COURSE OF DOCTORAL STUDIES

Course title	Field of science (branch) code	University / Faculty	Institute / Department
Groundwater Dynamics	Natural Sciences (Geology) N 005	Vilnius University / Faculty of Chemistry and Geosciences	Institute of Geosciences / Department of Hydrogeology and Engineering Geology

Study methods	Number of credits allocated	Study methods	Number of credits allocated
Lectures	—	Seminars	—
Individual work	11	Consultations	As needed

Course annotation

Advanced theoretical and computational study of groundwater flow and transport in porous media. The course develops hydrostatic principles, Darcy's law, hydraulic gradient and the groundwater flow equation from conservation of mass; examines saturated and unsaturated flow, aquifer heterogeneity, anisotropy, layered systems and boundary conditions. Emphasis is placed on analytical solutions for one-, two- and three-dimensional steady and transient flow, well hydraulics, recharge and discharge, pumping- and slug-test interpretation, and estimation of aquifer parameters. Doctoral students investigate numerical groundwater flow modeling with MODFLOW 6, including conceptual model development, discretization, boundary and initial conditions, calibration, validation, sensitivity and uncertainty. Additional topics include advective–dispersive solute transport, groundwater–surface water exchange, variable-density flow and introductory heat transport. Analytical and numerical results are evaluated critically in relation to assumptions, scale and data limitations.

Study methods and individual assignments

Guided independent reading of core and supplementary literature; consultations.

Assessment

Examination: five open-ended questions on groundwater dynamics, analytical solutions, hydraulic testing, numerical modeling and flow/transport interpretation, followed by an academic discussion of the answers, assumptions and modeling decisions. The assessment evaluates mathematical understanding, physical interpretation and the ability to apply and critically evaluate methods.

Main study literature

1. Uliana, M. M. (2025). Basic hydrogeology: An introduction to the fundamentals of groundwater science. The Groundwater Project. https://doi.org/10.62592/CBIQ7579. (Link)
2. Woessner, W. W., & Poeter, E. P. (2020). Hydrogeologic Properties of Earth Materials and Principles of Groundwater Flow. (Link)
3. Woessner, W. W., Campbell, A., & Poeter, E. P. (2023). An Introduction to Hydraulic Testing in Hydrogeology: Basic Pumping, Slug, and Packer Methods. (Link)
4. Winston, R. B. (2023). Getting Started with MODFLOW. (Link)
5. Juodkazis, V., Gregorauskas, M., & Mokrik, R. (2012). Regioninė hidrogeodinamika: požeminio vandens telkiniai ir ištekliai. Vilniaus universitetas. ISBN 978-609-459-113-6.
6. MODFLOW 6 practical exercises and official USGS documentation (including model construction, boundary conditions and transient simulations). (Link)

Additional literature

1. Todd D. K., Mays L. W. (2005). Groundwater Hydrology. John Wiley&Sons, Inc. NJ. 636 p.
2. C.W. Fetter, University of Wisconsin, Oshkosh. Applied Hydrogeology: Pearson New International Edition, 4th Edition. *2014. Pearson. 610 p.*

Coordinating lecturer

Vytautas Samalavičius, Associate Professor, Vilnius University.

Approval

Approved by the doctoral committee of Geology (N 005) on 19 October 2026 (5.2.2 E-15600-KT-3953)

Committee Chairman prof. dr. Sigitas Radzevičius