Module	Content	Duration/hours		Teacher	Compul-sory/ Compulsory Optional Subject	Prerequisites	Number of credits	Conditions for passing
		Lectures	Practice/ Self-study					
History of glass production, properties of glass and glass-forming melts	**Content:** • brief introduction to the history of glass production, • glass structure, crystallization, and phase separation, • properties of glass and glass-forming melts: o viscosity, o density, o surface tension, o thermal properties, o mechanical properties, o electrical properties, o optical properties, o chemical resistance, o influence of composition on glass properties. **Learning Outcomes:** Graduate: • Has theoretical knowledge in the history of glass production. • Understands the structure of glass. • Knows the most important properties of glass and glass-forming melts.	12	0/40	Ing. Jozef Kraxner, PhD., Dr. Arish Dasan, Dr. Akansha Mehta, Mokhtar Mahmoud, MSc., Dr. Diana Carolina Lago	Compulsory	Fundamentals of the technology of inorganic materials	2	Passing the final knowledge test (100 %, achieved min. score 75%)
Glass production technology	**Content:** **Theoretical part:** • basic raw materials for glass production, types of glass, special glasses, • melting and shaping, • furnace technology, • refractory materials, • defects in glass, • additive manufacturing-3D printing. **Practical part:** • calculation and preparation of a glass batch, • melting of glass in laboratory conditions, • preparation of glass microspheres, • preparation of 3D glass structures using additive manufacturing technology, • glass surface treatment by ion exchange. **Learning Outcomes:** Graduate: • Has theoretical and practical knowledge on glass production technology. • Recognizes the main types of industrially produced and special types of glass.	15	20/30	Ing. Jozef Kraxner, PhD., Dr. Arish Dasan, Dr. Akansha Mehta, Mokhtar Mahmoud, MSc., Dr. Diana Carolina Lago	Compulsory Optional	History of glass production, properties of glass and glass-forming melt	3	Passing the final knowledge test (60 %, achieved min. score 75%) Protocol from practical exercise (40 %)

	• Gains practical skills in the preparation of glass by melting, and preparation of glass microspheres by flame synthesis. • Masters the fundamentals of preparation of 3D structures using additive manufacturing technologies. • Masters the fundamentals of glass surface treatment by ion exchange in the laboratory.							
Sintering	**Content:** • Types of sintering, driving force of sintering, diffusion, defects and chemistry of defects. • Sintering mechanisms I: solid phase sintering, liquid phase sintering, grain growth. • Sintering mechanisms II: Viscous flow sintering and crystallization. • Assisted sintering: Pressure, Electric field, Cold sintering. • Practical application of sintering techniques (PBL). **Learning Outcomes:** Graduate: • Understands the principles and can choose suitable sintering method. • Understands the mechanisms of sintering and the influence of sintering conditions. • Can analyze the results of a simple sintering experiment.	8	24/30	Dr. Ali Talimian, Dr. Monika Michálková	Compulsory Optional	Physical Chemistry; Thermal analysis I; Fundamentals of the technology of inorganic materials	3	Oral exam (40 %) PBL protocol (60%)
Excursion	**Content:** • Completing an excursion in a company operating in the field of glass production and processing, e.g.: RONA a.s., Lednické Rovne. **Learning Outcomes:** Graduate: • Expands his/her theoretical knowledge with a practical demonstration of glass production and processing in a glass company.	0	8/0	Ing. Jozef Kraxner, PhD., Dr. Arish Dasan, Dr. Akansha Mehta, Mokhtar Mahmoud, MSc., Dr. Diana Carolina Lago	Compulsory Optional	Not necessary for this module	1	Attendance (100 %)
Nanomaterials for anti-corrosion coatings	**Content:** • methods and ways of corrosion protection, • highly effective coatings, • hybrid nanocomposites: optimization to achieve a highly crosslinked structure, • Sol-gel coatings, • overview of multifunctional coatings. **Learning Outcomes:** Graduate: • Is able to interpret basic electrochemical data. • Is competent to compare the effectiveness of various anti-corrosion coatings.	4	6/15	Ing. Milan Parchovianský, PhD.	Compulsory Optional	Fundamentals of colloidal chemistry	1	Presentation of results from practical exercises and answering the examiner's questions (60 %) Preparation of a protocol from a laboratory exercise (40 %)

	• Possesses basic knowledge of hybrid nanocomposites, their structure and methods of their synthesis. • Possesses basic knowledge on intelligent multifunctional coatings.							
