COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
Applied petrology	

Lecturer(s)	Department(s) where the course unit (module) is delivered
Coordinators: assoc.prof. Gražina Skridlaitė **Other(s): assoc.prof. Donatas Kaminskas**	Department of Geology and Mineralogy, Institute of Geosciences, Faculty of Chemistry and Geosciences, Vilnius University, M.K. Čiurlionio str. 21/27, LT-03101 Vilnius.

Study cycle	Type of the course unit (module)
Full-time studies (2nd stage, master)	Compulsory

Mode of delivery	Period when the course unit (module) is delivered	Language(s) of instruction
Face-to-face	Autum semester (1st semester).	Lithuanian (English)

Requirements for students	
Prerequisites: secondary school basic knowledge on physics, chemistry and mathematics. Knowledge of introduction to mineralogy, petrology and geochemistry is recommended.	**Additional requirements (if any):** no

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
5		64 (48 – lectures; 12 – exercises; 4 - seminars)	69

Purpose of the course unit (module): programme competences to be developed		
Main purpose is to enable the student to analyze complex evolution of the Earth crust during geological time using up-to-date investigation tools: to improve and deepen knowledge on the evolution of magmatic, metamorphic and sedimentary rocks leading to the formation of Earth's Crust and surface; to acquire skills of modern microscopic and geochemical and isotopic methods of investigation for different rocks, and their practical application. - Development of subject competences: enhanced knowledge on identification of rock varieties; understanding of principles of chemical and physical rock-forming processes; understanding of principles of geochemistry and geochronology as applied to the rock evolution; ability to explain and compare the obtained results in terms of rock evolutionary histories; ability to evaluate different investigation tools and to chose the most appropriate set for the solution of a particular scientific problem in the interest field; formation of skills for the identification of major rock types under microscope or according their chemical and isotopic composition. - Development of general competences: capability of self-study and improvement; ability to convey knowledge in oral and written forms; competence in analysis; competence in decision making; ability for scientific research		
Learning outcomes of the course unit (module)	**Teaching and learning methods**	**Assessment methods**
- understand and explain major rock forming processes through Earth's history implied from their compositional features; understand how rock composition and properties depend on their origin and tectonic setting;	Lectures, problem based learning; essay writing; seminar, exercises; self-study	Intermediate assessments (one written colloquium); defense of the essay theses; recognition of major rock types under microscope (optical or SEM); final written examination; formative assessment plus

		summative assessment;
- understand how isotopic systems evolved through the geological time; relate isotopic abundances and ratios to certain Earth's crust forming processes;		
- choose the most comprehensive and appropriate set of analytical methods in order to identify a rock or imply its evolution; to interpret properly the results of the microscopic and isotopic investigations;		
- be able to apply practically some of the methods for a particular scientific problem of rock-forming processes;		
-be able to recognize most common types of rocks under polarizing and scanning electron microscope or according their chemical and isotopic composition		

Content: breakdown of the topics	**Contact hours**							**Self-study work: time and assignments**	
	Lectures	Tutorials	Seminars	Exercises	Laboratory work	Internship/work placement	**Contact hours**	**Self-study hours**	**Assignments**
1. Introduction to major rock types and rock-forming processes: review of rock types and their origin, optical and chemical and isotopic properties and their tectonic settings.	4						**4**	**8**	Self-study of reference material.
2. Rock chemistry and its application for igneous and metamorphic rock classification and discrimination. Major discrimination diagrams for different rock types. Recalculations of chemical analyses and construction of classification and discrimination diagrams, their interpretation.	4			2			**6**	**4**	Self-study of reference material
3. P-T (pressure-temperature) calculations for the evaluation of rock-forming conditions: mineral associations suitable for P-T calculations, calculation programmes, errors, interpretation of the results.	4			2			**6**	**4**	Self-study of reference material
4. Nucleosynthesis, radioactive decay and mass spectrometry: introduction, laws, chemical separation, ion sources, application of MS-ICP-MS and other methods to radiogenic isotopes	4						**4**	**4**	Self-study of reference material
5. The Rb-Sr method: dating igneous and metamorphic rocks; the Sm-Nd method: Sm-Nd isochrons, Nd isotope evolution and model ages, the crustal growth problem; Lead isotopes: U-Pb isochrons, U-Pb (zircon) and U-Pb-Th (monazite) datings; Osmium isotopes: Os analysis, Re-Os decay schemes, petrogenesis and ore genesis. Recalculations of the obtained results and their interpretation	6			2			**8**	**8**	Self-study of reference material

