UNIVERSITY OF MISKOLC
FACULTY OF
EARTH AND ENVIRONMENTAL
SCIENCE AND ENGINEERING

HYDROGEOLOGY

Hydrogeology Engineer MSc mesterszak
2023/24 I. félév
2023/24 I. Semester

TANTÁRGYI KOMMUNIKÁCIÓS DOSSZIÉ

Miskolci Egyetem/University of Miskolc
Műszaki Föld- és Környezettudományi Kar/Faculty of Earth and Environmental Sciences and Engineering
Víz- és Környezetgazdálkodás Intézet/Institute of Water Resources and Environmental Management

Tartalomjegyzék

1. Tantárgyleírás, tárgyjegyző, óraszám, kreditérték

Course Title: Hydrogeology **Instructor:** Dr. Péter Szűcs, full professor	**Code:** MFKHT710017 **Responsible department/institute:** Institute of Environmental Management Type of course: Compulsory
Position in curriculum (which semester): 1	**Pre-requisites (if any): -**
No. of contact hours per week (lecture + seminar): 2+2	**Type of Assessment (examination/ practical mark / other):** exam
Credits: 5	**Course:** full time

Course Description:
The students will be familiar with the basic concepts of modern hydrogeology as well as field hydrogeology. The students will learn about the relationships of rocks and groundwater, and about the phenomena of groundwater flow through the pores and fractures. The students will be able to handle and solve basic problems in hydrogeology and contamination transport. The main relationships of well hydraulics concerning steady-state and transient problems are also discussed. The students will be able to calculate the discharge value, the depression curve and the velocity distribution of an operating well or a group of wells. The students will be able to carry out field pumping tests, and they will be able to interpret the obtained results effectively.
The short curriculum of the subject:
The main properties and quality aspects of groundwater. Classification of groundwater resources. Storage and hydraulic properties. Darcy-law, flow and seepage equations. Temperature properties under the surface. Shallow and deep groundwater. Karst water, river bank filtered water resources. Relationship between groundwater and surface water. Springs. Flow systems under the surface. Groundwater as a geologic agent. Determination of hydraulic conductivity. Transport processes in groundwater. Basics of well hydraulics. Calculation of well discharge, determination of depression curve and velocity distribution around wells. Group of wells. Pumping tests and their interpretation. Complex interpretation of groundwater data. Practical work: self-made solutions of simple casestudy problems.

Compatencies to evolve:
Knowledge:
T1 – It includes knowledge of hydrogeology, water resource management, water quality protection, water treatment, production and waterworks operat
T2 – Extensive knowledge of hydrogeological assessment and monitoring techniques related to watershed approach and considers ecological water demands.
T4 – Have a working knowledge of computer-aided design and analysis
T5 – Knows and understands hydrogeological modelling techniques.
T6 – Knows basic requirements of environmental protection, quality control, consumer protection, product liability, equal access approach, occupational health and safety, technical and economic legislation and engineering ethics.
T7 – Have knowledge of a wide range of problem-solving techniques for research or academic work.
T8 – Have general and specialist management skills to manage complex design work.
Ability:
K1 – Ability to understand the laws and relationships related to the location, movement and quality of groundwater, to apply and put into practice the knowledge acquired, and to use problem-solving techniques.
K2 – Ability to process information from the knowledge frontiers of professional experience of the discipline, ability of problemsolving, and interpreting hydrogeological issues.
K3 – Ability to independently plan and execute tasks related to groundwater exploration, exploitation and well hydraulics at a high professional level.
K4 – Ability to effectively apply water production techniques and knowledge of modern well construction technologies.

