UNIVERSITÀ DELLA CALABRIA
DIPARTIMENTO DI **INGEGNERIA DELL'AMBIENTE**

SUBSURFACE FLOW AND CONTAMINANTS TRANSPORT
A.A. 2021/2022

Teaching Unit	SUBSURFACE FLOW AND CONTAMINANTS TRANSPORT	
Unit Code		
Degree title (CdS)	ENVIRONMENTAL AND TERRITORIAL SAFETY ENGINEERING	
Degree level		
Module code		
Scientific Disciplinary Sector (SSD)	ICAR/01	
Number of ECTS credits (CFU)	6	
Teaching Unit Category (TAF)	CORE TEACHING UNIT	
Teaching Unit Qualification	COMPULSORY	
Course year	1	
Semester	FIRST SEMESTER	
Lecturer	SALVATORE STRAFACE	
Other instructors involved	MEMBERS OF THE EXAMINATION COMMETTEE	
Module breakdown	**Hours of Lectures**	36
	Hours of Practicals	12
	Hours of Laboratory	---
	Hours of Individual study	102
Language	English	
Mandatory prerequisites	NONE	
Prerequisites	Good knowledge of Mathematics I and II, Physics and Hydraulics	
Content	The Class is dedicated to the study of flow and transport of pollutant in aquifers. After an examination of the main parameters of the porous media, the equations describing the groundwater flow are obtained, starting from the conservation of mass (continuity equation) and momentum (Darcy equation). Then the pollutants transport into aquifers is analyzed. The physical processes that underlie the transport of a conservative solute into the aquifer and the corresponding equations are obtained and described; subsequently the transport of reactive solutes (pollutant) effected by adsorption and decay is modeled. Finally, the characterization of porous media by means of experimental tests like pumping and tracer tests are illustrated. Open source software packages are distributed to the students to solve numerically the flow and solute transport equations.	
Teaching objectives	Specific Competences: - The student at the end of the class must have knowledge of the topics covered, in order to be able to understand the phenomena related to groundwater, the related causes and the mechanisms underlying them; - The student must also be able to make a complete mathematical description of the phenomena of flow and transport in porous media, being able to clearly identify basic hypotheses, boundary conditions and correspondence with the physical meaning; - The student must be able to apply all the concepts learned during the course and combine them together to address the wide range of problems related to subsurface hydraulics. Transversal skills: - The student must be sufficiently independent in making the appropriate choices necessary to correctly frame the phenomena related to groundwater and to be able to identify the most appropriate model for the	

	solution of the related problems; - The student must be able to express himself in technical language suitable for the correct presentation of the arguments of subsurface hydraulics.
Programme	1. The hydrological cycle and aquifers – Hydrological systems – Aquifers: definitions and fundamental parameters – Characteristic properties of porous media 2. Water flow in saturated porous media – Darcy's concept of velocity – Heterogeneity and anisotropy of a porous medium – General equation of groundwater flow – Equations of groundwater flow at a regional scale – Boundary conditions – Analytical solutions of the flow equation – Pumping test in confined aquifers – Pumping test in unconfined aquifers – Numerical solution of the flow equation by means of Finite Difference Method 3. Transport of solutes in porous media - Non-reactive transport: – Convection – Molecular diffusion – Hydrodynamic dispersion – Péclet's number - Reactive transport: – Filtration – Adsorption instantaneous and kinetic – Radioactive decay - Analytical solutions of solute transport equation - Numerical solution of solute transport equation - Tracer tests
Delivery Mode	Frontal teaching
Teaching Methods	Frontal teaching assisted by slide shows; recordings will be made available for later viewing
Methods and Criteria of Learning Assessment	The oral examination is based on the homework, sent by e-mail one day in advance, and on the theoretical issues of the Class. Student performance assessment criteria are: i) quality in drafting a formally correct brief technical report, and ii) demonstrated understanding of the course material, ability in a clear and concise oral exposition, critical evaluation of the scientific literature. The final grade will be assigned on a scale 0-30, as a result of both parts of the exam (homework and oral).
Textbooks and recommended reading	Flusso e Trasporto nei mezzi porosi reali, Salvatore Straface, Edizioni LIBRARE, 2017. Quantitative Hydrogeology: Groundwater Hydrology for Engineers, De Marsily, Ghislain, Academic Press, Inc., 1986. Paper from Journals.
Peer review	
Teaching timetable	http://diam.unical.it
Examination calendar	http://diam.unical.it
Examinatory commission	http://diam.unical.it

ESTIMATED STUDENT WORKLOAD				
	Lectures [hours]	**Praticals [hours]**	**Laboratory [hours]**	**Individual study [hours]**
1. The hydrological cycle and aquifers: – Hydrological systems – Aquifers: definitions and fundamental parameters – Characteristic properties of porous media	3			6
Flusso e Trasporto nei mezzi porosi reali, Salvatore Straface, Edizioni LIBRARE, 2017				
2. Water flow in saturated porous media: – Darcy's concept of velocity – Heterogeneity and anisotropy of a porous medium – General equation of groundwater flow – Equations of groundwater flow at a regional scale – Boundary conditions – Analytical solutions of the flow equation – Pumping test in confined aquifers – Pumping test in unconfined aquifers – Numerical solution of the flow equation by means of Finite Difference Method	21	9		51
Flusso e Trasporto nei mezzi porosi reali, Salvatore Straface, Edizioni LIBRARE, 2017				
4. Transport of solutes in porous media - Non-reactive transport: – Convection – Molecular diffusion – Hydrodynamic dispersion – Péclet's number - Reactive transport: – Filtration – Adsorption instantaneous and kinetic – Radioactive decay - Analytical solutions of solute transport equation - Numerical solution of solute transport equation - Tracer tests	12	3		25
Quantitative Hydrogeology: Groundwater Hydrology for Engineers, De Marsily, Ghislain, Academic Press, Inc., 1986 - Flusso e Trasporto nei mezzi porosi reali, Salvatore Straface, Edizioni LIBRARE, 2017 Paper from Journals				
Hours dedicated to soft skills				
Reports/other homeworks				10
Additional hours dedicated to final exam preparation				10
TOTAL	**36**	**12**		**102**
OVERALL NUMBER OF HOURS	✓ **150**			