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

Department of geoengineering

# RESOURCE-SAVING TECHNOLOGIES OF MINING AND PROCESSING OF ROCKS

## Working program of the academic discipline (Syllabus)

### Details of the academic discipline

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|---|---|
| **Level of higher education** | ***Second (master's)*** |
| **Branch of knowledge** | *18 Production and technologies* |
| **Specialty** | *184 Mining* |
| **Educational program** | *Geoengineering* |
| **Certificate program** | *Geoengineering – SP Resource-saving technologies of subsoil use* |
| **Discipline status** | *Selective* |
| **Form of education** | *Intramural (daytime)/intramural (evening)/extramural/distance/mixed* |
| **Year of training, semester** | *1 year of study, spring semester* |
| **Scope of the discipline** | *4 credits* |
| **Semester control / control measures** | *Credit / Modular control work* |
| **Lessons schedule** | *http://rozklad.kpi.ua/* |
| **Language of teaching** | *English* |
| **Information about head of the course / teachers** | Lecturer: Professor of the Department of Geoengineering, Doctor of Technical Sciences, Professor Kostiantyn Tkachuk<br>Practical / Seminars: Professor of the Department of Geoengineering, Doctor of Technical Sciences, Professor Kostiantyn Tkachuk |
| **Placement of the course** | Available on the Sikorsky platform. The access code is provided by the teacher at the first lesson. |

### Program of educational discipline

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

*Global trends in mining are aimed at the maximum use and extraction of mineral reserves and the subsequent maximum possible restoration of the disturbed natural landscape of the area where mining operations were carried out. Therefore, the mastering of resource-saving technologies of extraction and processing of rocks is necessary for mining specialists.*

***The goal of the discipline*** *is to choose and rationally apply modern resource-saving technologies of mining and processing of rocks.*

***The subject of the discipline*** *is resource-saving technologies of mining and processing of rocks.*

***Program learning results.***

*K5. Ability to develop and implement resource-saving technologies for opencast mining and rock processing.*
*K6. The ability to determine measures to increase the degree of completeness of mineral extraction, maximum use of processing waste and reclamation of the earth's surface.*
*PH5. To optimize the technological processes of mining and processing of rocks in an open method according to the criteria of energy efficiency and resource conservation.*

*PH6. To be able to determine the efficiency indicators of enterprises according to the criterion of resource saving.*
*PH10. Be able to develop and realize (implement) innovative resource-saving technologies in order to increase the efficiency of subsoil use.*

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

*Before starting the study of the discipline "Resource-saving technologies of mining and processing of rocks", the student should be introduced with the basics of opencast mining, mining and geological conditions for the development of mineral deposits, and have a general idea of the technology and mechanization of opencast mining.*

## 3. Content of the academic discipline

*Topic 1. Assessment of the level of resource saving of classical technologies of opencast mining of mineral deposits.*
*Topic 2. Influence of open development of mineral deposits on the environment.*
*Topic 3. Resource-saving and environmentally safe designs of well charges.*
*Topic 4. Increasing the level of resource saving and environmental safety of mining complexes due to the parameters of drilling and blasting works.*
*Topic 5. The influence of the type of explosives and means of their initiation on the level of resource saving during opencast mining.*
*Topic 6. Dust suppression and neutralization of harmful gases without interfering with the technology of drilling and blasting.*
*Topic 7. Resource-saving rock processing technologies.*
*Topic 8. International experience of development and implementation of resource-saving technologies of subsoil use.*

## 4. Educational materials and resources

*Basic literature*


1. *Innovative development of resource-saving technologies for mining. Multi-authored monograph. Sofia: Publishing House "St.Ivan Rilski", 2018. 439 p.*
2. *Tverda O., Kofanova O., Repin M., Kofanov O., Tkachuk K., Guts N., Cabana E. A resource efficient and environmentally safe charge structure for mining in an open-pit. Mining of Mineral Deposits. 2021. Volume 15 (2021), Issue 4. P. 84–90.*
3. *Terentiev O., Tkachuk K., Tverda O., Kleshchov A. Mathematical model of the reverse water postpurification at mining enterprises when using electromagnetic focusing of contaminants. Eastern-European Journal of Enterprise Technologies. 2018. Volume 1, No 10 (91). P. 10–16. DOI: 10.15587/1729-4061.2018.122000*
4. *Tverda O., Plyatsuk L., Repin M., Tkachuk K. Controlling the process of explosive destruction of rocks in order to minimize dust formation and improve quality of rock mass. Eastern-European Journal of Enterprise Technologies. 2018. Volume 3, No 10 (93). P. 35–42. DOI: 10.15587/1729-4061.2018.133743*
5. *Tverda O., Kofanova O., Kofanov O., Tkachuk K., Polukarov O., Pobigaylo V. Gas-neutralizing and dust-suppressing stemming of borehole charges for increasing the environmental safety of explosion. Latvian Journal of Physics and Technical Sciences. 2021. Volume 58, Issue 4. P. 15–27. DOI: 10.2478/lpts-2021-0030*