Nanomaterials for biomedical applications	**Content:** Part 1. Introduction to nanomaterials and nanostructures ✓ Top-down and bottom-up approaches ✓ Classification of nanomaterials ✓ Dimensional classification of nanomaterials ✓ Types of nanomaterials based on their structure ✓ Types of nanomaterials based on their composition Part 2. Synthesis of nanomaterials (Methods - brief description) ✓ Sol-gel (explained in detail in another course) ✓ Microemulsion ✓ Hydrothermal and Solvothermal synthesis ✓ Electrospinning ✓ Others Part 3. Characterization of nanomaterials (brief description) ✓ Transmission electron microscopy (TEM) ✓ Scanning electron microscopy (SEM) ✓ Thermogravimetric analysis (TGA) ✓ Raman and infrared (IR) spectroscopy ✓ X-ray diffraction (XRD) ✓ N_2 sorption (BET) ✓ Nuclear magnetic resonance (NMR) ✓ Zeta potential ✓ Contact angle Part 4. Biological properties and characterization of nanomaterials. ✓ Bioactivity, biocompatibility, degradability ✓ Bioactive glass ✓ Intracellular signal modulation ✓ Other cellular mechanisms induced by nanomaterials ✓ Cell type specificity and sensitivity Part 5. Biomedical applications of nanomaterials ✓ Antibacterial and antimicrobial nanomaterials ✓ Drug delivery systems ✓ Hyperthermia ✓ Bioimaging ✓ Biosensors ✓ Photothermal therapy ✓ Theranostic nanoplatforms **Learning Outcomes:** Graduate: • Gains theoretical knowledge about nanomaterials.	6	30/30	Dr. Zulema Vargas Osorio, Dr. Germán A. Clavijo Mejia	Compulsory Optional	Fundamentals of the technology of inorganic materials	3	Participation in lectures and during the experimental work. Presentation of results from practical exercises and answering the examiner's questions (60 %) Preparation of a protocol from a laboratory exercise (40 %)

	• Gains theoretical knowledge about the different synthetic routes and characterization techniques for the study of nanomaterials. • Gains theoretical knowledge about the biological assessment of nanomaterials. • Gains theoretical knowledge about the biological applications of nanomaterials. • Can independently perform the synthesis of nanomaterials for a determined application.							
Nanomaterials for optical applications	**Content:** • Basic concepts: Wave optics and wave mechanics: Schrödinger and Helmholtz equations. • Overview of quantum mechanics: interactions of light and matter. • Time-dependent fault theory. • Confined light and quantum electrodynamics. • Basic concepts of nonlinear surface optics. • Nonlinear optical spectroscopy: surface conditions of semiconductors, metal quantum wells (quantum wells). • Optical properties of low-dimensional semiconductors. • Applications: Planar photonic crystals and photonic crystal optical fibers. **Learning Outcomes:** Graduate: • Gains the ability to interpret basic concepts about the optical properties of nanomaterials. • Has a basic knowledge of nonlinear optics, quantum constraints and its effect on optical properties. • Has a basic knowledge of semiconductor and photonic crystals.	6	6/30	doc. Dr. José Joaquín Velázquez García	Compulsory Optional	Fundamentals of colloidal chemistry	2	Presentation of results from practical exercises and answering the examiner's questions (60 %) Preparation of a protocol from a laboratory exercise (40 %)
Sol-gel and Surface modification of nanoparticles	**Content:** Part 1: Sol-gel • Sol-gel chemistry • Precursors for sol-gel • Definition of sol • Definition of gel • Gel point definition • Sol-gel reactions • Sol-gel mechanism • Sol-gel procedure stages • Sol-gel approaches • Parameters that affect the sol–gel mechanism • Advantages of sol–gel • Limitations and disadvantages of sol–gel Part 2: Surface modification • Introduction	6	30/30	Dr. Zulema Vargas Osorio, Dr. Si Chen	Compulsory Optional	Physical Chemistry and Types of chemical reactions and chemistry of selected chemical compounds	3	Participation in lectures and during the experimental work. Presentation of results from practical exercises and answering the examiner's questions (60 %) Preparation of a protocol from a laboratory exercise (40 %)

