**TARAS SHEVCHENKO NATIONAL UNIVERSITY OF KYIV**

**INSTITUTE OF GEOLOGY**

Department: **Petroleum Geology**

**«APPROVED»**

Deputy Director on academic work

«29» 08 2025

# WORK PROGRAMME OF THE DISCIPLINE

# Earth's Deep Underground Hydrosphere and Deep Geothermal Energy ( Глибинна гідросфера Землі та глибинна геотермальна енергія)

**for student**

| | |
|---|---|
| **Branch of knowledge** | ***E Natural sciences, mathematics, and statistics*** *(Е Природничі науки, математика та статистика)* |
| **Training direction (Specialty)** | ***E4 Earth Sciences*** *(Е4 Науки про Землю)* |
| **Educational level** | ***Master*** *(Магістр)* |
| **Educational program** | ***"Petroleum Geology"*** *(Геологія нафти і газу)* |
| **Type of discipline** | *Mandatory (Обов'язкова навчальна дисципліна)* |

| | |
|---|---|
| **Teaching mode** | ***full-time studies*** *(денна форма навчання)* |
| **Academic year** | ***2025/2026*** |
| **Semester** | ***2*** |
| **Number of credits ECTS** | ***4*** |
| **Language of teaching, learning and evaluation** | ***English*** *(англійська мова)* |
| **Form of final control** | ***modular test*** *(залік)* |

Lecturer: *BAYSAROVYCH Iryna, PhD in Geology, Associate professor, Department of Petroleum Geology*

To be continued

for 20__/20__ _____(_____) «__»___ 20__
for 20__/20__ _____(_____) «__»___ 20__
for 20__/20__ _____(_____) «__»___ 20__

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**Kyiv - 2025**

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Затверджено
Завідувач кафедри геології найти і газу
_____ (Віктор ОГАР)
Протокол №_1_від __29.08.2025

APPROVED
Head of department of Petroleum Geology
_____ (OGAR.V.)
Protocol #1 29.08.2025

Approved by Scientific-methodical Commission of Institute of Geology
Схвалено науково-методичною комісією ННІ «Інститут геології»

Protocol # 1 29/08/ 2025 (Протокол №1 від «29» серпня 2025)

Head of the scientific methodical commission _____ (DEMIDOV V.)
Голова науково-методичної комісії (Всеволод ДЕМИДОВ)

**The aim of the discipline** - is to familiarize students with the basic modern views on the peculiarity of the structure of the deep Tectonosphere and the Hydrosphere and the existing mechanisms for the transfer of matter (including hydrocarbons and hydrothermal fluids) and energy.
The subject of the study is to establish the relationships between physical fields and environmental parameters that determine the processes of transporting dissolved substances in the deep zones of the Earth, as well as to study the prospects for the use of geothermal energy.

**Мета дисципліни** - ознайомити студентів з основними сучасними уявленнями про особливості будови глибинної тектоносфери та гідросфери, а також існуючими механізмами перенесення речовин (у тому числі вуглеводнів, гідротерм) та енергії. Предметом дослідження є встановлення взаємозв'язків між фізичними полями та параметрами навколишнього середовища, що визначають процеси перенесення розчинених речовин у глибинних зонах Землі а також вивчення перспектив використання геотермальної енергії.

**Preliminary requirements:**

1. basic knowledge of tectonics, the basics of geophysics, hydrogeology, geology of oil and gas
2. the level of English proficiency not lower than B1.

**Попередні вимоги:**

1. базові знання з тектоніки, основ геофізики, гідрогеології, геології нафти і газу;
2. рівень володіння англійською мовою не нижче В1.

## Annotation of discipline:

Academic discipline "Earth's Deep Underground Hydrosphere and Deep Geothermal Energy" that integrates the principles of classical natural sciences is part of education and professional training program for the education level "master" branch of knowledge ***E Natural sciences, mathematics, and statistics*** *(Е Природничі науки, математика та статистика)* Educational program: Petroleum Geology.

This discipline is obligatory (ОК15) for educational program "Petroleum Geology".

The discipline is taught in the 2nd semester of 1 year Master's degree program in volume - 120 hours (4 credits ECTS) including lectures - 24 hours, practical classes - 14 hours, consultations - 1 hours, independent study work - 81 hours. The course content provides two modules and two module tests. The discipline is finished by test.

**The tasks of the discipline** – to highlight the following issues:

- planetary deep geological and geophysical section of the Earth;
- global structures and fluid systems and their distribution;
- methods of study of deep processes;
- the nature of the connections between the parameters of the medium (permeability, porosity, temperature, pressure);
- the mechanisms of transport of matter (fluids, including aqua-fluids) and energy (heat fluxes);
- links between hydrogeological parameters and seismic activity, induced seismicity.
- Geothermal energy resources and modern technology of their usage.

