1. GENERAL INFORMATION					
Study programme title	Graduate study of Geology				
Course title	Instrumental analytical methods			**Semester**	Winter
Teacher	Assoc. Prof. Sibila Borojević Šoštarić, PhD Prof. Ivan Sondi, PhD			**Course code**	27201
Course type	☒ obligatory ☐ elective			**ECTS**	4
Location	Faculty of Mining, Geology and Petroleum Engineering, Pierottijeva 6, Zagreb				
Language	☐ Croatian ☐ English				
Class type	**Weekly hours**	**Teaching staff**	**Office hours**	**Room**	**E-mail**
Class	2	Assoc. Prof. Sibila Borojević Šoštarić, PhD Prof. Ivan Sondi, PhD	Wednesday 11-13 p.m.	P6 309	sibila.borojevic-sostaric@rgn.hr
Practice	1	Assoc. Prof. Sibila Borojević Šoštarić, PhD Prof. Ivan Sondi, PhD	Monday 13-15 p.m.	P6 314	ivan.sondi@rgn.hr
Field lecture					
E-learning level		1	**Percentage of on-line class (max. 20%)**		5%

2. COURSE DESCRIPTION	
Course aims	Mastering basic knowledge in analytical methods and techniques that are applied in geosciences for determination of chemical and mineralogical composition, crystal structure, granulometry and morphological properties of minerals, rocks, recent sediments, and soil.
Requirements for applicants	None

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Programme level learning outcomes with course contribution	
Expected course level learning outcomes (4-10 outcomes)	Students will be able to: - explain specific analytical method, basic assumptions sample selection and characteristics of the instruments - prepare geological sample for microthermometry of fluid inclusions, XRD and AAS method - recalculate absorbance into concentrations within the sample - interpret microthermometrical data - prepare data in various graphs and tables - to interpret the powder XRD results and determine the qualitative and quantitative mineralogical composition - to use the IR spectroscopy in geosciences and elucidate the obtained IR spectra - to use the laser diffraction (LD) in determination of granulometric properties of sediments and soils - to apply the appropriate electronic microcopy methods (FESEM, HRTEM) in their research and understand obtained results

Course contents by individual lessons

Class	Practice
P1 – Getting to know the students. Evaluation criteria. Basic and advanced literature. Merlin. Consultations. Schedule of oral exams. Structure of the course.	V1 –
P2 – Atomic absorption spectrometry (AAS). Structure of the atom. Absorption and emission. Spectrometers. Lambert-Bear law. Detection limits. Preparation of the geological sample. Advantages and disadvantages of AAS method. Interference. AAS instrument. Graphite method.	V2 – chemical lab. – Measuring pH of soils in $CaCl_2$, KCl and H_2O using ISE electrode. – Extraction of element using aqua regia – Sample preparation using method of standard addition
P3 – Atomic emission spectrometry (AES). Basic principles. Temperatures and reaction within fire. Data quality. Detection limits.	V3 – AAS lab. – Lamps – Calibration solutions

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	– Calibration procedures – Blank – AAnalyst 700 working conditions – Atomization Results and reliability
P4 – Inductive coupled plasma (ICP-AES). Basic principles. Plasma and atomization. Instrument. Detection limits. Major advantages. Sample preparation.	V4 – Visit to ICP-AES lab at the Institute Ruđer Bošković. Demonstration exercise.
P5 –Fluid inclusion microterometry Fluid inclusions. Geological environments. Material selection. Sample preparation	V5 – Exercise in mineralogical practicum – petrography of fluid inclusions.
P6 – Fluid inclusion microterometry Linkam stage. Chaixmeca stage. Eutectic point. H2O system upon heating/freezing. PTX plots. H2O-NaCl system. Phase transformation. Tricomponent systems. Data interpretation.	V6 –Exercise at Chaixmeca stage. Data interpretation.
P7 –Electron microprobe method (EMPA).	V7 –Interpretation of the EMPA data
P8 - The use of Laser Diffraction (LD) method in determining the particle size of sediments and soils.	V8 –Interpretation of results of the laser diffraction (LD) technique in determining particle size of recent sediments and soils.
P9 - The use of the powder XRD techniques in determination of the qualitative and quantitative mineralogical composition of sediments and soils.	V9 - Interpretation of results of the XRD and determination of the qualitative and quantitative mineralogical composition of sediments and soils.
P10 - Application of the Infrared spectroscopy (IR) in the determination of the chemical properties of minerals.	V10 - Interpretation of results of the IR spectroscopy determination of the chemical properties of minerals (carbonates, phyllosilicates).
P11 - Thermal analyses in geoscience: Thermogravimetric analysis (TGA) and Differential Scanning Calorimetry (DSC).	V11 - Interpretation of results of the TGA and DSC analyses applied on carbonates and phyllosilicates.
P12 - FESEM and HRTEM microscopy. Usage and significance in geoscience.	V12 - Interpretation of results of the FESEM i HRTEM microscopy.

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P13 - FESEM and HRTEM microscopy. Usage and significance in geoscience.	V13 - Introducing and demonstrating the work of instruments at the Ruđer Bošković Institute, Zagreb.
P14 - Application of atomic force microscopy (AFM) in investigation of morphological features of mineral surfaces.	V14- Introducing and demonstrating the work of instrument at the Ruđer Bošković Institute, Zagreb.
P15 - A summary of the instrumental methods studied in the course.	V15 - Introducing and demonstrating the work of instruments at the Ruđer Bošković Institute, Zagreb.

Students' obligations	Lectures and exercises are obligatory. Student should gain signature for all practical exercises. Exercises are demonstrative with practical work of students in laboratories and auditive, focusing on interpretation of the analytical results.			
Students' work track *(indicate share in ECTS points for each activity so that overall ECTS number corresponds to class credits score):*	Class attendance	1	Research	
	Project		Report	
	Colloquium		Seminar paper	1
	Practical work	1,5	Oral exam	1,5
	Written exam		(Extra)	
Type of exam, grades and evaluation of students work during class and on final exam	Classes and examination Preconditions for successful fulfilment of the course is signature for all practical exercises and regular presence at lectures and exercise (3+1 absence maximum). Mark is generated from practical exercises (50 percent) and oral examination (50 percent). During the oral examination student will answer the whole course content.			
Mandatory literature (available in the Library and via other media)	Reed, S. J. B. (2010): Electron Microprobe Analysis and Scanning Electron Microscopy in Geology. Cambridge University Press, 201 str. Bish, D. L. & Post, J. E. (Eds.) (1989): Modern Powder Difraction. Rev. Mineral Geochem, 20; Mineralogical Society of America, 369 str. Skoog, D.A., West, D.M., Holler, F.J. (1999): Osnove analitičke kemije. Školska knjiga, Zagreb, 951 str.			
Aditional literature (at the moment of study program proposition application)	Angino, E.E., Billings, G.K. (1972): Atomic Absorption Spectrometry in Geology. Elsevier Publishing Company, Amsterdam-London-New York, 201 str. Vrkljan, M. (2000): Instrumentalne metode analize; AAS, FES, ICP-AES, Mössbauerova spektrometrija (skripta za internu uporabu).			

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Examination terms	Every Tuesday within exam-terms (at 9 a.m.).
Other	

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