*
Year of study, semester	*1 year of study, spring semester*
Discipline scope	*4 credits ECTS/120 hours (lectures – 27 hours, practical – 27 hours)*
Semester control / control measures	*Assessment / Modular control work / calculated graphic work*
Lessons schedule	*http://rozklad.kpi.ua/*
Language of Lecture	*Englich*
Information about course leader / lehrer	*Lecturer: Associate Professor of the Department of Geoengineering, Candidate of Technical Sciences, Associate Professor Nataliya Ivanivna Zhukova, nataliaz127@ukr.net, +380676962433* *Practical / Seminars Associate Professor of the Department of Geoengineering, Candidate of Technical Sciences, Associate Professor Natalia Ivanivna Zhukova, nataliaz127@ukr.net, +380676962433*
Course placement	*Available on the Sikorsky platform. The access code is provided by the teacher at the first lesson.*

Program of the discspline

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

In the current conditions in Ukraine, the problem of the lack of minerals, including fuel resources for the efficient and uninterrupted operation of industrial and communal enterprises, is worsening. The study of the discipline will give students of the specialty 184 Mining the opportunity to master modern approaches, methods and technologies of designing highly productive and environmentally safe mining enterprises. In the process of studying the discipline, students will study the following issues: the purpose and content of the quarry project, the organization of design works, design methods, including the automated design system, mathematical models of deposits, the design of the opening and development systems of mineral deposits, the economic basis of the quarry project, reclamation lands disturbed by mining operations.

The purpose of the discipline *is to provide the ability to design enterprises and individual objects of subsurface use from open-pit mining, to choose and apply modern design methods to determine the contours, depth and productivity of the pit.*

The subject of the discipline *is design of new and reconstruction of existing enterprises, study of design methods, environmental protection and rational use of material resources.*

Program learning outcomes.

Be able to draw up project documentation, technical and economic justification of project decisions, taking into account the regulatory framework. To justify and determine the optimal productivity of the quarry and the speed of development of mining operations based on existing design methods.

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

Prerequisites: in order to successfully master the discipline, the student must have knowledge of geology, engineering graphics, computer graphics, open-pit mining operations, mining and transport machines and complexes, rock destruction and industrial seismicity, economics and organization of production, reclamation of the earth's surface, ecology.

3. Content of the academic discipline

Topic 1. Organization of career design

Topic 2. Career design methods

Topic 3. Initial data for quarry design

Topic 4. Criterion for evaluating project solutions

Topic 5. Design of career contours

Topic 6. Methods of determining the final contours and pit depth

Topic 7. Formation of the working area of the career

Topic 8. Mathematical modeling of the working area of the quarry

Topic 9. Calendar schedule of mining works.

Topic 10. Career productivity design

Topic 11. Design of opening and field development systems

Topic 12. Designing the structure of complex mechanization

Topic 13. Designing a master plan

4. Educational materials and resources

Basic literature

1. *W. Hustrulid, M. Kuchta and R. Martin. Open Pit Mine Planning and Design. 3rd edition, CRC Press, USA, 2013. English, 1308 p.*
2. *Ashok Gupta, Dennis Yan. Mineral Processing Design and Operations, © Elsevier 2016 English p. 882.*
3. *Ravi Jain. Environmental Impact of Mining and Mineral Processing Management, Monitoring, and Auditing, © Butterworth-Heinemann 2015, English. p. 322.*
4. *A.J.S. (Sam) Spearing, Liqiang Ma, Cong-An Ma. Mine Design, Planning and Sustainable Exploitation in the Digital Age, ISBN 9781032028736. Published September 19, 2022 by CRC Press, 446 p. 322 B/W Illustrations.*
5. *Jaume Bech, Claudio Bini, Mariya Pashkevich. Restoration and Reclamation of Mining Influenced Soils Assessment, Language: English, Copyright: © Academic Press 2017, p. 520.*

6. *Frolov A.A., Kosenko T.V., Zhukova N.I. Innovative development of resource-saving technologies for mining. Formation of efficient energy flows at the contour blasting of borehole charges Multi-authored monograph. - Sofia: Publishing House "St. Ivan Rilski", 2018. - 196*

Additional literature

7. SME Mining Engineering Handbook, 2 Volume Set, Publication date 25 Feb 2011, 1984 p, Publisher *Society for Mining, Metallurgy, and Exploration*. *Publication City/Country Colorado, United States, Language English.*