	✓ Covalent methods ✓ Non-covalent adsorption ✓ Others ✓ Secondary modification Part 3: Silica-based mesoporous organic-inorganic hybrid materials ✓ Surfactants ✓ Surfactants classification ✓ Micelles and CMC ✓ Micelles formation ✓ Parameters that affect micelles formation ✓ Morphological aspects of amphiphile assembly ✓ Surfactants as structure-directing agents (SDA) ✓ Advantages of solvent extraction for surfactant removal ✓ Organic-inorganic interactions: surfactant-precursor species ✓ Organically Functionalized Mesoporous Silica Phases ✓ Advantages of functionalization ✓ Postsynthetic Functionalization of Silicas ("Grafting") ✓ Co-condensation (Direct synthesis) ✓ Co-condensation (Direct synthesis)_Disadvantages ✓ Periodic Mesoporous Organosilicas (PMOs) **Learning Outcomes:** Graduate: • Gains theoretical knowledge about sol-gel and surface modification of nanoparticles. • Can independently perform the synthesis of nanoparticles using sol-gel. • Can organically modify the surface of nanoparticles to tailor their properties.							
Introduction to analytical methods	**Content:** • analytical methods used to determine the chemical composition of materials, • criteria for selection of the analytical method, • dictionary of Analytical Chemistry, • steps included in the measurement process, • steps involved in the evaluation of analytical data, • importance of sampling, • design and implementation of a sampling plan, • , • dissolution and decomposition techniques. **Learning Outcomes:** Graduate: • Gains theoretical knowledge and confidence to design his/her own criteria for selecting an appropriate analytical	4	0/40	**Ing. Dagmar Galusková, PhD.,** Ing. Hana Kaňková, PhD.	Compulsory	Atom structure and chemical bond theory	2	Attendance at lectures, passing written/or oral exam (100 %, achieved min.score 75%)

	method and to solve common scientific analytical problems. • Gains theoretical knowledge and confidence in designing a sampling plan and sample preparation procedure.							
Methods of chemical analysis: ICP OES	**Content:** • Principles of liquid sample dosing in ICP spectrometry. • Sample requirements and preparation for the measurement. • ICP OES method used in quantitative analysis of materials **Learning Outcomes:** Graduate: • Gains theoretical knowledge of ICP techniques and an overview of their possibilities in quantitative chemical analysis of materials. • Gains basic practical skills in sampling and their preparation, processing and evaluation of data using the instrumental technique ICP OES.	2	8/40	**Ing. Dagmar Galusková, PhD.,** Ing. Hana Kaňková, PhD., Ing. Lenka Buňová, PhD.	Compulsory Optional	Atom structure and chemical bond theory, Introduction to analytical methods	2	Attendance at the practical lectures, passing written/ or oral exam (60 %, achieved min. score 75%) Protocol from practical exercise - (40 %)
Methods of chemical analysis: X-ray flourescence	**Content:** • introduction: application and limitations of XRF, • XRF principles: • sample types for XRF: advantages, limitations, preferences, • sample preparation and chemical analysis of the selected sample by XRF. **Learning Outcomes:** Graduate: • Masters theoretical and basic practical knowledge of XRF instrumentation and has an overview of the possibilities of using XRF in the characterization of materials. • Gains practical and basic skills in preparation of a sample, understands the measurement. • Can process and evaluate the measured data.	2	6/30	Ing. Hana Kaňková, PhD.	Compulsory Optional	Atom structure and chemical bond theory; Introduction to analytical methods	2	Attendance at practical lectures, passing the final written exam (60 %, achieved min. score 75%) Protocol from practical exercise- (40 %)
Electron microscopy	**Content:** • introduction and overview of the use of electron microscopy methods (SEM), • electron beam and sample interactions, • image creation and resolution, • analysis and detection of X-rays, • limitations of chemical analysis using SEM / EDS / WDS. **Learning Outcomes:** Graduate: • Gains theoretical and basic practical knowledge of SEM instrumentation. • Gains an overview of the possibilities of using SEM in the characterization of materials.	4	8/15	Mgr. Peter Švančárek, PhD.	Compulsory Optional	Atom structure and chemical bond theory; Introduction to analytical methods	1	Compulsory attendance at lectures, passing the final knowledge test (60 %, achieved min. score 75%) Protocol from practical exercise - sample preparation and analysis (40 %)

	• Has basic practical skills in preparation of a sample, making measurements and processing the data.							
