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

Applied Groundwater Modeling
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

2025

1. COURSE GOAL(s)

The goal of the course “Applied Groundwater Modeling” is to acquire knowledge, skills and experience in the field by providing students with sufficient training in the fundamental theory and application of groundwater modeling. This enables them to develop the necessary skill sets to address basic environmental problems commonly tackled through flow and solute transport modeling. Additionally, it involves characterizing the stages of competence formation and ensuring the achievement of the planned results of the educational programme.

The focus of this course will be on applying a suite of different hydrogeological modeling methods to examine flow and transport processes in the Earth.

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.
GPC-2	Able to 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. Knows how 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-3.	Capable of projecting, implementing, and managing a hydrogeological study of the territory during the exploration and development of a mineral deposit.	PC-3.1 Knows the theoretical foundations and methods of hydrogeological study of the territory at the stage of exploration and development of mineral deposits; PC-3.2 Knows how to apply methodological solutions in the design, implementation and management of hydrogeological study of the territory at the stage of exploration and development of mineral deposits; PC-3.3 Knows how to apply the knowledge and skills obtained in the design, implementation and management of the hydrogeological study of the territory at the stage of exploration and development of mineral deposits.

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	Modelling of Mineral Deposits;	Graduate Qualification Work
GPC-2	Able to independently formulating the research objectives and establishing a sequence for resolving professional problems.	Geological and Geophysical Basics of Mineral Prospecting and Exploration; Modelling of Mineral Deposits;	Work Experience Internship; Research Work; Graduate Qualification Work
PC-3.	Capable of projecting, implementing, and managing a hydrogeological study of the territory during the exploration and development of a mineral deposit.	Mining Geology; Mining Hydrogeology;	Work Experience Internship; Research Work; Pre-Graduation Practice; Graduate Qualification Work

4. COURSE WORKLOAD AND ACADEMIC ACTIVITIES

The total workload of the course "Applied Groundwater Modeling" is 4 credits.

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
			3
Contact academic hours		*28*	*28*
Lectures (LC)		-	-
Lab work (LW)		-	-
Seminars (workshops/tutorials) (S)		28	28
Self-studies		*89*	*89*
Evaluation and assessment (exam/passing/failing grade)		*27*	*27 Exam*
Course workload	academic hours	**144**	**144**
	credits	**4**	**4**

5. COURSE CONTENTS

Table 5.1. Course contents and academic activities types

Course module title	Course module contents (topics)	Academic activities types
	Topic 1.1. Principles of Ground-Water Flow	S
	Topic 1.2. Introduction to Numerical Simulation	S

Course module title	Course module contents (topics)	Academic activities types
Module 1. Principles and Procedures of Numerical Simulation	Topic 1.3. Hydrodynamic Groundwater Calculations	S
	Topic 1.4. Theoretical framework of computer simulation in hydrogeology	S
Module 2. Seepage and Groundwater Flow	Topic 2.1. Types of Groundwater flow	S
	Topic 2.2. Spatial discretization groundwater flow	S
Module 3. Numerical simulation of groundwater system	Topic 3.1. Hydrogeological conceptual model development	S
	Topic 3.2. Calibration Hydrodynamic model	S
	Topic 3.3. Predictive Modeling and Validation	S

** 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 (24 pcs.), a board (screen) and technical means of multimedia presentations.	Specialized software: • Surfer (or 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. Sanderson D.J., Zhang X., Numerical modelling and analysis of fluid flow and deformation of fractured rock masses, Elsevier, 2002 г., 300 p., ISBN: 0-08-043931-4, https://www.geokniga.org/books/30770

2. Fetter C.W., Applied hydrogeology / Applied hydrogeology, Waveland Press, 2018, 621p., , ISBN: 1-4786-3709-9, https://www.geokniga.org/books/31204

3. Merkel B.J., Planer-Friedrich B., Groundwater geochemistry. A practical guide to modeling of natural and contaminated aquatic systems, Springer, 2005 г., 206 стр., ISBN: 3-540-24195-7, https://www.geokniga.org/books/24600

4. Bloetscher F. Manual of water supply practices. Groundwater, American Water Works Association, 2014 г., 295 p., ISBN: 978-1-58321-964-5, https://www.geokniga.org/books/31486

Additional reading:

1. Schmid, Wolfgang, and Hanson, R.T., 2009, The Farm Process Version 2 (FMP2) for MODFLOW-2005—Modifications and Upgrades to FMP1: U.S. Geological Survey Techniques and Methods 6-A-32, 102 p. https://pubs.usgs.gov/tm/tm6a32/pdf/tm6a32.pdf

2. USGS Publications Warehouse, https://pubs.er.usgs.gov/

3. United states Environmental Protection Agency (EPA), https://www.epa.gov/

Additional reading (without public access):

1. Mary P. Anderson, William W. Woessner and Randall J. Hunt Book Applied Groundwater Modeling (Second Edition), Academic Press, 2015, Page iv, ISBN 9780120581030, https://doi.org/10.1016/B978-0-08-091638-5.00019-5

2. J.P. Brandenburg Geologic Frameworks for Groundwater Flow Models 2020 https://doi.org/10.21083/978-1-7770541-9-9

3. Hill, Mary C. (Mary Catherine) Effective groundwater model calibration: with analysis of data, sensitivities, predictions, and uncertainty/Mary C. Hill, Claire R. Tiedeman.

4. Bakker, M., & Post, V. (2022). Analytical Groundwater Modeling: Theory and Applications using Python (1st ed.). CRC Press. https://doi.org/10.1201/9781315206134

5. Konikow, L.F., Hornberger, G.Z., Halford, K.J., and Hanson, R.T., 2009, Revised multi-node well (MNW2) package for MODFLOW ground-water flow model: U.S. Geological Survey Techniques and Methods 6–A30, 67 p.

6. Poeter, Eileen Graphical Construction of Groundwater Flow Nets / Eileen Poeter and Paul Hsieh - Guelph, Ontario, Canada, 2020. 67 p.

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. The set of lectures on the course "Applied Groundwater Modeling".
2. Guidelines for students on the development of the course "Applied Groundwater Modeling".

* 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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