8. *HL Hartman. Introductory Mining Engineering 2e, Publication date 29 Oct 2002 Publisher John Wiley & Sons Inc. Publication City/Country New York, United States .592 p*
9. *Barry A. Wills , By (author) James Finch. Wills' Mineral Processing Technology : An Introduction to the Practical Aspects of Ore Treatment and Mineral Recovery, Publication date 20 Nov 2015, 512 p, Publisher Elsevier Science & Technology, Imprint Butterworth-Heinemann Ltd. Publication City/Country Oxford, United Kingdom.*

Literature, the bibliography of which is provided with a link, can be found on the Internet. Literature, the bibliography of which does not contain references, can be found in the library of KPI named after Igor Sikorsky.
Certain sections of the basic literature [1]-[4] are mandatory for reading. Sections of the basic literature, which are mandatory for reading, as well as the connection of these resources with specific topics of the discipline are given below, in the methodology of mastering the academic discipline. All other literary sources are optional, it is recommended to familiarize yourself with them

Educational content

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

Lecture classes

№	The name of the topic of the lecture and a list of main questions (references to the literature)
Lecture 1	***Career design organization.*** *Introduction. Career project. Purpose, tasks and structure of the discipline. Object and subject of research. General information about designing. Purpose and content of the career project. Design stages. Organization of project works. The main tasks in career design. Technical, mining-geometric, economic and technical-economic tasks of the project. Methods of solving problems in design.* ***Literature:*** *[1, 2]*
Lecture 2	***Career design methods****. Career design methods. Method of options. Analytical method. Graphical and graphoanalytical methods. Machine design methods. Fundamentals of CAD methodology. Mathematical models of deposits. Error estimation and conditions of application of simple geometric, analytical and numerical models****.*** ***Literature:*** *[1, 2]*
Lecture 3	***Initial data for quarry design.*** *List of initial data and requirements for them. Normative documentation for design. Design tasks. Geological and reconnaissance materials. Mineral reserves, their calculation. Requirements for mineral reserves. Mining-geometrical analysis of the quarry field for horizontal, sloping, inclined and steep deposits. Mode of mining operations. Methods of mining and geometric analysis* ***Literature:*** *[1]*

Lecture 4	***Evaluation criteria for project solutions.*** *Capital expenditure. Cost of production. Operational expenses. Methods of determining capital and operating costs. Total unit costs. Profit. Profitability.* ***Literature:*** *[1]*
Lecture 5	***Design of career contours.*** *Types of career paths. Working and non-working sides of the career and their composition. Design and dimensions of transport berms. Mathematical modeling of the sides of the quarry. Methods of determining the final contours and depth of the cavity.* ***Literature:*** *[1, 2]*
Lecture 6	***Methods of determining the final contours and pit depth.*** *Methods of determining the final pit depth. Peculiarities of determining the final contours of the quarry on flat and horizontal deposits. Factors determining the optimal final pit depth. Determination of contours of deep quarries.* ***Literature:*** *[1, 2]*
Lecture 7	***Formation of the working area of the career.*** *Determination of the angle of inclination of the side of the quarry under the condition of placement of mining equipment. Elements of working and non-working boards.* ***Literature:*** *[1]*
Lecture 8	***Mathematical modeling of the working area of the quarry.*** *Mathematical modeling of the working area of the quarry. The concept of career work area modeling. Similarity models and stencil models. Modeling of the working area of the quarry on the cross section. Volumetric modeling of the working area of the quarry.* ***Literature:*** *[1]*
Lecture 9	***Calendar schedule of mining works.*** *Rational calendar schedule of excavation and mining operations and its features. Parameters of the stage schedule of mining operations. Calendar plan of mining works. Career mode according to the norms of technological design. Transformation of the schedule of mining and geometric analysis into a calendar schedule of mining operations.* ***Literature:*** *[1]*
Lecture 10	***Designing career productivity.*** *Justification of career productivity. The quality and quantity of commodity products and the relationship between them. Factors limiting career productivity. The procedure for determining the productivity of a quarry for minerals and overburden. Justification of optimal career productivity by the method of options.* ***Literature:*** *[1,2]*
Lecture 11	***Discovery design and field development systems.*** *The choice of the method of discovery of the deposit. Terms. Opening and preparation of new horizons. Methods of deposit discovery. Ways of carrying out overburden works. Calculation of overburden parameters. The procedure for solving problems when designing an opening. Design of excavation works with small and large capacity of excavation* ***Literature:*** *[1, 3]*
Lecture 12	***Designing the structure of complex mechanization.*** *Selection of the type of main mining equipment. Terms. Standards for the design of excavation works. Selection, working schemes of excavators. Methods of designing excavation works. Requirements for the design of the complex mechanization structure. Basic provisions when choosing the type of mining equipment. The procedure for designing the structure of complex mechanization. Choosing a rational mode of transport. Factors affecting the choice of a rational mode of*

