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**Federal State Autonomous Educational Institution for Higher Education
PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA
NAMED AFTER PATRICE LUMUMBA
(RUDN University)**

Academy of Engineering

educational division (faculty/institute/academy) as higher education programme developer

COURSE SYLLABUS

Modeling of Mineral Deposits

course title

Recommended by the Didactic Council for the Education Field of:

05.04.01 Geology

field of studies / speciality code and title

The course instruction is implemented within the professional education programme of higher education:

Mining Geology

higher education programme profile/specialisation title

1. COURSE GOAL(s)

The goal of the course “Modeling of Mineral Deposits” is acquiring knowledge, skills and experience in the field of analysis and interpretation of geological information, as well as the construction of 2D and 3D models of subsoil plots in accordance with the task and using modern mining and geological information systems that characterize the stages of competence formation and ensuring the achievement of the planned results of the educational programme.

The main objectives of the course are:

- study and analysis of modern methods and approaches in the construction of resource, lithological and other types of geological models;
- formation of skills and abilities in the field of constructing frame and block models of subsoil plots;
- study and analysis of the scope of modern methods of geostatistical analysis;
- acquisition of skills in working with modern mining and geological information systems to solve problems in the field of professional activity in accordance with the profile of the educational program.

2. REQUIREMENTS TO LEARNING OUTCOMES

The course implementation is aimed at the development of the following competences (competences in part):

Table 2.1. List of competences that students acquire during the course

Competence code	Competence descriptor	Competence formation indicators (within this course)
GC-2	Able to manage a project at all stages of its life cycle.	GC-2.1. Formulates a problem whose solution is directly related to the achievement of the project goal;
		GC-2.2 Identifies the connections between the tasks and the expected results of their solution;
		GC-2.3 Identifies the available resources and constraints within the assigned tasks and the applicable legal regulations.
GC-6	Able to identify and implement the priorities of their own activities and ways to improve it based on self-assessment.	GC-6.1 Controls the amount of time spent on specific activities;
		GC-6.2. develops time management tools and methods for accomplishing specific tasks, projects, and goals;
		GC-6.3 Analyze one's resources and their limits (personal, situational, time, etc.) to successfully complete the assigned task.
GC-7	Capable: - search for the necessary sources of information and data, perceive, analyze, memorize and transmit information using digital means, as well as using algorithms when working with data received from	GC-7.1 Searches for relevant sources of information and data, perceives, analyzes, remembers and communicates information using digital tools and algorithms when working with data from various sources in order to effectively use the information to solve problems;
		GC-7.2 Evaluates information, its reliability, and draws logical conclusions from incoming information and data.

Competence code	Competence descriptor	Competence formation indicators (within this course)
	various sources in order to effectively use the information received to solve problems; - evaluate information, its reliability, build logical conclusions based on incoming information and data.	
GPC-2	Able of independently formulating the research objectives and establishing a sequence for resolving professional problems.	GPC-2.1. Knows the basics and methods of organizing research activities, methods of setting goals and methods of achieving them; GPC-2.2. is able to develop research methods; GPC-2.3. has methods of establishing cause-effect relationships and identifying the most significant among them and skills of independent formulation of research objectives.
PC-1	Capable of processing geological data, modeling ore bodies with modern software, resolving quality and mineral reserve management issues, and developing engineering and geological surveying measures for the territory.	PC-1.1. Knowledge of the basics of geological structure of ore deposits, the possibility of using specialized software; PC-1.2. Is able to apply methods of geological data processing, build ore body models, solve problems on quality and mineral reserves management, develop measures for engineering and geological study of the territory; PC-1.3. Have the skills to process geological data and build models of ore bodies using modern software.
PC-2	Capable of justifying the need, choosing the best methodology, planning, implementing, interpreting results, and supervising geophysical work at various stages of mineral site development.	PC-2.1. Know the theoretical basics of geophysical research; PC-2.2 Know how to select the best methodology, design, implement, interpret the results of geophysical works;
SPC-4	Capable of designing, assisting with, and supervising a geologic study of a subsoil area at various stages of development.	PC-4.1 Know the theoretical basis and methods of geological study of the subsoil area at various stages of its development; PC-4.2 Be able to apply methodological solutions in the design and implementation of the geological study of a subsoil area at various stages of its development;

3. COURSE IN HIGHER EDUCATION PROGRAMME STRUCTURE

The course refers to the variable component of (B1) block of the higher educational programme curriculum.

Within the higher education programme students also master other (modules) and / or internships that contribute to the achievement of the expected learning outcomes as results of the course study.

