Module	Content	Duration/hours		Teacher	Compulsory/ Compulsory Optional Subject	Prerequisites	Number of credits	Conditions for passing
		Lectures	Practice/ Self-study					
Ethics of scientific work and research integrity	**Content:** • research integrity and why and how it is violated, • proper research data management, • publication ethics and how not to violate it, • integrity in the mentor-mentored relationship, • solutions to violations of the principles of research integrity, • workshop – case studies. **Learning Outcomes:** Graduate: • Gains a general awareness of how to conduct research properly. • Knows the rules of ethics of publishing scientific results. • Knows what to expect from the PhD student and supervisor. • Knows how to behave when witnessing violations of research integrity principles. • Tests his/her knowledge on specific model cases.	7	3/20	RNDr. Soňa Ftáčniková, PhD.	Compulsory	Not necessary for this module	1	Presentation + demonstration of acquired knowledge at the final workshop
Physical Chemistry	**Content:** • fundamentals of thermodynamics, • phase equilibria, • equilibria of chemical reactions, • chemical kinetics, • transport processes, • electrochemistry, • physical chemistry of surfaces, • ad hoc topics according to the focus of students' dissertation theses. **Learning Outcomes:** Graduate: • Has consolidated and expanded knowledge acquired in the basic course of physical chemistry in the second stage of studies, especially, in those areas of physical chemistry that have the greatest importance, use and application in the field of materials research focused on non-metallic inorganic materials and glasses and the technology of their preparation and production.	22	0/30	**Dr.h.c. prof. Ing. Marek Liška, DrSc., doc. Ing. Róbert Klement, PhD.,** doc. Dr. Amirhossein Pakseresht, Mgr. Martin Blaško, PhD.	Compulsory	Not necessary for this module	2	Compulsory attendance at lectures/ consultations Final oral examination (100 %)
Atom structure and chemical bond theory	**Content:** • Getting familiar with different models of the structure of the atom.	8	7/30	Ing. Anna Prnová, PhD., Ing. Branislav Hruška, PhD.,	Compulsory	Not necessary for this module	2	Compulsory attendance at lectures and seminars.

	• Understanding and mastering the relationships between electron structure of elements, their properties and position in the Periodic table of elements (PT). • Properties, significance, and use of selected elements. • Understanding the principles of chemical bonding. molecular orbitals, fundamentals of quantum chemistry. **Learning Outcomes:** Graduate: • Masters the theory of atomic structure, can describe individual models, acquires the basics of the theory of molecular orbitals, learns the basics and principles of quantum chemistry. • Is able to predict properties of individual atoms, position in the PT, oxidation numbers they can acquire, atomic radii, electronegativity, types of bonds, the shape of the molecules they form and types of hybridization in the resulting molecules based on their electron structure (configuration).			**doc. Ing. Mária Chromčíková, PhD.**				Final written examination (60 %) Seminar paper 40 %)
Chemistry, thermochemistry and chemical kinetics	**Content:** • basic concepts in thermochemistry, • division of chemical reactions, thermochemical laws, and calculations of reaction heat, • basics of chemical kinetics, division of chemical reactions from the kinetic point of view, collision theory, activated complex theory, calculations of equilibrium constants, simple calculations of chemical reaction rates. **Learning Outcomes:** Graduate: • Gains the basic concepts used in thermochemistry. • Can calculate the reaction heat, determine the type of reaction based on the calculation of the reaction heat. • Knows the basics of chemical kinetics, masters simple calculations of chemical reaction rates and equilibrium constants of simple reactions.	6	8/30	Ing. Anna Prnová, PhD., Ing. Jana Valúchová, PhD., **doc. Ing. Mária Chromčíková, PhD.**	Compulsory	Physical Chemistry; Atom structure and chemical bond theory	2	Compulsory attendance at lectures and seminars. Final written exam (60 %) Seminar paper 40 %)
Types of chemical reactions and chemistry of selected chemical compounds	**Content:** • introduction to basic types of chemical reactions, • determination of stoichiometric coefficients of chemical reactions, • understanding the principles of calculations from chemical reactions, • information about the properties, importance, and use of selected chemical compounds (oxides, silicates, aluminosilicates, carbonates, nitrates, sulfates, chlorides) that are important in the preparation of glass and ceramic materials. **Learning Outcomes:**	10	6/30	Ing. Anna Prnová, PhD., Ing. Jana Valúchová, PhD., **doc. Ing. Mária Chromčíková, PhD.**	Compulsory	Atom structure and chemical bond theory; Chemistry, thermochemistry and chemical kinetics	2	Compulsory attendance at lectures and seminars. Final written exam (60 %) Seminar paper 40 %)