K6 – Prepared to tackle complex water resource management, water conservation and aquifer protection challenges.
K8 – Able to solve mining and pit dewatering problems at a high level
K9 – Ability to model hydrodynamics and transport of groundwater flow systems
K10 – Prepared to effectively apply relevant national and European professional, environmental and conservation legislation
K11 – Ability to implement an ecological approach in line with the EU Water Framework Directive
K12 – Ability to work in compliance with EU legislation, to cooperate with foreign partners to solve the tasks required by the EU Water Framework Directive
K13 – The ability to independently participate in and manage research, development and expertise in the field of hydrogeology
K14 – Ability to lead and participate in complex design work and project management in water management and water supply
K15 – Ability to solve complex problems in a flexible way through creative problem solving, to work in a team, to think and cooperate effectively with representatives of other disciplines (e.g. environment, quality, consumer protection, human health, construction, etc.)
Attitude:
A1 – Open-minded and receptive, active in learning about professional and technological methodological developments in the fields of geosciences and environmental engineering, and in solving geological problems from an engineering perspective
A2 – Open and sensitive to problems and sustainability issues related to the environment and its elements
A3 – Have the motivation to work in a changing work, geographical and cultural contexts
A4 – Deep commitment and professional solidarity
A5 – It is committed to lifelong learning, diversity and values
A6 – Respect and act in accordance with the ethical principles and written rules of work and professional culture, and be able to adhere to them when managing small teams
A7 – Adhere to and comply with health and safety, environmental protection, quality assurance and control requirements.
A8 – Characterised by intuition, consistency and a willingness to learn.
A9 – In addition to his technical and engineering background, he also has an interest in science.
Autonomy and responsibility:
F1 – Act independently and proactively to solve professional problems.
F2 – Have a responsible attitude towards the environment.
F3 – Takes decisions independently and in consultation with other disciplines (mainly legal, economic, energy and environmental), for which it takes responsibility.
F4 – In decisions, takes into account the principles and application of environmental protection, quality, consumer protection, product liability, equal access, health and safety at work, technical, economic and legal regulation and engineering ethics.
F5 – Committed to sustainable natural resource management practices.
F6 – He/she is responsible claims in expert oppinions, professional judgements and for the work carried out under his/her supervision.

Assessment and grading:

Students will be assessed with using the following elements.

Attendance:	15 %
Short quizzes	10 %
Midterm exam	40 %
Final exam	35 %
Total	100%

Grading scale:

% value	Grade
90 -100%	5 (excellent)
80 – 89%	4 (good)
70 - 79%	3 (satisfactory)
60 - 69%	2 (pass)
0 - 59%	1 (failed)

Compulsory or recommended literature resources:

- Péter Szűcs: Hydrogeology. Course materail for Geothermal engineers. University of Miskolc, 2011.
- David Daming: Introduction to Hydrogeology, McGraw-Hill Higher Education, 2002.
- P. F. Hudak: Principles of Hyrogeology. Lewis Publishers, 1999.
- S. E. Ingebritsen, W. E. Sanford: Groundwater in Geologic Processes. Cabridge University Press, 1998.
- Kruseman G.P. and Ridder N.A: Analysis and Evaluation of Pumping Test Data, ILRI publication, Wageningen, Netherlamds, 1990, pp. 1-377.
- Waterloo Hydrogeologic: AquiferTest Pro, User’s Manual, 2005, pp- 1-270.
- Neven Kresic: Quantitative Solutions in Hydrogeology and Groundwater Modeling. Lewis Publishers, 1997.

2. TANTÁRGYTEMATIKA

Hidrogeology.
Tantárgytematika (ÜTEMTERV)
Aktuális tanév őszi félév
Hidrogeológus mérnök mesterszak MSc, 1. félév, törzs tárgy

Hét		Előadás
1.	09.14	Most important facts, issues and relations in hydrogeology.
2.	09.21	Comprehensive examples related to groundwater resources.
3.	09.28	Groundwater basins. Groundwater flow systems.
4.	10.05	Sustainability issues. Artificial groundwater recharge
5.	10.12	The groundwater management challenges related to transboundary aquifers all over the world.
6.	10.19	Hydrogeology of the Carphatian Basin – interesting phenomena from a special hydrogeological laboratory.
7.	10.26	*No class (by Rector's Decision)*
8.	11.02	*No class (by Rector's Decision)*
9.	11.09	Isotope hydrogeology. The application of stable and radioactive environmental isotopes in hydrogeological interpretations. Hydrogeological case-study in a volcanic environment.
10.	11.16	Special interpretation methods in well hydraulics Groundwater and surface water interaction. Relationship between surface and groundwater resources.
11.	11.23	Karst hydrogeology, Groundwater modeling of karst systems
12.	11.30	Chemical hydrogeology. Transport processes. Chemical components in groundwater. Hydro-geochemistry.
13.	12.07	Recharge estimation of groundwater systems.
14.	12.14	Petroleum hydrogeology