Table 3.1. The list of the higher education programme components/disciplines that contribute to the achievement of the expected learning outcomes as the course study results

Competence code	Competence descriptor	Previous courses/modules	Subsequent courses/modules
GC-2	Able to manage a project at all stages of its life cycle.		Groundwater Dynamics; Applied Groundwater Modeling; Final state attestation
GC-6	Able to identify and implement the priorities of their own activities and ways to improve it based on self-assessment.		Final state attestation
GC-7	Capable: - search for the necessary sources of information and data, perceive, analyze, memorize and transmit information using digital means, as well as using algorithms when working with data received from various sources in order to effectively use the information received to solve problems; - evaluate information, its reliability, build logical conclusions based on incoming information and data.		Final state attestation
GPK-2	Able of independently formulating the research objectives and establishing a sequence for resolving professional problems.		Research Work (Mining Geology). Part 1; Research Work (Geological and Geophysical Survey). Part 1; Research Work (Mining Geology). Part 2; Research Work (Geological and Geophysical Survey). Part 2; Applied Groundwater Modeling; Final state attestation
SPC-1	Capable of processing geological data, modeling ore bodies with modern software, resolving quality and mineral reserve management issues, and developing engineering and		Pre-graduation Practical Training; Research Work (Geological and Geophysical Survey). Part 1; Research Work (Mining Geology). Part 1; Research Work (Geological and Geophysical Survey). Part 2; Research Work (Mining

Competence code	Competence descriptor	Previous courses/modules	Subsequent courses/modules
	geological surveying measures for the territory.		Geology). Part 2; Final state attestation
SPC-2	Capable of justifying the need, choosing the best methodology, planning, implementing, interpreting results, and supervising geophysical work at various stages of mineral site development.		Research Work (Geological and Geophysical Survey). Part 1; Research Work (Mining Geology). Part 1; Research Work (Geological and Geophysical Survey). Part 2; Research Work (Mining Geology). Part 2; Pre-graduation Practical Training; Mining Hydrogeology; Final state attestation
SPC-4	Capable of designing, assisting with, and supervising a geologic study of a subsoil area at various stages of development.		Pre-graduation Practical Training; Research Work (Geological and Geophysical Survey). Part 1; Research Work (Mining Geology). Part 1; Research Work (Geological and Geophysical Survey). Part 2; Research Work (Mining Geology). Part 2; Mining Hydrogeology; Final state attestation

4. COURSE WORKLOAD AND ACADEMIC ACTIVITIES

The total workload of the course “Modeling of mineral deposits” is 7 credit units.

Table 4.1. Types of academic activities during the periods of higher education programme mastering

Type of academic activities	TOTAL, ac. hrs.	Semesters/ training modules		
		1	2	
<i>Contact academic hours</i>	70	36	34	
Lectures (LC)	-	-	-	
Lab work (LW)	-	-	-	
Seminars (workshops/tutorials) (S)	70	36	34	
<i>Self-studies</i>	164	72	92	
<i>Evaluation and assessment (exam/passing/failing grade)</i>	18	0 <i>Failing grade</i>	18 <i>Exam</i>	
Course workload	academic hours	252	108	144
	credits	7	3	4

5. COURSE CONTENTS

Table 5.1. Course contents and academic activities types

Modules	Topics	Type of academic activities*
Module 1. Modeling in mining: types, main tasks and methods:	1.1.modeling in geology and mining; 1.2.statistical processing of geological data; 1.3.initial data for geological modeling at the stage of exploration and development of the deposit; 1.4.formation of a database containing initial geological data to build a block model of a solid mineral deposit. Search for errors in the geological database; 1.5.calculation of the conditional component for complex fields;	S
Module 2. Mining and geological information systems:	2.1.mining and geological information systems, the main functionality and differences of software products.	S
Module 3. Outlining and construction of wireframe models of ore deposits:	3.1.delineation of ore bodies; 3.2.conditions and their interpretation in geometric and mathematical modeling; 3.3.wireframe modeling; 3.4.delineation of ore bodies in sections using a mining and geological information system; 3.5.substantiation of conditional parameters based on a variant enumeration (cut-off grade, minimum thickness of ore bodies, maximum thickness of barren interlayers); 3.6.operations on frames; 3.7.construction of a lithological model of an ore deposit.	S
Module 4. Block modeling of ore deposits of minerals:	4.1.block modeling; 4.2.construction of a block model of an ore deposit in a mining and geological information system; 4.3.selection and justification of the size of the elementary unit of the block model; 4.4.block model evaluation; 4.5.evaluation of the block model in the mining and geological information system.	S
Module 5. Fundamentals of geostatistics:	5.1.basic geostatistical methods; 5.2.application of the IDW - method in modeling ore deposits of minerals. 5.3.substantiation of the parameters of the search ellipse based on the variability of the properties of geological bodies.	S
Module .6. Dynamic geological models:	6.1.conditional modeling in modern mining and geological information systems; 6.2.frameless modeling; 6.3.application of neural network and other technologies for field modeling; 6.4.topographic surface modeling using neural networks; 6.5.the use of dynamic geological models in modern mining industry;	S

Modules	Topics	Type of academic activities*
	6.6.basics of simulation modeling: its scope, basic methods and approaches, experience in using simulation models to solve mining and geological problems.	