	Graduate: • Masters the principles of basic types of chemical reactions. • Can calculate concentrations, amounts of reactants and products. • Acquires basic information about the importance and use of selected chemical compounds and their use in the production of inorganic non-metallic materials, • Can apply the acquired knowledge in practice.							
Fundamentals of the technology of inorganic materials	**Content:** • aterials: natural and synthetic materials, raw materials, classification, use, structure and microstructure, • Methods and processes used in the production of inorganic non-metallic materials, • Technological steps in the preparation of materials I: synthesis, modification and characterisation of input materials, • Technological steps in the preparation of materials II: shaping, • Technological steps in the preparation of materials III: basic theory of sintering. **Learning Outcomes:** Graduate: • Has complex information and overview of the most important inorganic non-metallic materials used in common technical practice and technologies of their production and preparation. • Knows the latest trends in the field of research and development of advanced inorganic non-metallic materials, the ways, scope and limits of their use, • Knows the latest trends in their development.	12	0/30	**prof. Ing. Dušan Galusek, DrSc.**	Compulsory	Not necessary for this module	2	Oral exam (60 %) Essay on a selected topic related to the dissertation thesis (40%)
Engineering ceramics: classification and properties	**Content:** • definition and classification of ceramics, • properties of traditional ceramics, • properties of oxide ceramics, • properties of non-oxide ceramics, • non-crystalline ceramics. **Learning Outcomes:** Graduate: • Knows how to classify ceramic materials into appropriate classes and select the appropriate material on the basis of the required properties. • Understands how individual groups of ceramic materials differ in their properties. • Is able to design suitable material on the basis of required properties.	12	0/20	Dr. Ali Talimian, **prof. Ing. Dušan Galusek, DrSc.**	Compulsory Optional	Fundamentals of the technology of inorganic materials	1	Oral exam (100 %)

Mechanical properties of materials	**Content:** • elastic and plastic deformation, • brittle fracture and linear elastic fracture mechanics, • statistics and types of defects, • time/temperature dependent materials failure: fatigue/creep, • mechanical properties and their classification, • problem-based learning (PBL): solving practical problems related to the dissertation thesis. **Learning Outcomes:** Graduate knows the fundamentals and can perform: • stress/strain analysis in (simple) structures, • statistical analysis of strength, • design a material with required mechanical properties.	8	24/30	Dr. Ali Talimian	Compulsory Optional	Fundamentals of the technology of inorganic materials	3	Written exam (40 %) PBL protocol (60%)
Experimental mechanics	**Content:** • methods of testing of mechanical properties, • elastic properties and fracture toughness, • indentation fracture mechanics, • strength of brittle materials (bending strength), • techniques for measuring residual stresses. **Learning Outcomes:** • Graduate knows the fundamentals and can perform: • measurement of strength of brittle materials with simple geometry, • analysis of strength measurement of materials, • indentation measurements, • fractographic analysis of brittle materials.	0	24/30	Dr. Ali Talimian	Compulsory Optional	Fundamentals of the technology of inorganic materials; Mechanical properties of materials	2	Practical test of acquired skills (50 %) Protocol of the test (50 %)
Functional properties of materials and methods of their measurement	**Content:** • structure and properties of materials, • thermal properties, • electrical conductivity and dielectric properties, • optical properties, • selected magnetic properties. **Learning Outcomes:** Graduate: • Understands the relationships between the structure and properties of functional non-metallic inorganic materials. • Can identify functional materials and knows their application in real life. • Knows how to select the correct measurement method with respect to the properties to be measured. • Selects/designs ceramics/glass based on the latest/ real life requirements/ trends.	24	0/30	Dr. Ali Talimian, **doc. Ing. Róbert Klement, PhD.**	Compulsory Optional	Fundamentals of the technology of inorganic materials	2	Oral exam (100 %)
Biomaterials: Introduction	**Content:** • introduction to the materials used in medicine	7	0/20	RNDr. Zuzana Neščáková, PhD.,	Compulsory Optional	Fundamentals of the technology of	1	Compulsory attendance at