	transport. Design procedure. Designing the limits of the use of different types of transport in quarries. ***Literature:*** *[1, 2, 3, 4, 5, 6]*
Lecture 13, 14	***Master plan design. General plan Concept of general plan.*** *General plan objects. Land and mining concession. A rational master plan and its features. Industrial site design. Dump design. Types of dumps. Dump parameters. Design of dumps during transportation of overburden by road, rail and conveyor transport. Designing schemes for transport-free landfill formation.* ***Literature:*** *[1, 2, 3, 4, 5]*

Practical training

№	Tasks that are assigned to practical classes
Practice session 1, 2	*Mining and geometric analysis of the quarry field for horizontal and sloping deposits (4 hours).*
Practice session 3, 4	*Transformation of the schedule of mining and geometric analysis into a calendar schedule of mining operations (4 hours).*
Practice session 5	*Determination of the volume, dimensions, productivity and service life of the quarry (2 hours).*
Practice session 6, 7	*Calculation of industrial mineral reserves (4 hours).*
Practice session 8	*Modular control work.*
Practice session 9, 10	*Modeling mineral deposits using simple geometric models (4 hours).*
Practice session 11, 12	*Analytical method of determining the volume, depth of the pit and the overburden coefficient (4 hours).*
Practice session 13	*Test.*

6. Independent work of a student/graduate student

The student's independent work involves:

preparation for classroom classes - 46 hours;

preparation for the module test - 4 hours;

execution of calculation work - 10 hours;

preparation for the test - 6 hours.

The name of the topic, for independent study

Calculation work: "determining the possible productivity of a mining pit and calculating the parameters of a technological scheme using a dragline" (determining the productivity of an overburden excavator and the parameters of a technological scheme with a simple transportless development system, choosing an excavator for mining, determining the width of the mine pit, determining the parameters of internal dumps, calculation of the daily advance of the face, determination of the working time of the overburden pit, determination of the possible productivity of the mining pit, calculation of mineral reserves ready for extraction.

After the work is completed, protection of the *Calculation work* is provided.

Policy and control

7. Policy of academic discipline (educational component)

At the time of each lesson, both lecture and practical, the student must have the Zoom application installed on the device from which he works (in the case of distance learning), and the course "Designing of open-cast mining enterprises" must be open on the "Sikorsky" platform (the 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 module test; methodical recommendations for the implementation of calculation work; variants of the credit test are posted on the "Sikorsky" platform and in the "KPI Electronic Campus" system.

During the course "Designing of opencast mining enterprises", students are obliged to adhere to the general moral principles and rules of ethical behavior specified in the Code of Honor of the National Technical University of Ukraine "Ihor Sikorskyi Kyiv Polytechnic Institute".

The deadlines for the completion of each task are specified in the course "Designing of opencast mining enterprises" on the "Sikorsky" platform.

All students, without exception, are obliged to comply with the requirements of the Regulations on the Academic Plagiarism Prevention System at the National Technical University of Ukraine "Ihor Sikorskyi Kyiv Polytechnic Institute".

Modular test papers are written in practical classes without the use of aids (mobile phones, tablets, etc.); the result is forwarded in a file to the appropriate Google Class Room directory;

For participation in the All-Ukrainian Olympiad (competition of scientific works), the 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 (RSE)

Current control:

1. The student's credit module rating is calculated out of 100 points. The starting rating (during the semester) consists of points that the student receives for:

- writing module test in a practical session (modular work consists of 3 questions - 20 points);

– performance and defense of practical works (6 works = 42 points);

– implementation and protection of calculation work (20 points);

– test (18 points);

2. Scoring criteria:

– 2.1. Modular test papers (maximum number of points – 20 points):

– "excellent" - complete answer (at least 90% of the required information) - 17.5-20 points;

– "good" - sufficiently complete answer with minor inaccuracies (at least 75% of the required information) - 13-17.0 points;

– "satisfactory" - incomplete answer (at least 60% of the required information) - 9-12.5 points;

– "unsatisfactory" - unsatisfactory answer (less than 60%) - <9 points.