3) MINTA ZÁRTHELYI

Hidrogeology c. tárgy zárthelyi dolgozat

MSC Hydrogeology practice
(TEST 1)

Sieve diameter (mm)	Remained (g)	Remained (%)	All remained (%)	All fallen through (%)
16	40			
8	60			
6,3	260			
4	132			
2	300			
1	406			
0,5	284			
0,25	100			
0,125	40			
0,06	366			
Sum:	**1988**	**100**		

1. After a sieve analysis, we got the results seen in the table. Calculate the rest of the table, and draw the particle size distribution curve. (5 points) Give the inequality coefficient (U) and the significant particle size (d_m) values, and name the sample. (4 points)

2. Give the following definitions:
   Hydrological equation (1p.):

   Hydraulic conductivity (sign + unit!) (2 p.):

   Porosity (sign + unit) (2 p.):

   Geothermal gradient (sign + unit) (2 p.):

3. Please give the methods for defining hydraulic conductivity! Please write down the measurement steps of the <u>laboratory method</u> used at practice! Give the two equation which is for the two interpretation method! (6 p.)

4. What does the axes of the two coordinate systems represent, in type curve fitting of Theis method? What kind of scale are used on the axes? (3 p.)

5. Consider an in-ground pool with impermeable walls and compacted clay lining on the bottom. The surface area of the pool is 20 m^3. The water level in the pool is at -0.5 m, while the groundwater level is at -3.0 m. The soil around the pool is composed of coarse sand. The clay lining is of 0.6 m width and its hydraulic conductivity is 2e-7 m/s. Calculate the rate of water loss from the pool, give it in m^3/day! (6 p.)

6. What are the major aquifer parameters which are determined using pumping tests? (3p.)

Miskolc, 8. Dec. 2016.

Teachers: Csaba Ilyés, Zsombor Fekete

Time available: 60 minutes, maximum points: 34 (0-19=failed; 20-31=pass; 32-34=excellent)
(60%<failed; 60-93%=pass; 94%>excellent)

MSC Hydrogeology practice
(TEST 1)
SOLUTION

Sieve diameter (mm)	Remained (g)	Remained (%)	All remained (%)	All fallen through (%)
16	40	2,01	2,01	97,99
8	60	3,02	5,03	94,97
6,3	260	13,08	18,11	81,89
4	132	6,64	24,75	75,25
2	300	15,09	39,84	60,16
1	406	20,42	60,26	39,74
0,5	284	14,29	74,55	25,45
0,25	100	5,03	79,58	20,42
0,125	40	2,01	81,59	18,41
0,06	366	18,41	100,00	0,00
Sum:	**1988**	**100**	**-**	**-**

7. After a sieve analysis, we got the results seen in the table. Calculate the rest of the table, and draw the particle size distribution curve. (5 points) Give the inequality coefficient (U) and the significant particle size (d_m) values, and name the sample. (4 points)

8. Give the following definitions:
Hydrological equation (1p.): *Inflows = Outflows± Changes in stored Water (ΔS)*

Hydraulic conductivity (sign + unit!) (2 p.): *Sign: - K (internationally), k (in Hungary), „velocity" dimension [m/d]. It characterise also the rock and the fluid, which flows through it pores*

Porosity (sign + unit) (2 p.): *The ratio of the pore volume and the whole volume, n = Vpore/Vwhole*

Geothermal gradient (sign + unit) (2 p.): *is the rate of increasing temperature with respect to increasing depth in the Earth's interior. Earth average is 3°C /100 m. In Hungary 5-7 °C /100 m*

9. Please give the methods for defining hydraulic conductivity! Please write down the measurement steps of the laboratory method used at practice! Give the two equation which is for the two interpretation method! (6 p.)