	• history of biomaterials, types of biomaterials, properties of biomaterials, • classes of materials used in medicine • glass, glass-ceramics and ceramics, polymers, metals, composites, • concept of bioactivity and bioactive materials introduction and history of bioactive glasses, basic principles, criteria for designing biomaterials, • interactions of biomaterials with host cells. **Learning Outcomes:** Graduate: • Has a basic overview of different types of materials suitable for medical use. • Understands the definition and knows the key properties of biomaterials. • Understands the concept of bioactivity, knows the basic principles and criteria for designing modern biomaterials. • Understands the basic interactions between applied biomaterials and cells of the host organism.			Ing. Martin Michálek, PhD.		inorganic materials		lectures (max. 2 absences) Final test (min. 75% success)
Biomaterials: Preparation, characterization and use	**Content:** • Introduction to preparation of biomaterials- preparation and properties of materials prepared by various techniques: from the melting method to the sol-gel method, production: from micro to nano (matrices, coatings, fibers, nanoparticles). • Influence of composition on properties and applications of biomaterials - structure, therapeutic ion release, influence of various dopants. • Introduction to biological testing of biomaterials. • Degradation of biomaterials in the biological environment - Chemical and biochemical degradation of biomaterials. • Introduction to medical applications of biomaterials- application potential in the tissue engineering - targeted drug delivery / growth factors, applications in bone and tooth regeneration. **Learning Outcomes:** Graduate: • Understands the relationship between the composition and properties of biomaterials. • Is able to select and use a suitable method of preparation of biomaterials and reflect the application requirements. • Has an overview of basic methods of biological testing of biomaterials. • Can choose a proper testing method with respect to the monitored properties and the intended application.	12	0/20	RNDr. Zuzana Neščáková, PhD., Ing. Martin Michálek, PhD.	Compulsory Optional	Fundamentals of the technology of inorganic materials; Biomaterials: Introduction	1	Compulsory attendance at lectures (max. 2 absences) Final test (min. 75% success)

	• Understands the principles of degradation in the biological environment. • Is acquainted with the possibilities of potential use of biomaterials in medicine, with the principles of tissue engineering, regenerative medicine and the therapy associated with their use.							
Coatings and thin films: preparation of characterization	**Content:** • Principles and methods of coating and thin film coating (thermal spray, chemical vapor deposition (CVD), physical vapor deposition (PVD), sol-gel). • Advantages and disadvantages of individual methods. • Overview and principles of analytical techniques used to characterize surfaces and coatings/ thin films. **Learning Outcomes:** Graduate: • understands the concept of surface engineering and its use in science and technology, • can use them as a basis for selecting suitable technologies used in the preparation of coatings / thin films, • is able to work in various areas of surface engineering in connection with surface treatment and surface treatment processes, surface analysis, parameters of surface adjustment processes and their relationship to the final properties of coatings / thin films.	10	10/30	doc. Dr. Amirhossein Pakseresht, Dr. Omid Sharifahmadian, Ing. Milan Parchoviansk ý, PhD.	Compulsory Optional	Physical Chemistry; Fundamentals of the technology of inorganic materials	2	Compulsory attendance at lectures (max. 2 absences) Final oral exam (100 %)