***The achievement of the stated educational goals will facilitate the acquisition of the following general competences by students:***

- Ability to communicate with representatives of other professional groups at different levels (with experts from other fields of knowledge/types of economic activity). Здатність спілкуватися з представниками інших прфесійних груп різного рівня (з експертами з інших галузей знань /видів економічної діяльності) (ЗК 3).
- Ability to work in the international context. Ability for writing and verbal communication in Ukrainian and foreign languages. Здатність працювати в міжнародному контексті. Здатність до письмової та усної комунікації українською та іноземними мовами. (ЗК 4).
- Understanding of a planet as a unique single system, the most important issues of its inner structure and evolution. Розуміння планети як єдиної системи найважливіших проблем її будови та розвитку.

**The results of study:**

| Learning results (1. to know; 2. be able to; 3. communication; 4. autonomy and responsibility) | | *Methods of teaching and learning* | *Assessment methods* | *Percentage in the final assessment of the discipline* |
|---|---|---|---|---|
| *1.1* | planetary geological and geophysical section and the limits of distribution of the fluids of the corresponding composition; | *Lecture, practical class* | Paperwork | *5%* |
| *1.2* | the nature of the connections between the parameters of the medium (permeability, porosity, temperature, pressure); | *Lecture, practical class* | Paperwork | *5%* |
| *1.3* | mechanisms of transport of matter (soluts) and energy (heat flows); | *Lecture, practical class* | Paperwork | *10%* |
| *1.4* | the main interconnections between the processes of mass transport and heat transport in the deep layers of the Earth, including the petroleum system | *Lecture, practical class* | Paperwork | *10%* |
| *1.5* | Physical-geological preconditions of interconnections of seismic processes and hydrogeological conditions of environment. Induced seismicity | *Lecture, practical class* | Paperwork | *10%* |
| *1.6* | general principles of choice and substantiation of liquid filtration models in the deep layers of the Earth | *Lecture* | Paperwork | *10%* |
| *2.1* | use the data of geothermal research in the study of the deep hydrosphere, the formation of deposits of thermal waters and hydrocarbons; | *Lecture, practical class* | Paperwork | *15%* |
| *2.2* | to identify "masking" effect of relief and aquifers on local parameters of a heat flow | *lecture* | Paperwork | *10%* |
| *2.3* | to plan the integrated assessments of the | *lecture* | Paperwork | *5%* |

| Learning results (1. to know; 2. be able to; 3. communication; 4. autonomy and responsibility) | | *Methods of teaching and learning* | *Assessment methods* | *Percentage in the final assessment of the discipline* |
|---|---|---|---|---|
| | impact of anthropogenic pressure on the induced seismicity; | | | |
| *3.1* | Ability to communicate in a foreign language (English). | *practical class* | Paperwork | *15%* |
| *4.1* | Ability to work in an international context and in global information by specialty. | *practical class* | Paperwork | *5%* |

**The correlation of the learning outcomes of the discipline with the "Petroleum Geology" program results**

| **Learning outcomes of the discipline** / **Program learning outcomes** | **1.1** | **1.2** | **1.3** | **1.4** | **1.5** | **1.6** | **2.1** | **2.2** | **2.3** | **3.1** | **4.1** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| To analyze the features of natural and anthropogenic systems and objects of the Earth's Geospheres, taking into account oil and gas potential of the subsoil. ПРН1 Аналізувати особливості природних та антропогенних систем і обєктів геосфер Землі з врахуванням нафтогазоносності надр. | + | + | + | + | + | + | + | + | + | | |
| To be able to communicate with specialists and experts of different levels of others field of knowledge, including in the international context, in the global information environment. ПРН3 Вміти спілкуватися з фахівцями та експертами різного рівня інших галузей знань, у тому числі в міжнародному контексті, в глобальному інформаційному середовищі | | | | | | | | | | + | + |
| Apply educational technologies and methods of teaching Earth science subject material in educational institutions ПРН11 Застосовувати освітні технології та методи викладання предметного матеріалу наук про Землю у закладах освіти | | | | | | | | | | + | + |

**Structure of discipline:** lectures, seminars, independent study work of student

**Scheme of grading forms:**

**Form of student evaluation:**

**- semester grading:**

1. **Control test - (min - 6, max - 10 grades)**
2. **Control test - (min - 6, max - 10 grades)**
3. **Works paper and oral reports (min - 32, max - 60 grades)**

**- final assessment ( modular test)** in form of the written test **(min - 12 , max - 20 grades)**

Final evaluation is in the form of a final test (total score of discipline (maximum 100 grades) is defined as the sum for the systematic work during the semester).