6. Major and trace elements in sedimentary rocks.	4						**4**	**3**	
7. Rare Earth Elements (REE), Chondrite normalization, REE NASC normalization for sediments. Interpretating REE patterns in sedimentary rocks.	4			2			**6**	**4**	
8. Variation of $d^{18}O$ in nature. Oxygen isotope thermometry. Fluid temperature calculations for calcite and dolomite from oxygen isotope data.	4			2			**6**	**4**	
9. Using carbon isotopes. Their distribution in nature. Applications. Carbon stable isotopes excursions.	4			2			**6**	**4**	
10. Main components of sedimentary rocks. Principles of thin section description of sedimentary rocks under a polarized light microscope	4						**4**	**4**	
11. Clay minerals. Classification and chemical composition. Dating of clay minerals	4						**4**	**2**	
9. Student presentations	2		2				**4**	**10**	Self-study of reference material
10. Student presentations (continued). Repetition.			2				**2**	**10**	Self-study of reference material
Total	**48**		**4**	**12**			**64**	**69**	

Assessment strategy	**Weight,%**	**Deadline**	**Assessment criteria**
Written colloquium	20	During the term	Knowledge and understanding of terminology and concepts, reasoning abilities, ability to synthesize different kinds of given information, analytical skills.
Essay and presentations	10	During the term	To write and defend essay before the final examination Essays assessment is based on comprehensiveness and brevity, clearness of writing style, degree of understanding of the chosen subject.
Recognition of major rock types under microscope and geochemical as well as isotopic calculations in order to imply rock origin	10	During the term	It is obligatory to recognize some major rock types under microscope
Final written examination	60	End of the term	Formative and summative essays evaluation and accumulative final score, 10-point system.

Author	**Year of publication**	**Title**	**Issue of a periodical or volume of a publication**	**Publishing place and house or web link**
Compulsory reading				
Gautam, Sen	2014	Petrology: Principles and Practice		Springer-Verlag Berlin
Reed, S .J. B.	2005	Electron Microprobe Analysis and Scanning Electron Microscopy in Geology		Cambridge University Press
Faure, G. and Mensing T.M.	2005	Isotopes: principles and applications (Third Edition)		John Willey & Sons, Inc., Hoboken, New Jersey
Dickin, A. P.,	2005	Radiogenic Isotope Geology (Second Edition)		Cambridge University Press
Rollinson, H.	1993	Using geochemical data: evaluation, presentation, interpretation		Longman Group UK Limited
Faure, G.	1991	Principles and applications of geochemistry: a comprehensive textbook for geology students		Prentice-Hall, Inc.

Optional reading				
Winter, John. D.	2014	Principles of Igneous and Metamorphic Petrology (second edition)		PEARSON
Faure, G.	2001	Origin of Igneous Rocks: the Isotopic Evidence		Springer-Verlag
Spear, F.S.	1993	Metamorphic Phase Equilibria and Pressure-Temperature-Time Paths		Mineralogical Society of America
Motuza. G.	2006	Magminių ir metamorfinių uolienų petrologija		Vilnius, Vilniaus universiteto leidykla
Tucker M. (ed.)	1998	Techniques in sedimentology		Blackwell Science Ltd
Skridlaite, G, Whitehouse, M., Rimša, A.,	2007	Evidence for a pulse of 1.45 Ga anorthosite-mangerite-charnockite-granite (AMCG) plutonism in Lithuania: implications for the Mesoproterozoic evolution of the East European Craton	*Terra Nova*, Vol. 19, issue 4, 294-301	Blackwell publicat
Skridlaite, G., Willingshofer, E., and Stephenson, R.	2003	P-T-t modelling of Proterozoic terranes in Lithuania: geodynamic implications for accretion of southwestern Fennoscandia	*GFF*, Vol. 125, 201-211	Taylor & Francis , Journal of the Geological Society of Sweden
Skridlaite, G., Bogdanova S., Page L	2	Mesoproterozoic events in Eastern and Central Lithuania as recorded by 40Ar/39Ar ages	*Baltica*, Vol. 19 (2), 91-98	Vilnius