*Additional literature*


1. *Tverda O., Hrebeniuk T., Tkachuk K., Repin M. Improvement of the rental payment system for special using of water by mining enterprises. Вісник КрНУ імені Михайла Остроградського. 2020. Випуск 2/2020 (121). С. 104–109. DOI: 10.30929/1995-0519.2020.2.104-109. URL: http://visnikkrnu.kdu.edu.ua/statti/2020_2_2020-2-104.pdf*

2. *Bilous A. Ya., Tverda O. Ya., Tkachuk K. K., Kofanova O. V., Kofanov O. Ye. Using crushed stone production waste for drinking water mineralization. Технічна інженерія. 2021. № 1 (87). С. 132–135. DOI: https://doi.org/10.26642/ten-2021-1(87)-132-135. URL: http://ten.ztu.edu.ua/issue/view/14148*
3. *Bondarenko A., Tverda O., Repin M., Tkachuk K., Kofanov O., Kofanova O. The use of waste from the production of gravel as fertilizer for cultivation of technical energy crops. Technology audit and production reserves. 2021. Vol. 3, No. 1 (59). P. 56–58. URL: http://journals.uran.ua/tarp/article/view/235198*
4. *Vovk O., Tkachuk K., Tverda O., Syniuk A., Kukuiashnyi E. Waste-Free Technology for The Production of Building Materials by Mining and Processing Plants. International Symposium on Sustainable Aviation – ISSA21 – Abstract Book. 2021. P. 50. URL: https://2021.issasci.org/wp-content/uploads/2022/03/ISSA21-Abstract-Book.pdf*

*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 Igor Sikorsky Kyiv Polytechnic Institute.*
*Certain sections of the basic literature [1]-[5] are mandatory for reading. The teacher will indicate the sections of the basic literature that are mandatory for reading in the corresponding lesson. 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**

| № in order | The name of the topic of the lecture and a list of main questions (references to the literature) |
|---|---|
| **Lecture 1** | **Assessment of the level of resource saving of classical technologies of opencast mining of mineral deposits**<br>Resource saving. Resource availability. Consequences of the application of classical technologies of opencast mining of mineral deposits for the environment. Basic principles of rational subsoil use. Modern requirements for completeness and quality of mineral extraction. Methods of forming modern resource saving policy. Resource saving management system at the enterprise. Environmentalization of open development of mineral deposits. |
| **Lectures 2-3** | **Influence of open development of mineral deposits on the environment**<br>The main sources and types of atmospheric pollution in the process of conducting opencast mining operations. Characteristics of sources of dust emission in the process of opencast mining of mineral deposits. Emissions of gaseous pollutants during mass explosions in quarries. Factors affecting the ingress of dust and gases into the atmosphere during the operation of mining complexes. The main technological and engineering measures aimed at reducing dust and gas emissions during mass explosions. The main sources and types of pollution of water objects in the process of conducting opencast mining operations. The reasons for the formation of dumps and their influence on the environment. The basics of environmental safety management and the level of resource saving during the operation of mining complexes. |
| **Lectures 4-5** | **Resource-saving and environmentally safe designs of well charges**<br>Comparison of the designs of well charges used during opencast mining according to the criteria of resource saving and energy efficiency. Comparison of the designs of wellhead charges used during opencast mining according to the criterion of resource saving and energy efficiency. Analysis of modern developments of structures of well charges. |

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| **Lecture 6** | **Increasing the level of resource saving and environmental safety of mining complexes due to the parameters of drilling and blasting works**<br>Determining the size of the network of wells and the direction of cutting from the point of view of resource saving. Selection of switching schemes taking into account the structural and textural features of the mining massif. |
| **Lectures 7-8** | **The influence of the type of explosives and means of their initiation on the level of resource saving during opencast mining**<br>Explosive mixing of the simplest composition type AN-FO. Emulsion explosives. Analysis of the experience of the USA and EU countries in the field of creation, production and use of explosives. Criteria for choosing an explosive substance. Non-electrical initiation systems. The influence of the chemical composition of the explosive substance on the output of harmful gases during mass explosions in quarries. |
| **Lecture 9** | **Dust suppression and neutralization of harmful gases without interfering with the technology of drilling and blasting**<br>Methods of dust suppression in quarries. Methods of neutralization of harmful gases. Organizational measures aimed at dust suppression and minimization of harmful gases. |
| **Lectures 10-12** | **Resource-saving rock processing technologies**<br>Crushed stone and sand production. Production of bricks, glass, cement, ceramic and asbestos-cement products. Coking of coal. Facing stone processing. Directions for utilization of crushed stone production waste based on the extraction of silica from them. Use of rubble production waste as fertilizers for growing technical energy crops. Use of mining and processing wastes of non-metallic minerals for mineralization of drinking water. Waste-free technology of production of building materials by mining and processing plants. |
| **Lectures 13-14** | **International experience of development and implementation of resource-saving technologies of subsoil use**<br>Resource-saving technologies used by the world's leading mining companies. World concepts and strategies for creating technological equipment for mining operations. Implementation of world achievements in the mining industry of Ukraine. |