***Final evaluation based on the results of the student's work throughout the semester.***
Procedure and evaluation system

| | **Semesters grades** | **Modular test** | **Final grade** |
|---|---|---|---|
| *Min* | *48* | *12* | *60* |
| **Max** | **80** | **20** | **100** |

For students who have obtained total grades less than critically-calculated minimum of 20 grades repeated control test is obligatory for taking the test. The modular test cannot be less than 12 grades in order to obtain a general positive assessment for the course.

**Grading**: For admission to the final grading it is obligatory: 1) to pass two control tests; 2) to prepare six oral reports, which can be presented in the form of presentations and abstracts. The final grading is carried out in the form of written modular test.

**Assessment:**

**Conformity scale**

| | |
|---|---|
| Passed | 60-100 |
| Fail | 0-59 |

## STRUCTURE OF THE DISCIPLINE

### PLAN OF LECTURES AND SEMINARS

| # | Theme | Hours | | |
|---|---|---|---|---|
| | | **Lectures** | **Seminars** | **Self – studying work** |
| ***Module 1. Internal heat and matter*** | | | | |
| 1 | **Theme 1.** Introduction. Earth as an evolving Planet. | 2 | 2 | 8 |
| 2 | **Theme 2.** Earth's internal heat. Heat flow. | 4 | 2 | 12 |
| 3 | **Theme 3.** Geothermal Processes. | 4 | 2 | 11 |
| 4 | **Theme 4.** Fluids in the crust. Petroleum system. "windows" of hydrocarbon generation . | 6 | 2 | 12 |
| | *Test 1* | | | 2 |
| ***Module 2. Concept of the system of natural circulation of groundwater and consequences of violation of its functioning from anthropogenic activities*** | | | | |
| 5 | **Theme 5.** Geothermal energy resources. | 4 | 2 | 12 |
| 6 | **Theme 6.** Geothermal technology | 2 | 2 | 10 |

| | | | | |
|---|---|---|---|---|
| 7 | **Theme 7.** Relationship between hydrological condition and seismic activity. Induced seismicity. | 2 | 2 | 10 |
| | *Test 2* | | | |
| | ***Modular test*** | | | 2 |
| | **Total** | **24** | **14** | **81** |

***Total hours of the discipline –*** *120, that include:*

Lectures **– 24** *hrs*
Practical classes - ***14*** *hrs*
Consultations - ***1*** *hrs*
Independent study work **- *81*** *hrs*

**RECOMMENDED LITERATURE**

***Basic:***


1. An Introduction to the World's Oceans, Seventh edition. McGraw-Hill Higher education. New York. 2003. - 521 p.
2. *Basic Ground-Water Hydrology*. Ralph C. Heath. U.S. Geological Survey Water- Supply Paper 2220. United States Government Printing office: 1989. - 85 p.
3. Basin Analysis: principles and application to petroleum play assessment / Philip A. Allen, Department of Earth Science & Engineering, Imperial College London & John R. Allen. Third edition. 2014. - 619 p.
4. Busby, J. 2010. Geothermal prospects in the United Kingdom. In: **World Geothermal Congress 2010**, Bali, Indonesia, 25–29 April 2010.
5. *Don L. Anderson "Theory of the Earth"* Seismological Laboratory. California Institute of Technology Pasadena, California Blackwell Scientific Publications, 1989, p 45-46.
6. *Groundwater in Geologic Processes. Cambridge University Press. S.E. Ingebristen, W.E. Sanford. 1998. - 341 p.*
7. *Understanding Earth. Second Edition. Harvard University. W.H. Freeman and Company.* New York. 1998. - 682 p.
8. *White W.M. Geochemistry. Washington: Mineral. Soc. Amer., 2001. - 701 p.*


***Additional:***


1. *Горбань І.В., Байсарович І.М., Вижва С.А.* Екологія водних ресурсів та природних систем: Навч. посібник. –К.: ВГЛ "Обрії", 2003. –35 с.
2. Гордієнко В.В., Гордієнко І.В. Завгородня О.В. та ін. Геотермічний атлас України. – К.: 2004 . -60 с.
3. *Geologica. Earth's Geological Past. Millenium House Pty Ltd. Australia. – 2007. - 576 p.*
4. Fyfe W.S. etc. Fluids in the Earth's Crust: Their Significance in Metamorphic, Tectonic and Chemical Transport Processes (Developments in geochemistry) Elsevier Science Ltd. - 402 p.
5. Won-Young Kim. Induced seismicity associated with fluid injection into a deep well in Youngstown, Ohio// Journal of Geophysical Research: Solid Earth - 2013. Vol 118 Issue7.
6. Scientific Rationale for Establishment of an International Program of Continental Scientific Drilling. / Report of the International Meeting on Continental Scientific Drilling. Potsdam, Germany, Aug. 30-Sept.1, 1993.