X-ray powder diffraction	**Content:** • principles of X-ray powder diffraction, • interaction of X-rays with matter, • diffraction and scattering, • X-ray experiment design (Bragg-Brentano, SAXS, WAXS), • phase composition identification, texture analysis and degree of crystallinity, • sample preparation, sample measurement, data evaluation. **Learning Outcomes:** Graduate: • understands the basic principles and theory of powder X-ray diffraction, • understands the role of optics in the path of the primary and diffracted beam, • can independently prepare a sample for measurement, • independently controls the basic functions of the X-ray powder diffractometer, • can perform independently a measurement at room temperature, • can evaluate data (phase identification and determination of qualitative and semi-quantitative phase composition of an unknown sample).	2	8/15	Mgr. Michal Žitňan, PhD., **prof. Ing. Dušan Galusek, DrSc.**	Compulsory Optional	Atom structure and chemical bond theory; Introduction to analytical methods	1	Compulsory attendance at lectures, passing the final knowledge test (60 %, achieved min. score 75%) Protocol from practical exercise - sample preparation and analysis (40 %)
Thermal analysis I	**Content:** • principles and methods of thermal analysis (DTA, DSC, TG, TMA), • thermal phenomena, • instrumentation, • familiarization with instrumentation, health and safety, • basic requirements for measured samples in terms of accuracy of analysis, • the importance and support of the accuracy of measurements using XRD, PSA, HT XRD, SEM a SEM EDX analysis, • crushing, sieving, washing of samples, drying, weighing, • basic requirements for measurement settings to obtain relevant data, • work with software for measuring and evaluating data, defining programs for calibrations, corrections and simple measurements of samples,	6	19/20	Ing. Anna Prnová, PhD., Ing. Monika Michálková, PhD., Ing. Beata Pecušová, PhD., **doc. Ing. Mária Chromčíková, PhD.**	Compulsory Optional	Physical Chemistry; Fundamentals of the technology of inorganic materials	2	Compulsory participation in lectures / seminars / laboratory exercises, Final test (weight 60%, achieved min. score 75%) Laboratory exercise protocol (weight 40%)

	• work with software for measuring and evaluating data, defining programs for basic analysis of model glasses and amorphous solids using DTA, DSC, TMA and TG, • data evaluation and interpretation, • evaluation of TMA and TG curves, weight loss, • evaluation of DSC and DTA curves (determination of basic parameters describing thermal effects), processing of measured data for publication. **Learning Outcomes:** Graduate: • Gains basic information and skills in the field of thermal analysis of glasses and amorphous materials. • Can plan analysis, evaluate measured data.							