* LC - lectures; LW - lab work; S - seminars.

6. CLASSROOM EQUIPMENT AND TECHNOLOGY SUPPORT REQUIREMENTS

Table 6.1. Classroom equipment and technology support requirements

Type of academic activities	Classroom equipment	Specialised educational / laboratory equipment, software, and materials for course study (if necessary)
Computer Lab	A classroom for conducting classes, group and individual consultations, current and mid-term assessment, equipped with personal computers (in the amount of 21 pcs), a board (screen) and technical means of multimedia presentations.	Specialized software: <ul style="list-style-type: none"> • MS Office licensed software package, • Micromine, • GIS GEOMIX, • QGIS.
Seminar	A classroom for conducting seminars, group and individual consultations, current and mid-term assessment; equipped with a set of specialised furniture and technical means for multimedia presentations.	
Self-studies	A classroom for independent work of students (can be used for seminars and consultations), equipped with a set of specialised furniture and computers with access to the electronic information and educational environment.	

7. RESOURCES RECOMMENDED FOR COURSE STUDY

Main reading:

1. Ashoke K. Talapatra. "Geochemical Exploration and Modelling of Concealed Mineral Deposits". Springer Cham, 2020 - <https://doi.org/10.1007/978-3-030-48756-0>
2. Andy J. Howard, Chris Carey, David Knight, Jane Corcoran, Jen Heathcote. "Deposit Modelling and Archaeology". Historic England, 2020 - <https://historicengland.org.uk/images-books/publications/deposit-modelling-and-archaeology/>
3. Jacqui Coombes. "The Art and Science of Resource Estimation". Coombes Capability, 2008 - <https://www.geokniga.org/bookfiles/geokniga-art-and-science-resource-estimation.pdf>

Additional reading:

1. Mario E. Rossi, Clayton V. Deutsch. "Mineral Resource Estimation". Springer Dordrecht, 2013 - <https://doi.org/10.1007/978-1-4020-5717-5>
2. Ye Zhang "Introduction to Geostatistics". University of Wyoming, 2011 - <http://geofaculty.uwyo.edu/yzhang/files/Geosta1.pdf>
3. Mohammad Ehteram, Zohreh Sheikh Khozani, Saeed Soltani-Mohammadi, Maliheh Abbaszadeh. "Estimating Ore Grade Using Evolutionary Machine Learning Models". Springer Singapore, 2022 - <https://doi.org/10.1007/978-981-19-8106-7>

Internet sources:

1. Electronic libraries (EL) of RUDN University and other institutions, to which university students have access on the basis of concluded agreements:
 - RUDN Electronic Library System (RUDN ELS) <http://lib.rudn.ru/MegaPro/Web>
 - EL "University Library Online" <http://www.biblioclub.ru>
 - EL "Yurayt" <http://www.biblio-online.ru>
 - EL "Student Consultant" www.studentlibrary.ru
 - EL "Lan" <http://e.lanbook.com/>
 - EL "Trinity Bridge" <http://www.trmost.ru>
2. Databases and search engines:
 - electronic foundation of legal and normative-technical documentation <http://docs.cntd.ru/>
 - Yandex search engine <https://www.yandex.ru/>
 - Google search engine <https://www.google.ru/>
 - Scopus abstract database <http://www.elsevierscience.ru/products/scopus/>

*Training toolkit for self- studies to master the course *:*

1. Guidelines for students on the development of the course "Modeling of Mineral Deposits".

* The training toolkit for self- studies to master the course is placed on the course page in the university telecommunication training and information system under the set procedure.

8. ASSESSMENT TOOLKIT AND GRADING SYSTEM* FOR EVALUATION OF STUDENTS' COMPETENCES LEVEL UPON COURSE COMPLETION

The assessment toolkit and the grading system* to evaluate the competences formation level (competences in part) upon the course study completion are specified in the Appendix to the course syllabus.

* The assessment toolkit and the grading system are formed on the basis of the requirements of the relevant local normative act of RUDN University (regulations / order).

DEVELOPERS:

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