<table>
<tr><th rowspan="2">Module</th><th rowspan="2">Content</th><th colspan="2">Duration/hours per semester</th><th rowspan="2">Teacher</th><th rowspan="2">Compul-sory/ Compulsory Optional Subject</th><th rowspan="2">Prerequisites</th><th rowspan="2">Number of credits</th><th rowspan="2">Conditions for passing</th></tr>
<tr><th>Lectures</th><th>Practice/ Self-study+ CO</th></tr>
<tr><td>History of glass production, properties of glass and glass-forming melts</td><td>Content:
• brief introduction to the history of glass production,
• glass structure, crystallization, and phase separation,
• properties of glass and glass-forming melts:
○ viscosity,
○ density,
○ surface tension,
○ thermal properties,
○ mechanical properties,
○ electrical properties,
○ optical properties,
○ chemical resistance,
○ 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.</td><td>12</td><td>0/38</td><td>Ing. Jozef Kraxner, PhD., Dr.Mokhtar Mahmoud, Dr. Diana Carolina Lago, Dr. Mai Truong, Dr. Ahmed Gamal, Dr. Abel Ourgessa</td><td>Compulsory</td><td>Fundamentals of the technology of inorganic materials</td><td>2</td><td>Passing the final knowledge test (100 %, achieved min. score 75%)</td></tr>
<tr><td>Glass production technology</td><td>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.</td><td>15</td><td>20/40</td><td>Ing. Jozef Kraxner, PhD., Mokhtar Mahmoud, MSc., Dr. Diana Carolina Lago, Dr. Ahmed Gamal, Dr. Abel Ourgessa, Dr. Mai Truong</td><td>Compulsory Optional</td><td>History of glass production, properties of glass and glass-forming melts</td><td>3</td><td>Passing the final knowledge test (60 %, achieved min. score 75%) Protocol from practical exercise (40 %)</td></tr>
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	• Recognizes the main types of industrially produced and special types of glass. • 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:** • Sintering fundamentals • Solid-State Sintering & Microstructure Evolution • Viscous-Flow Sintering • Liquid-phase Sintering • Classification of Sintering Methods • Practical Measurement & Characterization Methods • Thermodynamic approach • Modelling, Simulation & AI in Sintering **Learning Outcomes:** Graduate: • Explain and analyse sintering mechanisms • Conduct and interpret sintering experiments • Select appropriate sintering routes • Apply computational and AI/ML approaches	10	30/35	Prof. Karel Maca, Dr. Ali Talimian, Dr. Monika Michálková	Compulsory Optional	Physical Chemistry; Thermal analysis I; Fundamentals of the technology of inorganic materials	3	Oral/written exam (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. • Possesses basic knowledge of hybrid nanocomposites, their structure and methods of their synthesis. • Possesses basic knowledge on intelligent multifunctional 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 %)
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	6	30/39	Dr. Zulema Vargas Osorio, Dr. Germán A. Clavijo Mejia Onat Basak	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

	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. 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. • 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.							answering the examiner's questions (60 %) Preparation of a protocol from a laboratory exercise (40 %)
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.	6	6/38	doc. Dr. José Joaquín Velázquez García	Compulsory Optional	Fundamentals of colloidal chemistry Theoretical principles of molecular spectroscopy	2	Presentation of results from practical exercises and answering the examiner's questions (60 %) Preparation of a protocol from a laboratory exercise

	• 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.							(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 ✓ 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	6	30/39	Dr. Zulema Vargas Osorio, Dr. Si Chen	Compulsory Optional	Physical Chemistry, Inorganic chemistry	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 %)

	✓ 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 method and to solve common scientific analytical problems. • Gains theoretical knowledge and confidence in designing a sampling plan and sample preparation procedure.	4	0/46	**Ing. Dagmar Galusková, PhD.,** Ing. Hana Kaňková, PhD.	Compulsory	Inorganic chemistry	2	Attendance at lectures, passing written/or oral exam (100 %, achieved min. score 75%)
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. Hana Kaňková, PhD., **Ing. Dagmar Galusková, PhD.,** Ing. Lenka Buňová, PhD.	Compulsory Optional	Inorganic chemistry 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	**Content:** • introduction: application and limitations of XRF,	2	6/42	Ing. Hana Kaňková, PhD.	Compulsory Optional	Inorganic chemistry	2	Attendance at practical lectures,