Thermal analysis II.	**Content:** • Methods of obtaining relevant data for the study of crystallization kinetics. • Control and data processing for model calculations. • Calculations of kinetic data for model glasses, work with the software Kinpar (Netzsch). **Learning Outcomes:** Graduate: • Gains knowledge and skills in planning analyzes and evaluating measured data for the study of crystallization kinetics of glass. • Knows the criteria for selecting a suitable method for calculating the kinetic parameters of crystallization. • Can correctly determine the kinetic parameter of crystallization such as apparent activation energy, frequency factor, Avrami coefficient. • Masters the JMAK method for assessing the crystallization behavior of glasses.	2	8/30	Ing. Anna Prnová, PhD., **doc. Ing. Mária Chromčíková, PhD.**	Compulsory Optional	Thermal analysis I; Physical Chemistry; Fundamentals of the technology of inorganic materials	2	Compulsory participation in lectures / seminars / laboratory exercises, Final test (weight 60%, achieved min. score 75%) Laboratory exercise protocol (weight 40%)
Thermodynamics of electrochemical systems	**Content:** • electrolysis and Faraday's law, • thermodynamics of galvanic cells, • Nernst's equation, • basics of electrochemical corrosion. **Learning Outcomes:** Graduate: • Can identify cathodic and anodic reactions and calculate a mass transfer. • Can identify galvanic pair and predict the extent of corrosion. • Has a basic knowledge of thermodynamic equilibrium (electromotive force of the cell). • Has practical knowledge of electrode polarization and differential air corrosion.	8	5/15	TBA	Compulsory Optional	Physical Chemistry; Fundamentals of the technology of inorganic materials	1	Laboratory exercise protocol (weight 100 %)

Fundamentals of mathematical statistics	**Content:** • basic types of data and their properties, • verification of data distribution and normality, • basic descriptive data statistics, • null hypothesis, level of significance, level of probability. **Learning Outcomes:** Graduate: • Can independently assess the nature of the data during the design of the experiment. • Knows the methods of basic statistical data processing. • Has practical skills in verifying the nature of the measured data. • Has basic skills in using online statistical applets. • Has a basic knowledge of the interpretation of measured data.	12	12/30	RNDr. Vladimír Meluš, PhD. MPH	Compulsory	Not necessary for this module	2	Exam **- online e-test** (weight 100 %)
Mathematical statistics: practical application	**Content:** • parametric and non-parametric tests, • categorial data, contingency tables, • regression and correlation, • confidence intervals, interpretation of results. **Learning Outcomes:** Graduate: • Can independently select and use a specific statistical tests. • Can correctly process graphic attachments (tables, box graphs). • Has advanced skills in using online statistical applications. • Can independently interpret the data, taking into account the nature of the phenomenon under study.	12	12/30	RNDr. Vladimír Meluš, PhD. MPH	Compulsory Optional	Fundamentals of mathematical statistics	2	Exam **- online e-test** (weight 100 %)
Mathematical statistics: case studies	**Content:** • design of experiment in terms of requirements of a statistical test, • multidimensional statistical methods, • the difference between mathematical-statistical significance and significance in terms of the actual benefit of the tested parameter. **Learning Outcomes:** Graduate: • Can independently apply statistical methods in solving scientific problems and specific tasks in solving his dissertation. • Can independently interpret the results of experimental work in a broader context. • Can assess the adequacy of statistical analysis in other scientific published works and compare them with his/her own results.	12	12/30	RNDr. Vladimír Meluš, PhD. MPH	Compulsory Optional	Fundamentals of mathematical statistics	2	Exam **- online e-test** (weight 100 %)

Fundamentals of computational chemistry	**Content:** • introduction to computer simulations and their application in chemistry, • bases of atomic functions in MO-LCAO, • introduction to the method of density functional theory (DFT), • quantum - chemical simulations of the properties of atoms and molecules. **Learning Outcomes:** Graduate: • knows how to use quantum - chemical simulations in practice, • acquires basic knowledge for working with quantum - chemical programs, • has the basic knowledge necessary for creating utilities (scripts).	8	16/30	Dr.h.c. prof. Ing. Marek Liška, DrSc., **doc. Ing. Róbert Klement, PhD., doc. Amirhossein Pakseresht, PhD.**	Compulsory Optional	Physical Chemistry	2	• Test (weight 100%, achieved min.score 75%)
