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

Department of geoengineering

MANAGEMENT OF TECHNOLOGICAL PROCESSES OF OPENCAST MINING

Working program of the academic discipline (Syllabus)

Details of the academic discipline	
Level of higher education	***Second (master's)***
Branch of knowledge	*Production and technologies*
Specialty	*184 Mining*
Educational program	*Geoengineering*
Certificate program	*Resource-saving technologies of subsoil use*
Discipline status	*Selective*
Form of education	*intramural (day)*
Year of training, semester	*1st year, spring semester*
Scope of the discipline	*120 (27/27/66)*
Semester control / control measures	*Assessment / modular control work / computational and graphic work*
Lessons schedule	
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	Google classroom

Program of educational discipline

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

The educational discipline "Management of technological processes of opencast mining" belongs to the cycle of professional training of selective educational components. It is intended to provide knowledge, skills and abilities on the issues of effective management of technological processes in the development of mineral deposits by the open method.

The *goal* of studying the discipline is the formation of students' abilities to justify, determine the optimal parameters of technological processes and use them for the extraction of minerals by an open method.

The *subject* of the study of the discipline is the methods and means of managing technological processes for the effective extraction of minerals by an open method.

Learning outcomes are the acquisition of general and special competencies and skills:

3К1. 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.

3К2. The ability to communicate with specialists and experts of various levels in other fields of knowledge.

СК1. Ability to identify, set, solve problems and make informed decisions in professional activities.

СК3. Ability to develop and implement innovative products and measures to improve and increase the technical level of mining systems and technologies, ensuring their competitiveness.

CK5. Ability to organize production processes and technical management of systems and technologies of mining and geoconstruction enterprises.

PH8. Develop and implement innovative products and measures to improve and increase the technical level of mining systems and technologies, ensuring their competitiveness.

PH10. Organize production processes and technical management of systems and technologies of mining and geoconstruction enterprises.

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 discipline is in the final part of the structural and logical scheme of the educational and professional master's training program in specialty 184 "Mining" under the educational program "Geoengineering" of the certificate program "Resource-saving technologies of subsoil use". The study of the educational discipline "Management of technological processes of opencast mining" is preceded by the disciplines from the bachelor's training program in the specialty 184 "Mining" (**pre-requisites**): "Higher mathematics", "General physics", "Geology", "Geomechanics", "Introduction to the specialty (Basics of mining production)".

After studying the discipline "Management of technological processes of opencast mining", the knowledge, abilities and skills obtained as a result of the study are needed for successful mastering (**post-requisites**) of educational components - pre-diploma practice and execution of a master's thesis.

3. Content of the academic discipline

Chapter 1. BASIC PROVISIONS OF OPENCAST MINING

Theme 1. GENERAL INFORMATION ABOUT OPENCAST MINING.

The essence of open pit mining. The concept of mining technology. Types of equipment. Quarry elements and calculation of their parameters. Coefficient of opening. The average coefficient of opening. The current coefficient of opening. Contour coefficient of opening. Limit coefficient of opening.

Theme 2. ELEMENTS AND MAIN PARAMETERS OF QUARRY.

Quarry elements. Basic concepts. The main parameters of the quarry. Volume of mining mass. Final quarry depth. Dimensions of the quarry at the level of the day surface and in the final contours. Angles of slopes of quarry board. Mineral reserves. Cutting volume. The ledge and its elements.

Theme 3. DEPENDENCE OF MINING WORKS ON NATURAL FACTORS. PERIODS AND PRODUCTION PROCESSES OF OPENCAST MINING.

Dependence of opencast mining on natural factors. The position of the deposit relative to the earth's surface. Types of deposits by angle of incidence. Types of deposits by capacity and shape. Simple, complex, scattered deposits. The influence of climatic factors on opencast mining.

Periods and production processes of opencast mining. Preparation period. Construction period. Operational period. The period of repayment of mining works and land reclamation. Basic production processes. Auxiliary production processes.

Chapter 2. PRODUCTION PROCESSES OF OPENCAST MINING

Theme 4. PREPARATION OF ROCKS FOR EXTRACTION.

Rocks as an object of opencast mining. Ways of preparing rocks for extraction. Thawing of rocks. Hydraulic methods of rock preparation. Mechanical loosening. Explosive fluffing.

Technological requirements for the quality of explosive loosening of rocks. Blasting methods. The method of well charges. Method of boiler charges. The method of hole charges. Method of chamber charges. Method of overhead charges.

Theme 5. DRILLABILITY OF MOUNTAIN ROCKS.