2.2. Implementation and protection of practical works:

– performance of practical work - 7 points (7 points are awarded for high-quality work, 2 points for poor performance):

– "excellent" - a complete answer (at least 90% of the required information), relevant justifications and a personal opinion are provided - 7 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 - 5 points;

– "satisfactory" - an incomplete answer (at least 60% of the required information), completed in accordance with the requirements for the "stereotypical" level and containing some errors - 4 points;

– "unsatisfactory" - unsatisfactory answer - 0 points.

2.3. Execution and protection of calculation work (maximum number of points – 20 points):

– performance - a maximum of 10 points (9-10 points (90-100) are awarded for excellent work performance, 7.5-8.5 points (75-90%) for good performance, 6-7 points for satisfactory performance (60-75%), for unsatisfactory <6 points (<60%)),

– protection - a maximum of 10 points (9-10 points (90-100) are awarded for excellent protection of the work, 7.5-8.5 points (75-90%) for good protection, 6-7 points for satisfactory (60-75%), for unsatisfactory <6 points (<60%)).

2.4. Testing:

– the maximum number of points is 18 points. The test consists of 28 questions (0.5 points for a correct answer, 0 points for an incorrect answer).

Calendar control: is conducted 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 possible rating at the time of the corresponding calendar control.

Semester control: test. Conditions for admission to semester control: completed and credited practical work, module test and calculation work.

Students who have met all the admission requirements and have a rating of 60 or more points receive a rating corresponding to the rating without additional tests. The sum of the rating points received by the student during the semester is transferred to the final grade according to the table.

If the sum of the points is less than 60, but the practical works, module test, calculation work have been completed and credited, the student completes the credit control work. In this case, the sum of the points for practical work, module test, calculation work and for the credit control work is transferred to the final grade according to the table.

A student who received more than 60 points in the semester, but wants to improve his result, can take part in a credit test. In this case, the final result consists of the points obtained on the credit control work, points for module test, practical works and calculation work.

The credit control work is estimated at 42 points. The control task of this paper consists of three theoretical questions from the list provided in the appendix to the syllabus.

Each question is evaluated in 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 - 12-14 points;

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

– "satisfactory" - an incomplete answer (at least 60% of the required information), completed in accordance with the requirements for the "stereotypical" level and containing some errors - 6 - 7 points;

– "unsatisfactory" - unsatisfactory answer - 0 points.

For correspondence education

Current control: The structure of module test and calculation work, requirements for them and evaluation criteria are similar to those for full-time education and are listed above.

The sum of the starting points is transferred to the final grade according to the table.

Credit control work is estimated at 42 points as for full-time education. The evaluation criteria are given above.

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

Number of points	Evaluation
100-95	Perfectly
94-85	Very good
84-75	Fine
74-65	Satisfactorily
64-60	Enough
Less than 60	Unsatisfactorily
Admission conditions not met	Not allowed

9. Additional information on the discipline (educational component)

The list of questions submitted for semester control is given in the appendix to the syllabus.

A student of higher education has the opportunity to take an online course(s) on one or more topics provided by the work program of the academic discipline. The applicant can choose an online course independently or on the recommendation of a teacher. 1 hour of the course is valued at 0.83 points. The maximum number of hours that can be credited based on the results of non-formal education is 12 hours, accordingly the maximum number of points for such results is 10 points.

Working program of the academic discipline (syllabus):

Compiled by Associate Professor, Candidate of Technical Sciences, Associate Professor Nataliya Ivanivna Zhukova

Approved by the Department of Geoengineering

Agreed by the methodical council of Igor Sikorskyi KPI

Appendix to the syllabus

The list of questions that are submitted to the modular test

Option 1

1. Specify the content of technical specifications and types of project documentation.

2. Explain the main design tasks.

3. Reveal the concept of CAD. Specify the types of security.

Option 2

1. Describe the design stages.

2. Give the content of the career project.

3. Compare graphic and graphoanalytical design methods. The essence of the methods.

Advantages and disadvantages.