**Practical classes**

| № in order | Tasks that are given for practical classes |
|---|---|
| **Practical classes 1-2** | Determination of the level of resource saving of the proposed technology of opencast mining of a mineral deposit. Development of recommendations for increasing the level of resource saving during quartzite mining. |
| **Practical classes 3-4** | Assessment of the influence of poisonous gases and rock dust, formed as a result of mass explosions during the open mining of mineral deposits, on the state of the environment in the surrounding areas. Calculation of the risk to the health of the population of the territories adjacent to the quarry from atmospheric air pollution with Carbon (II) oxide and Nitrogen (IV) oxide. To propose ways (technologies, methods, measures) to reduce the influence of blasting on the environment. |
| **Practical classes 5-6** | Calculation of the parameters of the resource-saving structure of the well charge. To propose ways to improve the design of the charge in order to increase the level of resource saving and reduce the impact of blasting on the environment. |
| **Practical classes 7-8** | Calculation of the parameters of the resource-saving design of the wellhead plug. To propose methods of improving the design of the pit in order to increase the level of resource saving and reduce the impact of blasting on the environment. |
| **Practical classes 9-10** | Selection of an explosive substance for given mining and geological conditions from the point of view of resource saving and resource efficiency. Compilation of the list of the most environmentally safe explosives used in the world during blasting at mining enterprises. |

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| **Practical classes 11-12** | Create a closed cycle or transfer the mining enterprise to the rails of the circular economy (solutions are worked out on the example of a specific enterprise). |
| **Practical class 13** | Modular control work. |
| **Practical class 14** | **Credit.** |

### 6. Independent work of a student/graduate student

*The student's independent work involves:*

*preparation for classroom classes - 56 hours;*

*preparation for the Modular control work - 4 hours;*

*preparation for the credit - 6 hours.*

## Policy and control

### 7. Policy of academic discipline (educational component)

*At the time of each class, both lecture and practical, the student must have the Zoom application installed on the device from which he works (subject to distance learning), and the course "Mineral Processing and Enrichment Technologies" must be open on the platform " Sikorsky" (the access code to the course is provided at the first lesson according to the schedule). Classes according to the schedule are provided in the classroom or using the Zoom application (subject to distance learning). Syllabus; lecture material; tasks for each practical session; variants of modular control work; variants of the credit test are placed on the "Sikorsky" platform and in the "KPI Electronic Campus" system.*
*During the course "Mineral Processing and Enrichment Technologies", 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 "Igor Sikorsky Kyiv Polytechnic Institute".*
*The deadlines for the completion of each task are specified in the course "Mineral Processing and Enrichment Technologies" 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 "Igor Sikorsky 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 (edition included in Scopus or Web of Science) or 6 points (professional 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 results (RSE)

*Current control: activity in lecture classes (14 lectures × 1 point = 14 points), practical work (6 practical work × 10 points = 60 points),* Modular control work *(conducted directly in the practical class, in the presence of the teacher, 26 points).*
*Practical work is evaluated in 10 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 - 10-9 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 - 8-7 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 - 6 points;*
- *"unsatisfactory" - unsatisfactory answer - 0 points.*

*Modular control work (MCW) is estimated at 26 points and consists of two tasks: theoretical and practical (applied). Each task is evaluated at 13 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 - 13 - 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 - 10 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 - 9 - 8 points;*

– *"unsatisfactory" - unsatisfactory answer - 0 points.*

*For those students who could not perform it on time, a separate time is assigned at the end of the semester.*

***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:*** *credit. Conditions for admission to the semester control: completed and credited MCW, as well as a rating of at least 36 points.*

*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 points is less than 60, but greater than or equal to 36, and the MCW has been completed and credited, the student completes the credit control work. In this case, the sum of points for the MKR and for the final test 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 final test and the points for the MCW.*

*The credit control work is estimated at 74 points. The control task of this work consists of two theoretical questions from the list provided in the appendix to the syllabus and exercise.*

*Each theoretical question is estimated at 23 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 - 23 - 21 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 - 20 - 17 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 - 16 - 14 points;*

– *"unsatisfactory" - unsatisfactory answer - 0 points.*

*The exercise is estimated at 28 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 - 28 - 25 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 - 24 - 21 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 - 20 - 17 points;*

– *"unsatisfactory" - unsatisfactory answer - 0 points.*

<u>For extramural education</u>

***Current control:*** *MCW (26 points). The structure of MCW, its requirements and evaluation criteria are similar to those for intramural education and are listed above.*

***Semester control:*** *credit. Conditions for admission to the semester control: completed and credited MCW, as well as a rating of at least 36 points.*

*Students who have performed the conditions for admission to the credit, perform the credit control work. The sum of points for the MCW and for the credit control work is transferred to the final grade according to the table.*

*Credit control work is estimated at 74 points as for intramural education. The evaluation criteria are given above.*

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

| *Number of points* | *Rating* |
|---|---|
| 100-95 | Excellent |
| 94-85 | Very good |
| 84-75 | Fine |
| 74-65 | Satisfactorily |
| 64-60 | Sufficiently |
| 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. A student 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 of the Department of Geoengineering, Doctor of Technical Sciences, Associate Professor Tverda Oksana Yaroslavivna

**Approved** by the Department of Geoengineering (protocol № 18 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)