Drillability index. Drilling machines and technology of drilling explosive wells. Technical speed of well drilling. Classification of drilling machines. Rotary drilling machines. Ball drilling machines. Pneumatic impact machines. Calculation of productivity of drilling machines. Working fleet of drilling machines.

Theme 6. DESTRUCTION OF MOUNTAIN ROCKS BY EXPLOSION.

Specific consumption of the explosive substance. Categories of rocks according to the degree of depositability. Blast wells and their parameters. Diameter of wells. Depth of wells. Redrilling of wells. Angle of inclination of the well. The location and order of blasting wells. Charge initiation schemes. Construction of well charges. Calculation principle. Secondary grinding. Auxiliary work during drilling and blasting of wells.

Theme 7. EXTRACTING AND LOADING OPERATIONS.

General information about extracting and loading operations. Extracting and loading machines. Types of potholes. Methods of extraction and loading.

Classification and technological characteristics of excavators. Direct shovel. Draglines. Chain multi-bucket excavators. Rotary excavators.

Extraction of rocks with single-bucket excavators. Technological parameters of shovel and draglines. Technology of extracting mining mass and parameters of shovel pits. Mining mass extraction technology and parameters of draglines pits. Technological parameters of hydraulic excavators.

Extracting of rocks with multi-bucket excavators. Technology of extracting mining mass and parameters of pits of chain excavators. The technology of extracting mining mass and the parameters of pitting of rotary excavators. Calculation of the productivity of excavators.

Use of bulldozers, scrapers, loaders. Use of bulldozers during extraction and loading operations. The use of scrapers during removal and loading operations. The use of single-bucket loaders in the performance of extraction and loading operations.

Theme 8. MOVEMENT OF QUARRY LOADS.

The main types of quarry transport and their technological characteristics. Quarry vehicles. Technological characteristics of rolling stock. Technological characteristics of quarry roads. Calculation of the fleet of dump trucks, throughput and carrying capacity of roads. Organization of work of quarry vehicles.

Railway, conveyor and combined transport. Quarry railway transport. Characteristics of the route and rolling stock of railway transport. Road development schemes and organization of exchange operations on escarpments. Throughput and carrying capacity of the road. Calculation of the fleet of rolling stock.

Conveyor transport. Scope of application of conveyor transport in quarries. Schemes of work of conveyor transport in quarries and calculation of productivity. Combined quarry transport.

Theme 9. DUMPING OF OPEN ROCK.

The essence of the dumping process. Means of mechanization for stockpiling rocks. Dump parameters. Selection of the location of dumps. Dumping by motor vehicles. Dumping by railway transport. Dumping by conveyor transport.

Chapter 3. MANAGEMENT OF TECHNOLOGICAL PROCESSES OF MINING WORKS

Theme 10. FUNDAMENTALS OF MANAGEMENT OF TECHNOLOGICAL PROCESSES OF OPENCAST MINING.

Criteria for evaluating the efficiency of certain opencast mining processes. Interconnection of technological processes. Justification of rational parameters of technological processes in quarries. Mode of mining operations and factors affecting it. Economic bases of choosing a mode of mining operations. Regulation of the regime of mining operations.

Justification of the choice of the complex mechanization structure. Classification of complex mechanization structures. Principles of assembly of complex mechanization structures. General basics of complex mechanization structures.

4. Educational materials and resources

Basic literature

1. Traditions and innovations of resource-saving technologies in mineral mining and processing. Multi-authored monograph. Petroșani, Romania: UNIVERSITAS Publishing, 2019. 424 p. URL: http://lib.ktu.edu.ua/wp-content/uploads/2019/10/Monograph-6.pdf
2. Wetherelt A, Peter K, Wielen, V. Introduction to open pit mining. In: SME Mining Engineering Handbook. 2nd ed. Colorado: Society for Mining, Metallurgy, and Exploration Inc. 2011. p. 2161
3. Hustrulid W, Kuchta M, Martin R. Open Pit Mine Planning and Design—Volume 1: Fundamental. 3rd ed. London: Taylor and Francis. 2013. p. 995
4. Oggeri C, Fenoglio T, Godio A, Vinai R. Overburden management in open pits: Options and limits in large limestone quarries. International Journal of Mining Science and Technology. 2019. 29(2). 217-228
5. Copeland C. Mountaintop Mining: Background on Current Controversies. Congressional Research Service.7-5700. 2015. Available from: www.crs.gov. RS21421

Information resources

1. Library of Igor Sikorsky Kyiv Polytechnic Institute, http://kpi.ua/library.
2. Vernadsky National Library of Ukraine, www.nbuv.gov.ua/.
3. National Parliamentary Library of Ukraine, http://www.nplu.org/.
4. State Scientific and Technical Library of Ukraine, www.gntb.gov.ua.

