Module	Content	Duration/hours per semester		Teacher	Compulsory/ Compulsory Optional Subject	Prerequisites	Number of credits	Conditions for passing
		Lectures	Practice/Self-study+ CO					
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	3/15	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	0/28	**Róbert Klement, PhD., doc. Amirhossein Pakseresht, PhD.**	Compulsory	Not necessary for this module	2	Compulsory attendance at lectures/ consultations Final oral examination (100 %)

Inorganic Chemistry	**Content:** • Atom structure and chemical bond theory • Fundamentals of chemistry, thermochemistry and chemical kinetics • Fundamentals of quantum chemistry • Types of chemical reactions • Chemistry of selected chemical compounds • Chemistry in preparation and prediction of new kind of glasses, ceramics and glass ceramic materials **Learning Outcomes:** Graduate: • 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). • 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. • 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 prediction and production of inorganic non-metallic materials.	24	21/105	Ing. Anna Prnová, PhD., Ing. Branislav Hruška, PhD., **doc. Ing. Mária Chromčíková, PhD.,** Dr. Diana Carolina Lago, Dr. Avnee Chahuan	Compulsory	Not necessary for this module	6	Compulsory attendance at lectures and seminars. Final written examination (60 %) Essay on a selected topic related to the dissertation thesis (40%)
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:	12	0/38	**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%)

	• 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.							
Engineering ceramics: classification and properties	**Content:** • Oxide and non-oxide ceramics: structures, defects, and functional/structural properties • Microstructure formation: powders, processing routes, sintering, and densification • Structural–functional properties (mechanical, thermal, dielectric, magnetic, and optical behavior) • AI-supported approaches for developing engineering ceramics (literature mining, microstructure recognition, and property prediction) **Learning Outcomes:** Graduate: • Knows how to classify ceramic materials into appropriate classes and select the appropriate material on the basis of the required properties. • Can analyze microstructure and defect chemistry using advanced characterization methods • Can apply AI tools to design or optimize ceramic materials for advanced engineering applications	8	0/17	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 & plastic deformation; Brittle fracture & LEFM • Time/temperature-dependent failure • Advanced mechanics of ceramics and glass: • AI/ML for brittle materials mechanics **Learning Outcomes:** Graduate knows the fundamentals and can: • Analyze stress/strain and use LEFM/EPFM • Quantify statistical strength and interpret mechanical properties • Explain advanced mechanisms in ceramics/ glasses (TT, TRIP, SME, dislocation plasticity) • Use AI/ML tools and design a material or component that meets mechanical requirements	24	24/27	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	24/26	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–property relationships in functional inorganic materials: • Thermal properties & measurement: • Electrical & dielectric properties • Optical properties • Magnetic properties of selected functional ceramics • AI for analysing the functional properties of materials and developing functional materials **Learning Outcomes:** Graduate: • Explain and model structure–property relationships • **Identify and evaluate functional materials** • Select and justify measurement techniques • Design or select functional ceramics/glasses	8	0/42	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 • 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.	7	0/18	RNDr. Zuzana Neščáková, PhD., Ing. Martin Michálek, PhD.	Compulsory Optional	Fundamentals of the technology of inorganic materials	1	Compulsory attendance at lectures (max. 1 absence) Final test (min. 75% success)

	• 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.							
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. Cell Culture Basic – Hands on training – 3 hours Introduction to Aseptic work (Aseptic work area, Cell culture hood, Cell culture hood layout, Incubator) • Aseptic Technique (Sterile work area, Sterile media and reagents, Sterile handling) • Cell culture basic (cell lines, cell environment) • Cell culture method (maintaining cultured cells, thawing cell, subcultere cells, freezing cells) **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. • 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.	12	3/10	RNDr. Zuzana Neščáková, PhD., Mgr. Martina Vitázková, PhD.	Compulsory Optional	Fundamentals of the technology of inorganic materials; Biomaterials: Introduction	1	Compulsory attendance at lectures (max. 1 absence) Final test (min. 75% success)

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, Dr. Ashokraja Chandrasekar, Dr. Kamalan Mosas	Compulsory Optional	Physical Chemistry; Fundamentals of the technology of inorganic materials	2	Compulsory attendance at lectures (max. 2 absences) Final written examination (70 %) Essay/ Presentation 30 %)