Fundamentals of colloidal chemistry	**Content:** • Basic definitions and terms from colloidal chemistry and surface chemistry (colloid classification, intermolecular forces, interaction forces in colloidal systems, phase transitions and phase structure). • Liquid-gas and liquid-liquid interfaces and monolayers. Classification and significance of mono- and polylayers. • Thermodynamics of adsorption at gas-solid phase and liquid-solid phase interfaces. Adsorption in several layers, in porous solids, on the surface of crystals, Langmuir-Blogett film. • General characteristics of colloidal systems. • Surface of very small particles. • Charged surfaces. Coagulation and flocculation kinetics. • Emulsions: preparation, emulsification kinetics, stability, concentrated emulsions, multicomponent emulsions. • Suspensions: types, stabilization, effect of additives. • Aerosols: liquid aerosols, theory of droplet formation, formation of liquid aerosols by condensation, solid aerosols, decomposition of aerosols. • Gels: types, structure, properties, applications. • Gel casting: principles, polymerization of monomers, factors influencing polymerization. • Simulation of colloidal systems in thermodynamic equilibrium: general characteristics of simulation methods, MonteCarlo method, molecular dynamics, Brown molecular dynamics. **Learning Outcomes:** Graduate: • has basic knowledge in the field of colloidal chemistry,	12	8/30	doc.Dr. José Joaquín Velázquez García, **doc. Ing. Róbert Klement, PhD.,** Dr. Ali Najafzadeh,	Compulsory Optional	Physical Chemistry	2	Active participation in lectures. • Test (Weight 60%, achieved min. score 75%) • Elaboration of a thematic essay with a search of journal literature in the range of 15-20 pages on a topic related to the topic of the dissertation thesis, including a discussion of the results obtained in the exercise (weight 40%)

	• has the ability to independently perform synthesis of materials in different types of colloidal systems: emulsions, aerosols and gels, • can independently assess the adequacy of simulation methods for the investigated colloidal systems.							
Collodial systems: characterization and utilization	**Content:** • rheological properties of dispersion systems - viscosity, non-Newtonian fluids, • optical properties of dispersion systems - light scattering: Rayleigh theory, Mie's theory, • electrical properties of dispersion systems - electrical bilayer, electrokinetic phenomena, electrocapillary phenomena. • determination of ζ-potential. • viscoelectric effect, • other characterization techniques: microscopy, spectroscopy, calorimetry, • technological applications of solubilization phenomena in colloidal systems, • applications of dispersion systems in processes of nanomaterial synthesis, • analytical applications of colloidal systems, • sensors. **Learning Outcomes:** Graduate: • Has a basic knowledge of techniques for characterizing colloidal systems. • Can work independently in the laboratory and can independently interpret the results of experimental work in the broader context of colloidal systems. • Can select appropriate characterization techniques and use them in the characterization of colloidal systems. • Can compare and develop colloidal systems for specific applications.	8	10/30	doc. Dr. José Joaquín Velázquez García, **doc. Ing. Róbert Klement, PhD.,** Dr. Ali Najafzadeh, Dr. Ali Talimian	Compulsory Optional	Physical Chemistry Fundamentals of colloidal chemistry	2	Active participation in lectures. • Test (Weight 60%, achieved min. score 75%) • Elaboration of a thematic essay with a search of journal literature in the range of 15-20 pages on a topic related to the topic of the dissertation thesis, including a discussion of the results obtained in the exercise (weight 40%)
Theoretical principles of molecular spectroscopy	**Content:** • basic terms and definitions, • theoretical principles of molecular spectroscopy and instrumentation. **Learning Outcomes:** Graduate: • Masters the basic concepts and theoretical principles of molecular spectroscopy methods. • Understands the principles and understands the way electromagnetic radiation interacts with matter.	15	0/40	**doc. Ing. Róbert Klement, PhD.,**	Compulsory	Physical Chemistry	2	• Compulsory participation in lectures. • Test (weight 60%, achieved score min. 75%) • Essay on selected topic related to the dissertation thesis (weight 40%)