Educational content

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

Lecture classes

№ з/п	The name of the topic of the lecture and a list of main questions (a list of didactic tools, references to the literature and tasks on the independent work of student)

1	*General information about opencast mining* The essence of opencast mining. The concept of mining technology. Types of equipment. Quarry elements and calculation of their parameters. Coefficients of opening (average, current, contour, limit)
2	*Elements and main parameters of the quarry* Quarry elements. Basic concepts. The main parameters of the quarry. Volume of mining mass. Final quarry depth. Dimensions of the pit at the level of the day surface and in the final contours. Angles of slopes of quarry board. Mineral reserves. Cutting volume. The ledge and its elements.
3	*Dependence of mining works on natural factors. Periods and production processes of opencast mining.* Dependence of opencast pit mining on natural factors. The position of the deposit relative to the Earth's surface and its types by angle of incidence, power and shape. Simple, complex, scattered deposits. The influence of climatic factors on opencast mining. Periods and production processes of opencast mining. Preparation period. Construction period. Operational period. The period of repayment of mining works and land reclamation. Basic production processes. Auxiliary production processes.
4	*Preparation of rocks for extraction* Rocks as an object of opencast mining. Ways of preparing rocks for extraction. Technological requirements for the quality of explosive loosening of rocks. Blasting methods. The method of well charges. Method of boiler charges. The method of hole charges. Method of chamber charges. Method of overhead charges.
5	*Drillability of mountain rocks* Drillability index. Drilling machines and technology of drilling explosive wells. Technical speed of well drilling. Classification of drilling machines. Rotary drilling machines. Ball drilling machines. Pneumatic impact machines. Calculation of productivity of drilling machines. Working fleet of drilling machines.
6	*Destruction of rocks by explosion* Specific consumption of the explosive substance. Categories of rocks according to the degree of depositability. Blast wells and their parameters. The location and order of blasting wells. Charge initiation schemes. Construction of well charges. Calculation principle. Secondary grinding. Auxiliary work during drilling and blasting of wells.
7	*Extracting and loading operations. Extraction of rocks with single-bucket excavators* General information about extracting and loading operations. Extracting and loading machines. Types of potholes. Methods of extraction and loading. Classification and technological characteristics of excavators. Direct shovel. Draglines. Chain multi-bucket excavators. Rotary excavators. Technological parameters of shovel and draglines. Technology of extracting mining mass and parameters of shovel pits. Mining mass extracting technology and parameters of draglines. Technological parameters of hydraulic excavators.
8	*Extracting and loading operations. Extraction of rocks with multi-bucket excavators* Technology of extracting mining mass and parameters of pits of chain excavators. The technology of extracting mining mass and the parameters of pits of rotary excavators. Calculation of the productivity of excavators. Use of bulldozers, scrapers, loaders. Use of bulldozers during extracting and loading operations. The use of scrapers during extracting and loading operations. The use of single-bucket loaders in the performance of extracting and loading operations.

9	*Movement of quarry loads. Quarry vehicles.* The main types of quarry transport and their technological characteristics. Quarry vehicles. Technological characteristics of rolling stock. Technological characteristics of quarry roads. Calculation of the fleet of dump trucks, throughput and carrying capacity of roads. Organization of work of quarry vehicles.
10	*Movement of quarry loads. Railway, conveyor and combined transport.* Quarry railway transport. Characteristics of the route and rolling stock of railway transport. Road development schemes and organization of exchange operations on escarpments. Throughput and carrying capacity of the road. Calculation of the fleet of rolling stock. Conveyor transport. Scope of application of conveyor transport in quarries. Schemes of work of conveyor transport in quarries and calculation of productivity. Combined quarry transport.
11	*Dumping of open rocks* The essence of the dumping process. Means of mechanization for stockpiling rocks. Dump parameters. Selection of the location of dumps. Dumping by motor vehicles. Dumping by railway transport. Dumping by conveyor transport.
12	*Basics of management of technological processes of opencast mining* Criteria for evaluating the efficiency of certain opencast mining processes. Interconnection of technological processes. Justification of rational parameters of technological processes in quarries.
13	*Management of technological processes of opencast mining operations. Mode of mining operations* Mode of mining operations and factors affecting it. Economic bases of choosing a mode of mining operations. Regulation of the regime of mining operations.
14	*Management of technological processes of opencast mining. Justification of the choice of the complex mechanization structure* Classification of complex mechanization structures. Principles of assembly of complex mechanization structures. General basics of complex mechanization structures.

