Faculty of Civil Engineering / Infrastructures / Grounwater Hydraulics

Prerequisites	None.
Aims	Knowledge acquisitione from groundwater hydraulics.
Lecturer / Teaching assistant	Prof. Dr. Milan Radulović – lecturer
Metdod	Lectures, exercises, tests, colloquiums.
Week 1, lectures	Introduction. Groundwater as part of water cycle. Structures of rocks porosity. Hydrogeological function of rocks masses. Recharge and discharge of aquifers. Examples from the territory of Montenegro
Week 1, exercises	Introduction. Groundwater as part of water cycle. Structures of rocks porosity. Hydrogeological function of rocks masses. Recharge and discharge of aquifers. Examples from the territory of Montenegro
Week 2, lectures	Aquifer parameters (hydraulic conductivity, porosity, groundwater velocity, hydraulic gradient, etc.). Darcy law. Heterogeneity and anisotropy of aquifer.
Week 2, exercises	Aquifer parameters (hydraulic conductivity, porosity, groundwater velocity, hydraulic gradient, etc.). Darcy law. Heterogeneity and anisotropy of aquifer.
Week 3, lectures	Groundwater flow through the saturated zone. Flow lines and flow mesh. Basic equatations of groundwater flow. Mass balance equatation. Generalization of Darcy law.
Week 3, exercises	Groundwater flow through the saturated zone. Flow lines and flow mesh. Basic equatations of groundwater flow. Mass balance equatation. Generalization of Darcy law.
Week 4, lectures	Steady-state groundwater flow in the confined and unconfined aquifers.
Week 4, exercises	Steady-state groundwater flow in the confined and unconfined aquifers.
Week 5, lectures	Transient groundwater flow in the confined and unconfined aquifers.
Week 5, exercises	Transient groundwater flow in the confined and unconfined aquifers.
Week 6, lectures	Methods for solving the differential equitation of groundwater flow.
Week 6, exercises	Methods for solving the differential equitation of groundwater flow.
Week 7, lectures	I TEST, I COLLOQUIUM
Week 7, exercises	I TEST, I COLLOQUIUM
Week 8, lectures	Numerical models. Transfer of the conceptual model to the numerical model. MODFLOW. Geometry of groundwater model. Parameters of groundwater model.
Week 8, exercises	Numerical models. Transfer of the conceptual model to the numerical model. MODFLOW. Geometry of groundwater model. Parameters of groundwater model.
Week 9, lectures	Boundary conditions. Calibration of groundwater model. Sensitivity analysis. Verification of model.
Week 9, exercises	Boundary conditions. Calibration of groundwater model. Sensitivity analysis. Verification of model.
Week 10, lectures	Groundwater flow to the well. Pumping test data processing.
Week 10, exercises	Groundwater flow to the well. Pumping test data processing.
Week 11, lectures	Groundwater flow in the karst aquifer. Limits of Darcy law in the karst aquifers.
Week 11, exercises	Groundwater flow in the karst aquifer. Limits of Darcy law in the karst aquifers.
Week 12, lectures	Field investigation works. Groundwater flow through and under dams and embankments.
Week 12, exercises	Field investigation works. Groundwater flow through and under the dams and embankments.
Week 13, lectures	Groundwater inflow to the tunnels and excavations.
Week 13, exercises	Groundwater inflow to the tunnels and excavations.
Week 14, lectures	II TEST, II COLLOQUIUM
Week 14, exercises	II TEST, II COLLOQUIUM
Week 15, lectures	Repetition of lessons.
Week 15, exercises	Repetition of lessons.
Student obligations	Attendance, preparation of graphical papers, taking the tests.
Consultations	Attendance, preparation of graphical papers, taking the tests.
Workload	Weekly

	3.0 credits x 40/30 = 4 hours Total workload for the Subject 3.0x30 = 90 hours
Literature	Cherry JA, Freeze RA (1979) Groundwater. Prentice-Hall, Inc., Englewood Cliffss, New Jersey
Examination metdods	- Attendance to lectures and exercises: max 4 pt; - Graphic works: max 4 pt; - Seminary Essays: max 10 pt; - Tests: max 12 pt; - Colloquiums: max 40 pt; - Final exam: max 30 pt; - Pass requires minimum 50 pt.
Special remarks	
Comment	Further information about the Subject can be required from the lecturer/assistant, head of the study program and vice dean of academic affairs
Learning outcomes	After having passed the exam, students will be able to: 1. Explan functioning of hydrogeological systems; 2. Explain parameters of porosous areas; 3. Understand equations of groundwater streaming; 4. Apply methods for solution of differential equations of groundwater streaming; 5. Create conceptual hydrogeological model; 6. Use MODFLOW-based softwares; 7. Develop mathematical model of groundwater streaming.