	• 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.					Introduction to analytical methods		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. • Has basic practical skills in preparation of a sample, making measurements and processing the data.	4	8/13	Mgr. Peter Švančárek, PhD.	Compulsory Optional	Inorganic chemistry 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 %)
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,	2	8/15	Mgr. Michal Žitňan, PhD., **prof. Ing. Dušan Galusek, DrSc.**	Compulsory Optional	Inorganic chemistry 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 %)

	• 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).							
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, • 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.	6	19/25	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 (60%, achieved min. score 75%) Laboratory exercise protocol (40%)
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.	2	8/40	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 (60%, achieved min. score 75%) Laboratory exercise protocol (40%)

	• 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.							
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	5/12	Dr. Orhan Sisman	Compulsory Optional	Physical Chemistry; Fundamentals of the technology of inorganic materials	1	Laboratory exercise protocol (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	12/26	RNDr. Vladimír Meluš, PhD. MPH	Compulsory	Not necessary for this module	2	Exam - **online e-test** (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.	12	12/26	RNDr. Vladimír Meluš, PhD. MPH	Compulsory Optional	Fundamentals of mathematical statistics	2	Exam - **online e-test** (100 %)

	• 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.							
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	12/26	RNDr. Vladimír Meluš, PhD. MPH	Compulsory Optional	Fundamentals of mathematical statistics	2	Exam **- online e-test** (100 %)
Fundamentals of computational materials science	**Content:** • Introduction to Computational Materials Science • Introduction to atomistic simulations: Density Functional Theory (DFT) and Molecular Dynamics (MD) • Introduction to the Finite Element Method (FEM). • Equations of mechanics of materials (equilibrium, linear elasticity) • Failure criteria (Isotropic and anisotropic Materials) • Practical overview of FEM using ANSYS **Learning Outcomes:** • Understand the fundamental length and time scales involved in computational materials science and select appropriate modelling approaches accordingly • Communicate effectively with computational and experimental researchers using a shared technical vocabulary • Understand the fundamental principles and assumptions of FEM • Formulate basic mechanical problems using continuum mechanics • Use ANSYS at a basic level for structural and materials simulations	12	9/4	Dr. Ali Najafzadeh, Dr. Alfredo Sanchez Rossi	Compulsory Optional	Fundamentals of the technology of inorganic materials	1	• Written exam (35%) • Oral exam/ scientific discussion (25%) • Mini-projects (DFT, MD, FEM) (25%) • Participation, paper discussion, engagement (15%)

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, • 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.	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 (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 (40%)
Collodial systems: cheracterization 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,	8	10/32	doc. Dr. José Joaquín Velázquez García, **doc. Ing. Róbert Klement, PhD.,** Dr. Ali Najafzadeh,	Compulsory Optional	Physical Chemistry Fundamentals of colloidal chemistry	2	Active participation in lectures. • Test (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

	• 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.							related to the topic of the dissertation thesis, including a discussion of the results obtained in the exercise (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	0/35	doc. José Velázquez García	Compulsory	Physical Chemistry	2	• Compulsory participation in lectures. • Test (60%, achieved score min. 75%) • Essay on selected topic related to the dissertation thesis (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.	10	15/25	**doc. Ing. Róbert Klement, PhD.,** Mgr. Michal Žitňan, PhD.	Compulsory Optional	Theoretical principles of molecular spectroscopy	2	• Active participation in lectures. • Test (80%, achieved min. score 75%) • Practical demonstration of the use of the method (20%)

	• 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.							
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. • Can independently measure, evaluate and interpret results	10	20/45	**doc. Ing. Róbert Klement, PhD.,** Mgr. Michal Žitňan, PhD.	Compulsory Optional	Theoretical principles of molecular spectroscopy	3	Active participation in lectures. • Test (80%, achieved min. score 75%) • Practical demonstration of the use of the method (20%)
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.	10	10/30	Ing. Branislav Hruška, PhD., doc. Dr. José Joaquín Velázquez García**,**	Compulsory Optional	Theoretical principles of molecular spectroscopy	2	• Consultations and test (50%, achieved min. score 30%) Seminar paper (20%)• Practical demonstration of the use of the method (30%)

	• Masters the appropriate experimental techniques. • Can independently measure, evaluate and interpret results.							
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	Dr. Surjyakanta Rana	Compulsory Optional	Theoretical principles of molecular spectroscopy	1	• Active participation in lectures. • Test (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 (100%, achieved min. score 75%)