Practical training

№ з/п	Name of the subject of the lesson and list of main questions (a list of didactic support, references to the literature and tasks on the independent work of student)
1	Graphic representation of elements of opencast mining
2	Determination of the volume, dimensions, productivity and service life of the pit, mineral reserves and coefficient of opening
3	Calculation of opening cuttings
4	Calculation of opening cuttings
5	Calculation of the productivity of the rotary drilling machine
6	Determination of the productivity of looseners and parameters of mechanical loosening of rocks
7	Preparation of rocks for extraction. Setting the required degree of grinding
8	Preparation of rocks for extraction. Choice of drilling method and type of drilling equipment
9	Calculation of drilling-blasting parameters
10	Calculation of a complex of extracting and loading equipment. Determination of the parameters of the elements of the development system
11	Calculation of a complex of extracting and loading equipment. Calculation of productivity of mining and opening equipment

12	Calculation of quarry transport equipment. Automobile transport
13	Calculation of quarry transport equipment. Railways transport

5. Independent work of the student

№ з/п	The name of the topic submitted for independent processing	Number of hours of independent work of the student
1	General information about opencast mining	6
2	Types, purpose and implementation of mining works in quarries	6
3	Technological processes and development systems of opencast mining	6
4	Ways of preparing rocks for extraction during their extraction by an open method	6
5	Preparation of rocks for extraction by drilling-blasting method	6
6	Extracting and loading processes in quarries	6
7	Methods of loads transportation. Types of quarry transport and their technological characteristics	6
8	Peculiarities of the process of dumping in quarries	6
9	Interrelationship of technological processes of mineral extraction in quarries	6
10	Ways of regulating the regime of mining operations	6
11	Variants of assembly of complex mechanization structures	6

Policy and control

6. Policy of academic discipline (educational component)

The method of studying the discipline consists in providing theoretical material in lectures, which is then consolidated in practical classes by solving individual problems. Theoretical material is provided in the form of lecture notes. An analytical review of resources (independent work of students) is used when working on individual topics independently, when searching for certain information. The level of training of the student in the discipline and its assessment is established by the rating system of evaluation (RSE) and is determined by the results of express controls, modular control tests, and, if necessary, the performance of credit control work.

The main goals of conducting modular control works (MCW):

- better assimilation of lecture material;
- checking the degree of assimilation of the acquired knowledge;
- development of the ability to use acquired knowledge to solve certain problems.

It is planned to carry out two modular control tests MCW) before each semester of student attestation.

MCW are held in practical classes for the 1st academic hour.

MCW consists of three separate tasks of the theoretical course for each student.

A set of control tasks for MCW are attached to the syllabus.

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

Current control: Modular control work, answers in practical classes, express control.

Modular control work (MCW). The MCW is divided into two control works with a duration of one academic hours each – 2×15 points = 30 points;

MCW rating scale:

– 14…15 points – the answer is full;
– 11…13 points – almost a full answer;
– 7...10 points – answer with minor flaws;
– 5...6 points – the answer has some shortcomings or is incomplete;
– 3...4 points – the answer is enough;
– 1...2 points – the answer is partial.

Work in practical classes (13 classes for 2 points each);
– 2 points – full or sufficiently complete answer (at least 75% of the required information);
– 1 point – incomplete answer (at least 50% of the required information) and minor errors;
– 0 points – the answer is missing or incorrect.

Express control at lectures (14 lecture classes for 1 point each):
– 1 point – the answer is correct;
– 0 points – the answer is incorrect.

Computational and graphic work (CGW) is estimated at 30 points according to the following criteria:
– 30-25 points – the work is done correctly in full;
– 24-20 points – the work is done generally correct with minor errors or deficiencies;
– 19-10 points – the work is done completely, but has some flaws;
– 0-10 points – the work is done incorrect, incomplete or not completed.

Calendar control: is carried out twice a semester as a monitoring of the current state of fulfillment of the syllabus requirements.

Evaluation of students during the calendar control (for 8 and 14 weeks of semesters) is carried out according to the value of the student's current rating at the time of attestation. If the value of this rating is at least 50% of the maximum possible at the time of attestation ("ideal student"), the student is considered attested. Otherwise, "not attested" is displayed in the attestation statement. Also, the student is not attested if he fails to complete the semester individual assignment, the deadline for submission of which was before the attestation week, or if he does not complete all the practical work planned for that time.