Option 3

1. Explain the method of options. The essence of the method. Advantages and disadvantages

2. Provide initial data for design

3. Describe the mining and geometric analysis of the quarry field

Option 4

1. Explain the essence of mathematical modeling of deposits

2. Explain the analytical design method.

3. Purpose and content of the career project.

Option 5

1. Simple geometric models, their application

2. Characterized the cost criteria of the optimality of project solutions.

3. Define the concept and types of career paths

Option 6

1. Digital models, their application.

2. Methods of designing career paths.

3. List the main tasks in designing a career.

Option 7

1. Describe the design of pit contours.

2. Method of discounting (method of reducing costs over time)

3. Specify the design and parameters of the sides of the quarry.

Option 8

1. Describe analytical models.

2. Describe the method of determining the final contours of a career.

3. List the types of project documentation.

Option 9

1. List and describe the documentation contained in the completed career project.

2. Modeling deposits using simple geometric models.

3. The essence of the method of options and the analytical method. Their advantages and disadvantages.

Option 10

1. Describe deposit modeling using digital models

2. Specify the composition and content of the career project.

3. Give the criteria for evaluating project solutions.

The list of questions submitted for semester control

1. *Visit machine design methods.*
2. *Throughput capacity of transport communications in the quarry.*
3. *Describe the calendar plan of mining operations.*
4. *To determine the stable angle of inclination of the working side of the pit from the conditions of the location of the working equipment on it.*
5. *Describe design methods.*
6. *Calendar mode of work at the quarry.*
7. *Design documentation used in quarry design.*
8. *The procedure for determining optimal career productivity.*
9. *Mineral reserves. Methods of counting stocks.*
10. *Determination of industrial mineral reserves.*
11. *Initial data for career design.*
12. *Requirements and design procedure of complex mechanization structure.*
13. *Give the concept of a development system. Types of development system. Calculation of development system parameters.*
14. *Determining the productivity of the mine and overburden quarry.*
15. *Features of determining the final depth and final contours of the quarry for horizontal and sloping deposits.*
16. *Calendar schedule of mining works. Characteristics of a rational calendar schedule of mining operations.*
17. *Design methods and stages.*
18. *Quarry is a design object. Composition of the career project.*
19. *Factors limiting career productivity.*
20. *Design and dimensions of pit sides. Calculation of the slope angles of the sides of the quarry.*
21. *Ways of conducting overburden works and calculating their parameters. Factors affecting the choice of the place of installation of overburden.*
22. *Application of the method of successive approximations to determine the final career contour.*
23. *Simple geometric, digital and analytical models used in career design.*
24. *Designing dumps.*
25. *Modeling of the working area of the quarry.*
26. *Types of career outlines and their design.*
27. *Mineral reserves. Categories of reserves by degree of intelligence. Methods of calculating mineral reserves.*
28. *Mining and geometric analysis of the quarry field. Give the methodology.*
29. *Design tasks.*
30. *Application of simple geometric models for modeling deposits.*
31. *Modeling of deposits.*
32. *Criterion for evaluating project solutions.*
33. *Designing career development.*
34. *Designing an industrial site.*
35. *Transformation of the schedule of mining and geometric analysis into a calendar plan of mining operations.*
36. *Give a description of the opening coefficients.*
37. *Design and dimensions of transport berms. Calculation of the angle of inclination of the non-working side of the quarry.*
38. *Factors limiting career productivity.*
39. *Complex project.*
40. *Concept of general plan and its types. General plan design.*
41. *Criteria for evaluating project solutions.*
42. *Initial data for career design.*

43. *Problems to be solved during the design of the opening.*
44. *Factors affecting the choice of location of overburden.*
45. *Design documentation used in quarry design.*
46. *Career opening. Characterize overburden, give parameters and calculation of overburden.*
47. *Mathematical modeling of the working area of the quarry. The concept of career work area modeling. Similarity models and stencil models.*
48. *Modeling of the working area of the quarry on the cross section. Volumetric modeling of the working area of the quarry.*
49. *Design of dumps during transportation of overburden by road, rail and conveyor transport.*
50. *Designing schemes for transport-free landfill formation.*