Field methods, laboratory method, calculation methods.
Sample is fitted into the measurement tube, and water is flown through it. In fixed wall method, we measure the differences in water levels through time.
k=2.3(f*l)/F*(1/ΔT)*lg(h0/hi)*
k=2.3(f*l)/F*ctg(alfa)*

10. What does the axes of the two coordinate systems represent, in type curve fitting of Theis method? What kind of scale are used on the axes? (3 p.)

Axis x= time [s]
Axis y=depression [m]
Logarithmic scale

11. Consider an in-ground pool with impermeable walls and compacted clay lining on the bottom. The surface area of the pool is 20 m^3. The water level in the pool is at -0.5 m, while the groundwater level is at -3.0 m. The soil around the pool is composed of coarse sand. The clay lining is of 0.6 m width and its hydraulic conductivity is 2e-7 m/s. Calculate the rate of water loss from the pool, give it in m^3/day! (6 p.)

12. What are the major aquifer parameters which are determined using pumping tests? (3p.)

Transmissivity, Storage coefficient, hydraulic conductivity

Miskolc, 8. Dec. 2016.

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Time available: 60 minutes, maximum points: 34 (0-19=failed; 20-31=pass; 32-34=excellent)
(60%<failed; 60-93%=pass; 94%>excellent)

4) VIZSGA TÉTELSOR

Hidrogeology C. TÁRGY
TÉTELSOR

1. What is the definition of the aquifer? What are the principal aquifer rock types? Please give examples for the values of hydraulic conductivity in case of different rock types. What is the definition of the storage coefficient?
2. What is hydrogeology? Please describe the Darcy-equation and its components. What are the elements of hydrologic cycle? Please describe the global hydrological (water budget) equation.
3. What is the definition of groundwater basin? Please describe the Hubert's model and the Toth's flow model. Please describe the local, medium and regional flows in a basin. Please describe the Ghyben-Hetrzberg equation in case of sea water intrusion. How can this phenomenon jeopardize drinking water supply in coastal regions?
4. Please describe the main steps of the Theis pumping test evaluation. Please give the main equations with the well function. What is the meaning of recovery data in well hydraulics? Why can experts prefer field data to laboratory data concerning the hydraulic conductivity.
5. Please describe the evolution of the safe yield concept. What are the most important groundwater management tools? What kinds of aspects have the term of sustainability?
6. How does artificial recharge work in reality? Which regions can be suitable for this method? What are the main technical solutions for implementing the artificial recharge? What is the advantage of conjunctive water use?
7. What is the importance of transboundary aquifers? Which is the more preferable position in case of water management? Downstream side or upstream side? What is the situation in Hungary concerning the internationally shared aquifers? How can groundwater flow simulations help the decision makers?
8. Drinking, mineral, medicinal and thermal water resources and their utilization from aquifers. Please give the basic definitions. How can geothermal gradient and heat flow be defined? What is the relationship between hydrogeology and geothermal energy utilization?
9. Please describe the main properties, features and aspects of karst aquifers? What is epikarst? What kinds of methods are existing in karst investigations? What is a tracing experiment? Please give information about hydrograph analysis. Classify hydrograph analytical methods. What are the main features of a hydrograph peak? What is the Maillet formula? What is recession coefficient? Which aquifer parameters influence recession coefficient?
10. What are the main steps of the comprehensive water management focusing on water status? Please describe the concepts of the Water Framework Directive. Why is the Danube watershed so special?
11. Please describe the isotope hydrology techniques in groundwater investigation. Please give the most important radioactive and stable isotopes in hydrogeology. What are the methods for groundwater age determination?
12. How can you estimate the groundwater recharge with environmental isotopes in the unsaturated and the saturated zone? What kind of interaction can exist between groundwater and surface water?

5. EGYÉB KÖVETELMÉNYEK

A zárthelyi dolgozat írása és a vizsga közben a mobiltelefon használata tilos!