The condition of the first attestation is obtaining at least 18 points. The condition of the second attestation is obtaining at least 50 points and enrollment of CGW.

Semester control: credit.

Passing the theoretical material of the missed lectures and practical classes, as well as the completion and protect of the CGW, is a necessary condition for admission to the credit.

A student who received at least 60 points in the semester can take part in the credit test. In this case, the points obtained by him on the credit control work are final.

The credit control work is valued at 45 points. The control task of this work consists of three questions from the list provided in the appendix to the work program of the credit module.

Each question is valued at 15 points according to the following criteria:

- "excellent", full answer (at least 90% of the required information) - 45-40 points;
- "good", sufficiently full answer (at least 70% of the required information, or minor inaccuracies) - 39-31 points;
- "satisfactory", incomplete answer (at least 25% of the required information and some errors) - 30-11 points;
- "unsatisfactory", the answer does not meet the conditions for "satisfactory" - 10-0 points.

The total amount of rating points received by the student during the semester is transferred to the final grade according to the table.

Table of conversion of rating points to grades

Rating point of the acquirer	University scale of assessments of the level of acquired competences
95…100	Excellent
85…94	Very good
75…84	Fine
65…74	Satisfactorily
60…64	Sufficiently
Less than 60	Unsatisfactorily
Non-fulfillment of conditions for admission to semester control	Not allowed

8. Additional information on the discipline (educational component)

A list of questions to perform the MCW

MCW №1

1. Reveal the essence of opencast mining.
2. What is the coefficient of opening and what are they? Give the definition.
3. The main elements of a quarry, their definition.
4. Describe the main parameters of the quarry.
5. Define the ledge and its elements.
6. State the dependence of opencast mining operations on natural factors.
7. Periods of opencast mining operations.
8. Production processes of opencast mining.
9. Describe the rocks as an object of opencast mining.
10. What are the known methods of preparing rocks for extraction?
11. Technological requirements for the quality of explosive loosening of rocks.
12. What is the essence of blasting methods?
13. Drillability of rocks. Drillability index.
14. What drilling machines and drilling technologies are used in Ukraine?
15. What is the essence of calculating the productivity of drilling machines?
16. What is the specific consumption of an explosive substance and how is it determined?
17. The main parameters of explosive wells and their definition.
18. What are the locations and order of blasting wells?
19. Give charge initiation schemes.
20. What are the designs of well charges? The principle of charge calculation.
21. Reveal the essence of secondary crushing of rocks.
22. Give general information about extracting and loading operations.

MCW №2

23. Classification and technological characteristics of excavators.
24. What are the technological parameters of shovel and draglines?
25. Describe the technology of extraction of mining mass and the parameters of the pits of shovel.
26. Describe the technology of extraction of mining mass and the parameters of the pits of draglines.
27. What are the technological parameters of hydraulic excavators?
28. Technology of extracting mining mass and parameters of pits of chain excavators.

29. What is the technology of extracting mining mass and the parameters of pits of rotary excavators?
30. Calculate the productivity of excavators.
31. Describe the use of bulldozers for extracting and loading operations.
32. Describe the use of scrapers for extracting and loading operations.
33. How are single-bucket loaders used for extracting and loading operations?
34. What are the main types of quarry transport and their technological characteristics?
35. Provide technological characteristics of quarry vehicles and quarry roads.
36. How is the fleet of dump trucks, throughput and carrying capacity of roads calculated?
37. Organization of work of quarry vehicles.
38. Describe the route and rolling stock of quarry railway transport.
39. What are the road development schemes and the organization of exchange operations on the escarpments? Throughput and carrying capacity of the railway track.
40. Give the sequence of calculating the fleet of rolling stock of railway transport.
41. Conveyor transport. Scope of application of conveyor transport in quarries.
42. What are the schemes of operation of conveyor transport in quarries and calculation of its productivity?
43. Reveal the essence of combined career transport.
44. The essence of the process of process of dumping. Selection of the location of dumps.
45. What is the essence of dumping by motor vehicles?
46. Reveal the essence of dumping by railway transport?
47. The essence of the process of dumping by conveyor transport.

Working program of the academic discipline (syllabus):

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Approved by the department _____ (№ 19 from June 29, 2022)

Agreed by the Faculty's Methodical Commission[1] (protocol № __ from _____)