UV-vis-NIR spectroscopy	**Content:** Theoretical part: • basic terms and definitions, units, • lambert-Beer law and its application, • KM function, Tauc graph, electron transitions in organic molecules, RE and TM ions, • the probability of spectral transitions and the relationship to the intensity of absorption, • selection rules, Frank-Condon principle, influence of solvent / matrix on the displacement and intensity of absorption bands, • instrumentation (transmittance and diffuse reflection), • basic calculations. Practical part: • Instrumentation and acquisition of spectra (solutions, solid samples) in transmission and diffusion reflectance. • Spectrophotometry- spectrophotometric measurement of chemical reaction kinetics. • Experimental data processing and interpretation. **Learning Outcomes:** Graduate: • masters the basic principles of UV-vis-NIR spectrometry, • masters the appropriate experimental technique, • can independently measure, evaluate and interpret results.	10	15/30	**doc. Ing. Róbert Klement, PhD.,** Mgr. Michal Žitňan, PhD.	Compulsory Optional	Theoretical principles of molecular spectroscopy	2	• Compulsory participation in lectures. • Test (weight 80%, achieved min. score 75%) • Practical demonstration of the use of the method (weight 20%)
Photoluminescence spectroscopy	**Content:** Theoretical part: • basic terms and definitions, units, • theoretical foundations of fluorescence spectroscopy (Jablonsky diagram and photochemical / photophysical processes in matter, PL transitions in TM and RE ions, selection rules, luminescence quenching mechanisms, lifetime, quantum yield), • instrumentation (steady state and time-resolved PL spectroscopy). Practical part: • instrumentation and acquisition of spectra (solutions, solid samples) - excitation and emission spectra, • instrumentation and measurement of quenching time (solutions, solid samples), • quantum yield measurement, • experimental processing and interpretation of data. **Learning Outcomes:** Graduate: • Masters the basic principles of photoluminescence spectroscopy. • Masters the appropriate experimental technique.	10	20/40	**doc. Ing. Róbert Klement, PhD.,** Mgr. Michal Žitňan, PhD.	Compulsory Optional	Theoretical principles of molecular spectroscopy	3	Compulsory participation in lectures. • Test (weight 80%, achieved min. score 75%) • Practical demonstration of the use of the method (weight 20%)

	• Can independently measure, evaluate and interpret results							
Infrared and Raman spectroscopy	**Content:** Teoretical part: • basic terms and definitions, units, theoretical foundations of vibrational spectroscopy (rotational, vibrational and vibrational-rotational spectra), • instrumentation (IR and Raman spectroscopy), Practical part: • IR spectrum measurement (various techniques, e.g.KBr, ATR), • measurement of Raman spectra, • experimental data processing and interpretation. **Learning Outcomes:** Graduate: • Masters the basic principles of infrared and Raman spectroscopy. • Masters the appropriate experimental techniques. • Can independently measure, evaluate and interpret results.	10	10/30	Dr.h.c. prof. Ing. Marek Liška, DrSc., Ing. Branislav Hruška, PhD., doc. Dr. José Joaquín Velázquez García, **doc. Amirhossein Pakseresht, PhD.**	Compulsory Optional	Theoretical principles of molecular spectroscopy	2	• Consultations and test (weight 50%, achieved min. score 30%) Seminar paper (weight 20%)• Practical demonstration of the use of the method (weight 30%)
Solid phase NMR spectroscopy	**Content:** • basic terms and definitions, units, • theoretical foundations of NMR spectroscopy and its applicability in materials research: chemical shift, spectral line / band and its width, • spectrum vs. structural motives, • examples of NMR spectra of glasses and polycrystalline materials, • data processing. **Learning Outcomes:** Graduate: • masters the basic principles of NMR spectroscopy, • knows the scope of application of the method and can apply it to solve tasks related to the topic of his dissertation thesis.	10	0/15	TBA	Compulsory Optional	Theoretical principles of molecular spectroscopy	1	• Active participation in lectures. • Test (weight 100%, achieved min. score 75%)
XPS: X-ray phosphoelectron spectroscopy	**Content:** • theoretical foundations of XPS and instrumentation, • sample preparation, • possibilities and limits of the technique in advanced materials research. **Learning Outcomes:** Graduate: • masters the basic principles of XPS, • knows the scope of application of the method and can apply it to solve tasks related to the topic of his dissertation.	10	0/15	Dr. Kamalan Kirubaharan, Dr. Ashokraja Chandrasekar, Dr. Omid Sharifahmadian	Compulsory Optional	Theoretical principles of molecular spectroscopy	1	• Active participation in lectures. • Test (weight 100%, achieved min. score 75%)